

**Non-Confidential Business Information
(Non-CBI)**

Certification Test Report

**RAIS A/S
Freestanding Wood Stove
Viva L Series**

Models: Viva 100 L (CA) USA, Viva 100 L G (CA) USA, Viva 100 L Classic (CA) USA, Viva 100 L G Classic (CA) USA, Viva 120 L (CA) USA, Viva 120 L G (CA) USA, Viva 120 L Classic (CA) USA, Viva 120 L G Classic (CA) USA, Viva 160 L (CA) USA, Viva 160 L G (CA) USA, Viva 160 L Classic (CA) USA, Viva 160 L G Classic (CA) USA

Prepared for: RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark

Prepared by: OMNI-Test Laboratories, Inc.
13327 NE Airport Way
Portland, OR 97230
(503) 643-3788

Test Period: 2/6/2017 - 2/13/2017

Report Date: April 2017


Report Number: 0138WS017E

All data and information contained in this report are confidential and proprietary to RAIS A/S. Its significance is subject to the adequacy and representative character of the samples and to the comprehensiveness of the tests, examinations, or surveys made. The contents of this report cannot be copied or quoted, except in full, without specific, written authorization from RAIS A/S and OMNI-Test Laboratories, Inc. No use of the OMNI-Test Laboratories, Inc. name, logo, or registered mark (O-TL) is permitted, except as expressly authorized by OMNI-Test Laboratories, Inc. in writing.

AUTHORIZED SIGNATORIES


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

Technician:




Aaron Kravitz
OMNI-Test Laboratories, Inc.

QA Review:



Alex Tiegs, QA Administrator
OMNI-Test Laboratories, Inc.

Evaluation Decision:



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

April 13, 2017
Issue Date

TABLE OF CONTENTS

PREFACE.....	(3 pages)
1. SAMPLING PROCEDURES AND TEST RESULTS	4
Introduction.....	5
Sampling Procedure.....	5
Summary of Results.....	5
Testing Narrative	6
<u>Summary Tables</u>	
Table 1 - Particulate Emissions Results.....	8
Table 2 - Particulate Emissions Results (First Hour).....	8
Table 3 – B415.1 Efficiency and CO Emissions	9
Table 4 - Test Facility Conditions	9
Table 5 - Fuel Measurements and Crib Descriptions - Pretest	9
Table 6 - Fuel Measurements and Crib Descriptions - Test	10
Table 7 - Dilution Tunnel Gas Measurements and Sampling Data	10
Table 8 – Average Temperature Data.....	10
Table 9 - Pretest Configurations	11
Table 10 - Test Configurations	11
2. PHOTOGRAPHS/APPLIANCE DESCRIPTION	12
Fuel Photographs	13
Appliance Description	18
3. TEST DATA BY RUN.....	21
Run 1	24
Run 2.....	33
Run 3.....	42
Run 4.....	51
Run 5.....	60
Run 6.....	69
Run 7.....	78
Run 8.....	87
4. QUALITY ASSURANCE/QUALITY CONTROL	96
Sample Analysis.....	98
Calibrations – EPA Method 28R, ASTM E2515, ASTM E2780	121
Example Calculations	140
5. LABELING & OWNER’S MANUAL.....	156

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Section 1

Sampling Procedures and Test Results

INTRODUCTION

RAIS A/S retained *OMNI* to perform U.S. Environmental Protection Agency (EPA) certification testing on the Viva L Series wood stove. The Viva L Series wood stove is a radiant-type room heater. The firebox is constructed of mild steel. Usable firebox volume was measured to be 1.29 cubic feet and the stove is vented through a 6" flue collar located at the top of the unit.

The testing was performed at *OMNI*'s facilities in Portland, OR. The altitude of the laboratory is 30 feet above sea level. The unit was received in good condition and logged in on 1/30/2017, then assigned and labeled with *OMNI* ID #2223. *OMNI* representatives Aaron Kravitz and Sebastian Button conducted the certification testing and completed all testing by 2/13/2017.

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

SAMPLING PROCEDURE

The Viva L Series wood stove was tested in accordance with the U.S. EPA 40 CFR Part 60, Subpart AAA – Standards of Performance for New Residential Wood Heaters using EPA Method 28R, ASTM E2515 and ASTM E2780. Particulate emissions were measured using sampling trains consisting of two filters (front and back).

The model Viva L Series was tested for thermal efficiency and carbon monoxide (CO) emissions in accordance with CSA B415.1-10.

SUMMARY OF RESULTS

The weighted average emissions of the four test runs included in the results indicate a particulate emission rate of 1.13 grams per hour.

Five additional test runs were conducted in Category II. ASTM E278 section 9.5.13 states:

If more than one test run is conducted at a specified burn rate, the results from at least two thirds of the test runs in that burn rate category shall be used in calculating the weighted average emission rate.

In accordance with this requirement, only four of the six (runs 3, 4, 5, and 6) Category II tests are included in the weighted average. All measurement data and results from the other two runs (runs 1 and 2) are included in this report.

The Viva L Series results are within the emission limit of 2.0 g/hr for affected facilities manufactured on or after May 15, 2020.

The proportionality results for all eight test runs were acceptable. Quality check results for each test run are presented in Section 4 of this report.

TESTING NARRATIVE

Run 1 - To achieve a fuel loading density in accordance with the requirements of ASTM E2780, using two different lengths of fuel piece was required. The fuel pieces in the rear of the firebox were 10.5" in length and the front pieces were 12.5". Targeted category I burn rate at an air setting on 14mm open. Result of 1.04 kg/hr (category II).

Run 2 - Due to poor emissions performance in run 1, run 2 was performed with the same settings and fuel sizes as a potential replacement run. Result of 0.86 kg/hr (category II).

Run 3 - During run 2 the size of the front fuel pieces, which spanned nearly 100% of the firebox length, was observed impeding combustion airflow. It was then determined that if fuel pieces very near to the 35 lb/ft³ density limit were used, loading density requirements could be met with all five fuel pieces cut to the appropriate length of 10.5". Run 3 and all subsequent runs used this test fuel piece length.

Targeted category I at air setting of 15mm open. Result of 1.11 kg/hr (category II).

Run 4 - Targeted category I at an air setting of 13mm open. Result of 0.99 kg/hr (category II).

Run 5 - Repeat of run 4. Targeted category I at an air setting of 13mm open. Result of 0.93 kg/hr (category II).

Run 6 - Repeat of run 3. Targeted category II at an air setting of 15mm open. Result of 1.06 kg/hr (category II).

Run 7 - Targeted category III at an air setting of 22mm open. Result of 1.29 kg/hr (category III).

Run 8 - Targeted category IV at primary air setting of fully open. Result of 1.73 kg/hr (category III). Since no higher air adjustment is possible, this run is considered a category IV for the purposes of reporting.

No sampling anomalies occurred during any run, and all proportionality results are acceptable, so all test runs are valid for inclusion in the weighted average.

Since the lowest air setting used was 13mm open, a fixed stop at this setting will be included in all production units. See drawing # 2728510USA for details.

CATEGORY I BURN RATE RATIONALE

EPA Method 28 section 8.1.1.3.2 states the following:

Evidence that a wood heater cannot be operated at a burn rate less than 0.80 kg/hr shall include documentation of two or more attempts to operate the wood heater in burn rate Category I and fuel combustion has stopped, or results of two or more test runs demonstrating that the burn rates were greater than 0.80 kg/hr when the air supply controls were adjusted to the lowest possible position or settings... NOTE: After July 1, 1990, if a wood heater cannot be operated at a burn rate less than 0.80 kg/hr, at least one test run with an average burn rate of 1.00 kg/hr or less shall be conducted.

The U.S. Environmental Protection Agency Applicability Determination Index, under Control Number WDS-109, states the following regarding this requirement of Method 28:

The purpose of this requirement is to ensure that a good-faith effort has been made to achieve a Category I burn rate. However, if the air supply control is tamper-proof, EPA will accept one test as adequate documentation that the stove cannot achieve a Category I burn rate. Note that this applies only to stoves which do not reach the low burn rate because of limits on the air supply; manufacturers of stoves which cannot sustain a burn rate at lower air settings will still be required to submit documentation of two or more attempts. In all cases, a test series consisting of at least four runs is required.

As the Run Notes in Section 3 and Table 10 in Section 1 of this report show, Runs 4 and 5 were operated at a burn-rate of less than 1.0 kg/hr with the combustion air inlet open an area of 0.60 cm². The primary air control was designed and manufactured with a stop that provides an area of 0.60 cm² when the control is set to the minimum position. See attached drawings of the primary air control system. The air controls for this heater are tamper-proof. When tested in accordance with EPA Method 28 the heater cannot be induced to operate at a burn rate less than 0.80 kg/hr therefore Runs 4 and 5 fulfill the requirements of the standard.

Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark

Table 1 – Particulate Emissions

Run	Burn Rate (kg/hr dry)	EPA 28R Category	ASTM E2515 Emissions (g/hr)	ASTM E2780 Weighting
1	1.04	II	17.79	0.0%*
2	0.86	II	50.60	0.0%*
3	1.11	II	1.29	12.6%
4	0.99	II	0.79	5.9%
5	0.93	II	0.99	24.1%
6	1.06	II	0.90	5.9%
7	1.29	III	0.94	25.4%
8	1.73	IV	1.51	26.0%
Weighted Average of 6 test runs:			1.13	g/hr

*Runs 1 & 2 excluded from the weighted average per the requirements of EPA Method 28R/
ASTM E2780

Table 2 – Particulate Emissions (First Hour)

Run	ASTM E2515 Emissions – First Hour (g/hr)
1	46.19
2	60.91
3	3.12
4	1.08
5	1.58
6	0.70
7	0.59
8	1.02

Table 3 – B415.1 Efficiency and CO Emissions

Run	Heat Output (BTU/hr)	HHV Efficiency (%)	LHV Efficiency (%)	CO Emissions (g/MJ Output)	CO Emissions (g/kg Dry Fuel)	CO Emissions (g/hr)
1	12,285	63.0%	68.1%	21.16	264.21	274.00
2	9,150	57.2%	61.9%	31.59	358.23	304.74
3	14,587	70.8%	76.6%	9.97	139.86	153.27
4	13,175	72.2%	78.0%	8.54	122.08	118.59
5	12,490	72.6%	78.4%	8.68	124.84	114.32
6	13,820	71.9%	77.7%	8.14	115.93	118.61
7	17,028	73.0%	78.9%	4.99	72.19	89.63
8	22,857	71.7%	77.5%	4.51	64.12	108.79
Weighted average HHV efficiency of 6 test runs: 72.2%						

Table 4 – Test Facility Conditions

Run	Room Temperature (°F)		Barometric Pressure (in. Hg)		Air Velocity (ft/min)	
	Before	After	Before	After	Before	After
1	70	71	29.72	29.79	<50	<50
2	71	71	29.89	29.89	<50	<50
3	69	67	29.83	29.77	<50	<50
4	70	70	29.51	29.50	<50	<50
5	72	71	29.53	29.61	<50	<50
6	69	72	29.96	29.99	<50	<50
7	71	71	30.02	30.09	<50	<50
8	72	71	30.29	30.24	<50	<50

Table 5 – Fuel Measurement and Crib Description Summary – PRETEST

Run	Pretest Fuel Weight (Starting weight in lbs)	Pretest Moisture (Dry basis - %)	Coal Bed Weight (lbs)
1	9.2	22.91	2.1
2	9.3	20.89	2.1
3	8.8	19.72	2.1
4	8.3	20.81	2.0
5	8.3	21.45	2.1
6	8.3	20.92	1.7
7	8.7	20.75	2.1
8	9.5	21.11	1.7

Table 6 – Fuel Measurement and Crib Description Summary – TEST

Run	Test Fuel Wet Basis (lbs)	Test Fuel Moisture (Dry basis %)	Test Fuel Dry Basis (lbs)	Fuel Loading Density (Wet Basis lbs/ft ³)	Piece Length (in)	2x4s (count)	4x4s (count)
1	8.4	22.50	6.88	6.51	10.5 & 12.5	5	0
2	8.4	22.19	6.95	6.51	10.5 & 12.5	5	0
3	8.2	19.83	6.92	6.36	10.5	5	0
4	8.2	20.95	6.92	6.36	10.5	5	0
5	8.2	21.89	6.84	6.36	10.5	5	0
6	8.3	22.69	7.01	6.43	10.5	5	0
7	8.4	22.79	7.10	6.51	10.5	5	0
8	8.3	21.07	7.00	6.43	10.5	5	0

Table 7 – Average Dilution Tunnel Gas Measurements

Run	Static Pressure	Flow Rate	Temperature
	(in. H ₂ O)	(dscf/min)	(°F)
1	-0.28	196.14	85.6
2	-0.26	200.58	82.6
3	-0.26	196.16	87.1
4	-0.27	192.06	89.9
5	-0.27	194.13	89.4
6	-0.27	190.76	91.7
7	-0.27	192.84	96.4
8	-0.27	184.87	106.7

Table 8 - Average Temperature Data

Run	Surface Delta T (F)*
1	8.2
2	64.6
3	44.0
4	56.2
5	64.6
6	56.6
7	80.2
8	42.0

*Represents the difference between beginning and ending average surface temperatures.

Table 9 – Pretest Configuration

Run	Combustion Air	Fuel Added	Fuel Removed	Time (min)
1	14 mm Open	None	None	73
2	14 mm Open	None	None	67
3	15 mm Open	None	None	83
4	13 mm Open	None	None	72
5	13 mm Open	None	None	83
6	15 mm Open	None	None	74
7	22 mm Open	None	None	68
8	Fully Open	None	None	60

Table 10 – Test Configurations

Run	Five-Minute Startup Procedures	Combustion Air Setting
1	<u>Fuel Loading:</u> Completed by 0:40 <u>Door:</u> Closed at 0:50 <u>Startup Air:</u> Closed at 4:00 <u>Primary Air:</u> Closed from fully open to test setting from 4:30 – 5:00	14 mm Open
2	<u>Fuel Loading:</u> Completed by 0:25 <u>Door:</u> Closed at 0:30 <u>Startup Air:</u> Closed at 4:30 <u>Primary Air:</u> Closed from fully open to test setting from 4:50 – 5:00	14 mm Open
3	<u>Fuel Loading:</u> Completed by 0:35 <u>Door:</u> Closed at 0:45 <u>Startup Air:</u> Closed at 4:30 <u>Primary Air:</u> Closed from fully open to test setting from 4:50 – 5:00	15 mm Open
4	<u>Fuel Loading:</u> Completed by 0:20 <u>Door:</u> Closed at 0:25 <u>Startup Air:</u> Closed at 4:30 <u>Primary Air:</u> Closed from fully open to test setting from 4:50 – 5:00	13 mm Open
5	<u>Fuel Loading:</u> Completed by 0:25 <u>Door:</u> Closed at 0:35 <u>Startup Air:</u> Closed at 4:30 <u>Primary Air:</u> Closed from fully open to test setting from 4:50 – 5:00	13 mm Open
6	<u>Fuel Loading:</u> Completed by 0:30 <u>Door:</u> Closed at 0:35 <u>Startup Air:</u> Closed at 4:30 <u>Primary Air:</u> Closed from fully open to test setting from 4:50 – 5:00	15 mm Open
7	<u>Fuel Loading:</u> Completed by 0:25 <u>Door:</u> Closed at 0:35 <u>Startup Air:</u> Closed at 4:00 <u>Primary Air:</u> Closed from fully open to test setting from 4:50 – 5:00	22 mm Open
8	<u>Fuel Loading:</u> Completed by 0:30 <u>Door:</u> Closed at 0:40 <u>Startup Air:</u> Closed at 4:00 <u>Primary Air:</u> At test setting by 4:00	Fully Open

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Section 2

Photographs/Appliance Description/Drawings

Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark

RAIS A/S
Viva L Series
Test Dates: 2/6/2017 - 2/13/2017



Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark

RAIS A/S Viva L Series

Run 1 – Fuel



Run 1 – Newly Loaded Stove



Run 2 – Fuel



Run 2 – Newly Loaded Stove



*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

RAIS A/S Viva L Series

Run 3 – Fuel



Run 3 – Newly Loaded Stove



Run 4 – Fuel



Run 4 – Newly Loaded Stove



*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

RAIS A/S Viva L Series

Run 5 – Fuel



Run 5 – Newly Loaded Stove



Run 6 – Fuel



Run 6 – Newly Loaded Stove



*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

RAIS A/S Viva L Series

Run 7 – Fuel



Run 7 – Newly Loaded Stove



Run 8 – Fuel



Run 8 – Newly Loaded Stove



Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark

WOOD HEATER DESCRIPTION

Appliance Manufacturer: RAIS A/S

Wood Stove Model: Viva L Series

Type: Freestanding, radiant-type non-catalytic woodstove

WOOD HEATER INFORMATION

Materials of Construction: The unit is constructed primarily of mild steel. The firebox is lined with formed vermiculite conforming to the unit's cylindrical shape. The feed door has a 17"x16" curved inner glass panel sealed with a 1/2" fiberglass rope gasket.

Air Introduction System: The wood heater has four air introduction systems: primary, secondary, pilot, and auxiliary startup. The secondary and pilot systems are fixed and non-adjustable, while the primary and auxiliary are user-adjustable via a single adjustment handle.

The primary air system draws air through the bottom of the unit and into the firebox via an opening across the top of the loading door. The primary air control's minimum setting corresponds to an intake area of 0.06 cm², and the area for the maximum setting is 7.84 cm².

The secondary air system draws air through the bottom of the unit to intake holes in the back of the firebox. Air is routed from these holes through the vermiculite firebox lining, with exit holes into the firebox chamber in the rear of the firebox and in the front of the main baffle.

The pilot introduces air supplied by the secondary system to the firebox through a 1/4" diameter tube located in the lower rear of the firebox.

The auxiliary startup air draws air through the bottom of the firebox, and routes it into the firebox through the ash grate. When the startup air system is open, the primary air intake area is 13.68 cm².

Combustion Control Mechanisms: A single air slide handle controls both the auxiliary air and primary air adjustment. Users are alerted to the point at which auxiliary air is fully closed and primary air fully open by a positive-engagement point midway through the full range of adjustment.

Internal Baffles: The unit features two vermiculite baffles to route flue gas. The main, lower baffle contains secondary air holes, while the upper baffle is solid.

Other Features: The unit features an ash cleanout grate which empties into a removable cleanout drawer located beneath the firebox. The grate includes a lower "shaker" grate which is operated by a handle that can be accessed only while the loading door is open

Flue Outlet: The 6" diameter flue outlet is located at the top of the unit.

Model Variants: The Viva L series comes with several different options, for a total of 24 distinct variations. A full list of models can be found in the Engineering Drawings section. Each option, and its effect on emissions performance, is summarized below:

Bi-metallic Air Control:

The Viva L models designated “CA” are specified with the “CleverAir” system, a thermostatic control for the air damper that replaces the manual air control slide. A bi-metallic spring mounted above the airbox, enclosed within the flue gas baffle, is permanently attached to the linkage that actuates the air slide.

The fixed stops for minimum and maximum air settings remain in place, though the division between primary and startup air is eliminated. However, the spring mimics the action of the manual startup system by limiting air as the unit warms.

Models incorporating the CleverAir system have no user adjustment whatsoever. There is no air slide, and owners are instructed to build and maintain the fire in accordance with flue draft and coal bed conditions. The system is tamper-proof and located behind the firebox vermiculite, preventing any unauthorized user interference with airflow.

Due to these design features of the system, no effect on emissions performance is anticipated. Therefore Viva L “CA” models are included in this certification.

Side Glass Panels:

The Viva L models designated “G” can be specified with two fixed glass panels that flank the feed door. In models without these panels, the firebox weldment and vermiculite extends all the way to the feed door. Models with these panels feature an additional inner glass panel on the loading door to compensate for the reduced heat capacity and increased radiant heat loss.



This option does not affect firebox volume or airflow, and the effects on emissions performance by any variance in heat retention was carefully considered. The heat capacity and insulation value of the additional steel and vermiculite are far greater than those of additional glass panel. Therefore, the model with the side glass option was tested, and all variants are included in certification.

Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark

Full Length Glass:

The loading door is available either with a front glass panel that extends the entire height of the door, or a “Classic” version with a smaller glass panel enclosed in a steel door. This variation does not affect the viewing (or volumetric) area of the firebox, nor does it impact heat capacity or radiation. Therefore, both versions are included in certification as this option will not affect emissions performance.



Viva L Classic

Viva L

Taller Pedestal and Header:

The tested model, designated Viva “100” L, is 100cm tall. Two additional options, designated “120” L and “160” L, are 120cm and 160 cm tall, respectively. These height increases are achieved simply by extending the cylindrical body of the unit above and below the firebox. None of the emissions control features of the design, such as air controls, baffles, or insulation, are extended or raised. The dimensions of the firebox and airflow through the unit are not affected, so these options have no impact on emissions performance. All variants are included in certification.



Viva 100 L

Viva 120 L

Viva 160 L

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Section 3

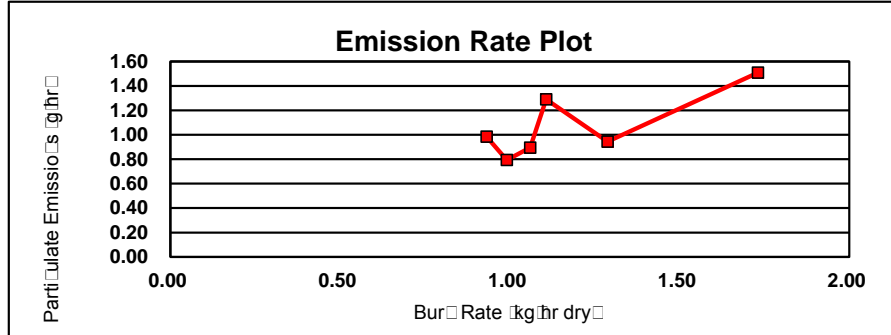
Test Data by Run

EPA Weighted Average Emissions EPA Method 28R

Client: RAIS
 Stove Model: Viva L
 Test Dates: 2/6/2017 - 2/13/2017
 Project Number: 0138WS017E
 Tracking Number: 2233

Status: Final
 Stove Type: Non-Catalytic Stove

Emissions (g/hr):	1.1
Weighted Averages HHV Efficiency (%):	72.2%
LHV Efficiency (%):	78.0%



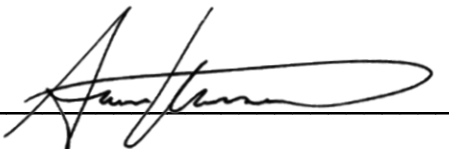
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Run #</td> <td style="width: 30%;">5</td> <td style="width: 30%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td>Burn Rate (dry kg/hr)</td> <td>0.93</td> <td></td> <td></td> </tr> <tr> <td>Category</td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>LHV Efficiency (%)</td> <td>0.784525057</td> <td></td> <td></td> </tr> <tr> <td>HHV Efficiency (%)</td> <td>0.725861482</td> <td></td> <td></td> </tr> <tr> <td>Emissions (g/hr)</td> <td>0.986120153</td> <td></td> <td></td> </tr> <tr> <td>Weighting Factor</td> <td>0.370</td> <td>24.10%</td> <td></td> </tr> </table>	Run #	5			Burn Rate (dry kg/hr)	0.93			Category	2			LHV Efficiency (%)	0.784525057			HHV Efficiency (%)	0.725861482			Emissions (g/hr)	0.986120153			Weighting Factor	0.370	24.10%		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Run #</td> <td style="width: 30%;">7</td> <td style="width: 30%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td>Burn Rate (dry kg/hr)</td> <td>1.29</td> <td></td> <td></td> </tr> <tr> <td>Category</td> <td>3</td> <td></td> <td></td> </tr> <tr> <td>LHV Efficiency (%)</td> <td>0.774869834</td> <td></td> <td></td> </tr> <tr> <td>HHV Efficiency (%)</td> <td>0.729867802</td> <td></td> <td></td> </tr> <tr> <td>Emissions (g/hr)</td> <td>0.943246237</td> <td></td> <td></td> </tr> <tr> <td>Weighting Factor</td> <td>0.390</td> <td>25.45%</td> <td></td> </tr> </table>	Run #	7			Burn Rate (dry kg/hr)	1.29			Category	3			LHV Efficiency (%)	0.774869834			HHV Efficiency (%)	0.729867802			Emissions (g/hr)	0.943246237			Weighting Factor	0.390	25.45%	
Run #	5																																																								
Burn Rate (dry kg/hr)	0.93																																																								
Category	2																																																								
LHV Efficiency (%)	0.784525057																																																								
HHV Efficiency (%)	0.725861482																																																								
Emissions (g/hr)	0.986120153																																																								
Weighting Factor	0.370	24.10%																																																							
Run #	7																																																								
Burn Rate (dry kg/hr)	1.29																																																								
Category	3																																																								
LHV Efficiency (%)	0.774869834																																																								
HHV Efficiency (%)	0.729867802																																																								
Emissions (g/hr)	0.943246237																																																								
Weighting Factor	0.390	25.45%																																																							
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Run #</td> <td style="width: 30%;">4</td> <td style="width: 30%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td>Burn Rate (dry kg/hr)</td> <td>0.99</td> <td></td> <td></td> </tr> <tr> <td>Category</td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>LHV Efficiency (%)</td> <td>0.78007925</td> <td></td> <td></td> </tr> <tr> <td>HHV Efficiency (%)</td> <td>0.721748114</td> <td></td> <td></td> </tr> <tr> <td>Emissions (g/hr)</td> <td>0.793146295</td> <td></td> <td></td> </tr> <tr> <td>Weighting Factor</td> <td>0.090</td> <td>5.88%</td> <td></td> </tr> </table>	Run #	4			Burn Rate (dry kg/hr)	0.99			Category	2			LHV Efficiency (%)	0.78007925			HHV Efficiency (%)	0.721748114			Emissions (g/hr)	0.793146295			Weighting Factor	0.090	5.88%		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Run #</td> <td style="width: 30%;">8</td> <td style="width: 30%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td>Burn Rate (dry kg/hr)</td> <td>1.73</td> <td></td> <td></td> </tr> <tr> <td>Category</td> <td>3</td> <td></td> <td></td> </tr> <tr> <td>LHV Efficiency (%)</td> <td>0.784525057</td> <td></td> <td></td> </tr> <tr> <td>HHV Efficiency (%)</td> <td>0.716928238</td> <td></td> <td></td> </tr> <tr> <td>Emissions (g/hr)</td> <td>1.508187561</td> <td></td> <td></td> </tr> <tr> <td>Weighting Factor</td> <td>0.399</td> <td>26.03%</td> <td></td> </tr> </table>	Run #	8			Burn Rate (dry kg/hr)	1.73			Category	3			LHV Efficiency (%)	0.784525057			HHV Efficiency (%)	0.716928238			Emissions (g/hr)	1.508187561			Weighting Factor	0.399	26.03%	
Run #	4																																																								
Burn Rate (dry kg/hr)	0.99																																																								
Category	2																																																								
LHV Efficiency (%)	0.78007925																																																								
HHV Efficiency (%)	0.721748114																																																								
Emissions (g/hr)	0.793146295																																																								
Weighting Factor	0.090	5.88%																																																							
Run #	8																																																								
Burn Rate (dry kg/hr)	1.73																																																								
Category	3																																																								
LHV Efficiency (%)	0.784525057																																																								
HHV Efficiency (%)	0.716928238																																																								
Emissions (g/hr)	1.508187561																																																								
Weighting Factor	0.399	26.03%																																																							
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Run #</td> <td style="width: 30%;">6</td> <td style="width: 30%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td>Burn Rate (dry kg/hr)</td> <td>1.06</td> <td></td> <td></td> </tr> <tr> <td>Category</td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>LHV Efficiency (%)</td> <td>0.765591654</td> <td></td> <td></td> </tr> <tr> <td>HHV Efficiency (%)</td> <td>0.718823009</td> <td></td> <td></td> </tr> <tr> <td>Emissions (g/hr)</td> <td>0.895296048</td> <td></td> <td></td> </tr> <tr> <td>Weighting Factor</td> <td>0.090</td> <td>5.90%</td> <td></td> </tr> </table>	Run #	6			Burn Rate (dry kg/hr)	1.06			Category	2			LHV Efficiency (%)	0.765591654			HHV Efficiency (%)	0.718823009			Emissions (g/hr)	0.895296048			Weighting Factor	0.090	5.90%																														
Run #	6																																																								
Burn Rate (dry kg/hr)	1.06																																																								
Category	2																																																								
LHV Efficiency (%)	0.765591654																																																								
HHV Efficiency (%)	0.718823009																																																								
Emissions (g/hr)	0.895296048																																																								
Weighting Factor	0.090	5.90%																																																							
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Run #</td> <td style="width: 30%;">3</td> <td style="width: 30%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td>Burn Rate (dry kg/hr)</td> <td>1.11</td> <td></td> <td></td> </tr> <tr> <td>Category</td> <td>2</td> <td></td> <td></td> </tr> <tr> <td>LHV Efficiency (%)</td> <td>0.77691774</td> <td></td> <td></td> </tr> <tr> <td>HHV Efficiency (%)</td> <td>0.708343841</td> <td></td> <td></td> </tr> <tr> <td>Emissions (g/hr)</td> <td>1.290780152</td> <td></td> <td></td> </tr> <tr> <td>Weighting Factor</td> <td>0.194</td> <td>12.64%</td> <td></td> </tr> </table>	Run #	3			Burn Rate (dry kg/hr)	1.11			Category	2			LHV Efficiency (%)	0.77691774			HHV Efficiency (%)	0.708343841			Emissions (g/hr)	1.290780152			Weighting Factor	0.194	12.64%																														
Run #	3																																																								
Burn Rate (dry kg/hr)	1.11																																																								
Category	2																																																								
LHV Efficiency (%)	0.77691774																																																								
HHV Efficiency (%)	0.708343841																																																								
Emissions (g/hr)	1.290780152																																																								
Weighting Factor	0.194	12.64%																																																							

Wood Heater Conditioning Data - ASTM E2780/ ASTM E2515

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 12/21/16 - 1/6/17
 Technician: Villy Jacobsen
 Operation Category: II-III

Elapsed Time (hr)	Flue Gas Temp (° F)	Catalyst Exit Temp (° F)
0	769.4	N/A
1	849.7	N/A
2	499.4	N/A
3	975.3	N/A
4	504.0	N/A
5	922.2	N/A
6	478.3	N/A
7	388.1	N/A
8	908.6	N/A
9	523.0	N/A
10	907.6	N/A
11	446.3	N/A
12	375.3	N/A
13	723.1	N/A
14	835.3	N/A
15	438.1	N/A
16	1040.0	N/A
17	480.9	N/A
18	424.6	N/A
19	750.7	N/A
20	480.8	N/A
21	384.1	N/A
22	780.5	N/A
23	913.9	N/A
24	416.5	N/A
25	364.0	N/A

Elapsed Time (hr)	Flue Gas Temp (° F)	Catalyst Exit Temp (° F)
26	631.5	N/A
27	939.0	N/A
28	422.8	N/A
29	383.8	N/A
30	760.5	N/A
31	433.3	N/A
32	331.7	N/A
33	736.4	N/A
34	464.6	N/A
35	859.5	N/A
36	418.8	N/A
37	358.0	N/A
38	898.1	N/A
39	425.4	N/A
40	352.9	N/A
41	803.8	N/A
42	482.4	N/A
43	960.2	N/A
44	499.3	N/A
45	836.5	N/A
46	477.3	N/A
47	915.5	N/A
48	493.3	N/A
49	767.3	N/A
50	436.2	N/A

Technician Signature: 

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 1

Wood Heater Preburn Data - ASTM E2780

Run: 1

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/6/2017
 Beginning Clock Time: 12:53

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>9</u>		
Total Preburn Weight (lb):	<u>9.2</u>		
	<u>23.9</u>	<u>24.8</u>	<u>24.5</u>
Fuel Moisture Readings (% DB):	<u>23.9</u>	<u>24.5</u>	<u>19.2</u>
	<u>24.9</u>	<u>24.5</u>	<u>22.6</u>
	<u>20.1</u>	<u>19.1</u>	
Avg Preburn Moisture (% DB):	<u>22.91</u>		

Coal Bed 1.7 2.1
 Range (lb): (min) (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	6.3	-0.038	491	285	281	266	306	325.7	306	68	
10	5.6	-0.035	563	285	287	277	301	342.8	266	69	
20	5.0	-0.036	596	277	291	288	308	351.8	280	69	
30	4.1	-0.040	632	267	294	300	317	362.1	318	69	
40	3.3	-0.041	669	257	303	310	327	373.3	344	69	
50	2.6	-0.039	708	251	314	321	336	385.9	331	70	
60	2.3	-0.030	681	249	326	332	347	387.1	256	70	
70	2.2	-0.025	584	252	326	321	334	363.3	215	70	
73	2.1	-0.023	556	253	323	312	327	354.0	207	70	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/6/2017
Run No.: 1

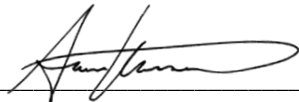
Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	11.7
2x4 Crib Weight (lb):	8.4
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	6.9	
Fuel Density (lb/ft ³ , Dry Basis):	29.40	OK
Loading Density (lb/ft ³ , Wet Basis):	6.51	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.68 - 2.1

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1	2"x 4"	22.5	23.2	22.9	0.81
2	1.2	2"x 4"	23.1	22.5	22.9	0.98
3	1.2	2"x 4"	21.6	22.5	19.1	0.99
4	1.6	2"x 4"	24.2	22.1	19.9	1.31
5	1.4	2"x 4"	24.5	22.8	23.7	1.13

Spacer Readings (Dry Basis %)			
22.7	23.4		
22.7	20.4		
23.6	13.8		
23.2	22.1		
21.2	19.4		
23.1	22.3		
21.1	21.9		
14.3			
13.5			
23.7			
22.5			
23.6			
19.3			

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 1

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 06-Feb-17
 Beginning Clock Time: 14:07
 Total Sampling Time: 180 min
 Recording Interval: 10 min
 Background Sample Volume: 0 cubic feet
 Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)
 Barometric Pressure: Begin Middle End Average
29.72 29.75 29.79 29.75 "Hg
 OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.280 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99
 Avg. Tunnel Velocity: 17.67 ft/sec
 Initial Tunnel Flow: 191.7 scfm
 Average Tunnel Flow: 196.1 scfm
 Post-Test Leak Check (1): 0.000 cfm @ -5 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ -5 in. Hg
 Average Test Piece Fuel Moisture: 22.50 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.052	0.070	0.080	0.060	0.052	0.076	0.080	0.062	0.088
Temp:	92	92	92	92	92	92	92	92	92
V _{strav}	17.78 ft/sec				V _{scnt} 20.18 ft/sec				F _p 0.881

Elapsed Time (min)	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data			
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.85	73	1.84	0.68	74	1.2	97	0.088			8.4		545	253	322	310	329	352	N/A	266	68	68	68	68	70	-0.032	1.72	0.54
10	1.666	1.688	0.17	0.17	1.35	74	2.14	1.21	74	1.3	85	0.088	102	101	7.7	-0.7	484	275	300	271	282	322	N/A	225	70	70	70	70	69	-0.027	2.47	1.45
20	3.312	3.389	0.16	0.17	1.35	75	2.15	1.20	76	1.3	82	0.088	100	101	7.3	-0.4	418	296	293	244	256	301	N/A	189	70	70	70	70	69	-0.022	2.88	1.78
30	4.959	5.089	0.16	0.17	1.33	77	2.15	1.19	77	1.3	80	0.088	100	100	6.8	-0.5	374	298	285	232	246	287	N/A	183	70	70	70	70	69	-0.021	4.18	1.86
40	6.605	6.788	0.16	0.17	1.34	78	2.17	1.19	78	1.4	80	0.088	99	100	6.3	-0.5	359	293	282	230	246	282	N/A	187	70	70	70	70	69	-0.021	3.79	2.53
50	8.249	8.483	0.16	0.17	1.33	79	2.2	1.18	79	1.4	83	0.088	99	100	5.3	-1	401	286	283	239	255	293	N/A	260	71	71	71	71	69	-0.034	8.53	2.73
60	9.891	10.175	0.16	0.17	1.32	80	2.22	1.18	80	1.4	86	0.088	99	100	4.3	-1	506	278	292	265	279	324	N/A	287	71	71	71	71	70	-0.035	10.33	2.83
70	11.546	11.865	0.17	0.17	1.33	81	2.17	1.17	81	1.4	89	0.088	100	100	3.3	-1	585	270	302	286	305	350	N/A	309	72	72	72	72	70	-0.038	11.64	1.74
80	13.200	13.557	0.17	0.17	1.33	81	2.18	1.17	81	1.4	91	0.088	100	100	2.5	-0.8	638	262	314	304	322	368	N/A	304	73	73	73	73	70	-0.036	10.25	2.25
90	14.854	15.248	0.17	0.17	1.33	82	2.18	1.18	82	1.4	90	0.088	100	100	1.9	-0.6	677	255	323	318	335	382	N/A	284	73	73	73	73	71	-0.033	9.12	0.81
100	16.508	16.941	0.17	0.17	1.34	83	2.19	1.18	83	1.4	89	0.088	100	100	1.5	-0.4	616	251	328	321	340	371	N/A	242	73	73	73	73	71	-0.028	5.93	3.25
110	18.165	18.635	0.17	0.17	1.34	83	2.19	1.18	83	1.4	87	0.088	100	100	1.3	-0.2	578	250	334	323	338	365	N/A	242	73	73	73	73	72	-0.026	7.57	0.82
120	19.824	20.332	0.17	0.17	1.35	83	2.19	1.18	84	1.4	86	0.088	100	100	1.1	-0.2	553	253	346	328	351	366	N/A	228	73	73	73	73	71	-0.024	7.41	0.76
130	21.484	22.029	0.17	0.17	1.34	84	2.2	1.19	84	1.4	85	0.088	100	99	0.9	-0.2	527	260	352	334	350	365	N/A	218	73	73	73	73	72	-0.022	7.11	0.95
140	23.145	23.728	0.17	0.17	1.34	84	2.19	1.19	84	1.4	84	0.088	100	99	0.8	-0.1	507	268	354	333	349	362	N/A	215	73	73	73	73	71	-0.022	7	1.08
150	24.806	25.427	0.17	0.17	1.34	84	2.19	1.18	84	1.4	84	0.088	100	99	0.6	-0.2	493	275	358	333	348	361	N/A	212	72	72	72	72	71	-0.021	6.72	1.31
160	26.468	27.126	0.17	0.17	1.35	84	2.19	1.18	84	1.4	83	0.088	100	99	0.5	-0.1	481	282	361	335	346	361	N/A	210	72	72	72	72	71	-0.021	6.71	1.45
170	28.130	28.825	0.17	0.17	1.35	84	2.2	1.19	84	1.4	83	0.088	100	99	0.3	-0.2	472	288	363	335	346	361	N/A	205	72	72	72	72	71	-0.020	6.52	1.27
180	29.793	30.524	0.17	0.17	1.35	84	2.19	1.19	84	1.4	83	0.088	100	99	0.0	-0.3	466	293	363	331	347	360	N/A	204	72	72	72	72	71	-0.020	7.39	0.91
Avg/Tot	29.793	30.524	0.17	0.17	1.31	81		1.16	81		86	0.088	100	100								8.2				72	72	72	70	-0.026		

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
Model: Viva L
Project No.: 0138WS017E
Tracking No.: 2233
Run: 1
Test Date: 02/06/17

Burn Rate	1.04 kg/hr dry
Average Tunnel Temperature	86 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.67 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11768.2 dscf/hour
Average Delta p	0.088 inches H2O
Total Time of Test	180 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	29.793 cubic feet	30.524 cubic feet	9.891 cubic feet
Average Gas Meter Temperature	70 degrees Fahrenheit	81 degrees Fahrenheit	81 degrees Fahrenheit	81 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	28.550 dscf	29.409 dscf	9.478 dscf
Total Particulates - m _n	0 mg	43.5 mg	44.1 mg	37.2 mg
Particulate Concentration (dry-standard) - C _i /C _s	0.000000 grams/dscf	0.00152 grams/dscf	0.00150 grams/dscf	0.00392 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	53.79 grams	52.94 grams	46.19 grams
Particulate Emission Rate	0.00 grams/hour	17.93 grams/hour	17.65 grams/hour	46.19 grams/hour
Emissions Factor		17.24 g/kg	16.97 g/kg	30.42 g/kg
Difference from Average Total Particulate Emissions		0.43 grams	0.43 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	53.37 grams
Particulate Emission Rate	17.79 grams/hour
Emissions Factor	17.10 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	46.19 grams
Particulate Emission Rate	46.19 grams/hour
Emissions Factor	30.42 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/06/17
Run: 1
Control #: 0138WS017E
Test Duration: 180
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	63.0%	68.1%
Combustion Efficiency	80.8%	80.8%
Heat Transfer Efficiency	78%	84.3%

Output Rate (kJ/h)	12,950	12,285	(Btu/h)
Burn Rate (kg/h)	1.04	2.29	(lb/h)
Input (kJ/h)	20,544	19,489	(Btu/h)

Test Load Weight (dry kg)	3.11	6.86	dry lb
MC wet (%)	18.37		
MC dry (%)	22.50		
Particulate (g)	N/A		
CO (g)	822		
Test Duration (h)	3.00		

Emissions	Particulate	CO
g/MJ Output	N/A	21.16
g/kg Dry Fuel	N/A	264.21
g/h	N/A	274.00
lb/MM Btu Output	N/A	49.17

Air/Fuel Ratio (A/F)	14.65
----------------------	-------

VERSION:

2.2

12/14/2009

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 1

Model: VIVA L Tracking Number: 2233 Date: 2/6/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

Secondary: Fixed

14 mm open from fully closed*
* will be installed to correspond to low burn

Tertiary/Pilot: Fixed

Fan: N/A

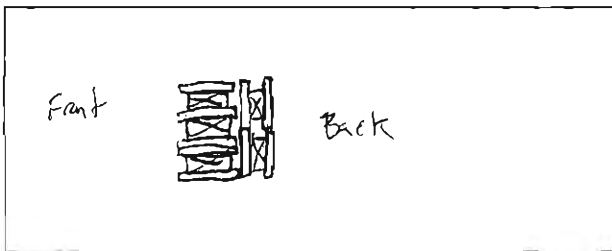
upon completion of testing a fixed stop
test setting, this setting above represents distance
without fixed stop in place.

Preburn Notes

Time	Notes
	N/A

Test Notes

Sketch test fuel configuration:



Start up procedures & Timeline:

Bypass: N/A
 Fuel loaded by: 40 sec
 Door closed at: 50 sec
 Primary air: Air @ max for 4 min then turned to click, @ 4:05 min. Manly turned down to test setting.
 Notes: _____

Time	Notes
	N/A

Technician Signature: [Signature]

Date: 2/6/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 1
 Model: VIVAL Tracking Number: 2233 Date: 2/6/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 14107 Booth #: E1

Stop Time: 17113

Stack Gas Leak Check:

Initial: ∅ Final: ∅

Sample Train Leak Check:

A: 0.00 @ -5 "Hg
 B: 0.00 @ -5 "Hg

Calibrations: Span Gas CO₂: 16.74 CO: 4.20 CO (ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>9:25</u>	<u>9:31</u>		
CO ₂	<u>0.00</u>	<u>16.74</u>	<i>N/A</i>	
CO (γ)	<u>0.00</u>	<u>4.20</u>		

CO (ppm) 0 505

Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Pitot Tube Leak Test: Initial: ∅ Final: ∅

Stack Diameter (in): 6"

Induced Draft: ∅

% Smoke Capture: 100%

Flue Pipe Cleaned Prior to First Test in Series:

Date: 2/2/17 Initials: AK

	Initial	Middle	Ending
P _b (in/Hg)	<u>29.72</u>	<u>29.75</u>	<u>29.79</u>
RH (%)	<u>18.5</u>	<u>22.1</u>	<u>25.3</u>
Ambient (°F)	<u>70</u>	<u>71</u>	<u>71</u>

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
<u>0.026</u>	<u>0.052</u>	<u>92</u>
<u>0.035</u>	<u>0.070</u>	<u>92</u>
<u>0.040</u>	<u>0.080</u>	<u>92</u>
<u>0.03</u>	<u>0.060</u>	<u>92</u>
<u>0.026</u>	<u>0.052</u>	<u>92</u>
<u>0.038</u>	<u>0.076</u>	<u>92</u>
<u>0.040</u>	<u>0.080</u>	<u>92</u>
<u>0.031</u>	<u>0.062</u>	<u>92</u>
Center:		
<u>0.044</u>	<u>0.088</u>	<u>92</u>

Background Filter Volume: N/A

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
<u>-0.27</u>	<u>-0.28</u>

Technician Signature: [Signature]

Date: 2/6/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 1

Model: VIVA L Tracking Number: 2233 Date: 2/6/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel					
Calibration:		Cal Value (1) = 12%	Actual Reading <u>12%</u>		
		Cal Value (2) = 22%	Actual Reading <u>22%</u>		
Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>9"</u> in	<u>23.9</u>	7	<u>9 24.6</u> in	<u>24.9</u>
2	<u>9"</u> in	<u>24.8</u>	8	<u>9 24.5</u> in	<u>24.5</u>
3	<u>9"</u> in	<u>24.5</u>	9	<u>9</u> in	<u>22.6</u>
4	<u>9"</u> in	<u>23.9</u>	10	<u>9</u> in	<u>20.1</u>
5	<u>9"</u> in	<u>24.5</u>	11	<u>9</u> in	<u>19.1</u>
6	<u>9"</u> in	<u>19.2</u>	12	<u>9</u> in	<u>19.1</u>
Total Pre-Burn Fuel Weight: <u>9.2</u>		Pre-Burn Fuel Average Moisture: <u>22.9%</u>			
Time (clock): <u>11:30</u>		Room Temperature (F): <u>65</u>		Initials: <u>SB</u>	

Test Fuel					
Firebox Volume (ft ³): <u>1.29 ft³</u>		Test Fuel Piece Length (in): <u>2@ 10.5" 3@ 12.5"</u>			
Load Weight Range (lb): <u>8.2 - 9.9</u>		Total Wet Fuel Load Weight (lb): <u>8.4</u>			
Fuel Type & Amount: 2 x 4: <u>5</u>		4 x 4: <u>0</u>			
Weight (with spacers): <u>8.4</u>		Weight (with spacers): <u>0</u>			
Piece:	Weight (lbs):	Moisture Readings (%DB):		Fuel Type:	
1	<u>1.0</u>	<u>22.5</u>	<u>23.2</u>	<u>22.9</u>	<u>2x4</u>
2	<u>1.2</u>	<u>23.1</u>	<u>22.5</u>	<u>22.9</u>	<u>2x4</u>
3	<u>1.2</u>	<u>21.6</u>	<u>22.5</u>	<u>19.1</u>	<u>2x4</u>
4	<u>1.6</u>	<u>24.2</u>	<u>22.1</u>	<u>19.9</u>	<u>2x4</u>
5	<u>1.4</u>	<u>24.5</u>	<u>22.8</u>	<u>23.7</u>	<u>2x4</u>
6	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
7	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
Spacer Moisture Readings (%DB)					
<u>22.7</u>	<u>21.2</u>	<u>13.5</u>	<u>19.3</u>	<u>13.8</u> ^{or}	<u>22.1</u>
<u>22.7</u>	<u>23.1</u>	<u>23.7</u>	<u>23.4</u>	<u> </u>	<u>19.4</u>
<u>23.6</u>	<u>21.1</u>	<u>22.5</u>	<u>20.4</u>	<u> </u>	<u>22.3</u>
<u>23.2</u>	<u>14.3</u>	<u>23.6</u>	<u>13.8</u>	<u> </u>	<u>21.6</u>
Time (clock): <u>11:00</u>		Room Temperature (F): <u>65</u>		Initials: <u>SB</u>	

Technician Signature: [Signature]

Date: 2/6/2017

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 2

Wood Heater Preburn Data - ASTM E2780

Run: 2

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/7/2017
 Beginning Clock Time: 11:19

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>8</u>		
Total Preburn Weight (lb):	<u>9.3</u>		
	<u>19.7</u>	<u>20.9</u>	<u>19.2</u>
Fuel Moisture Readings (% DB):	<u>18.9</u>	<u>20.6</u>	<u>19.1</u>
	<u>22.2</u>	<u>24.3</u>	<u>19.2</u>
	<u>22.9</u>	<u>22.8</u>	
Avg Preburn Moisture (% DB):	<u>20.89</u>		

Coal Bed Range (lb): 1.7 (min) 2.1 (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	7.2	-0.052	609	359	333	343	318	392.5	454	70	
10	5.8	-0.047	664	371	353	344	333	413	399	72	
20	4.9	-0.040	680	361	367	345	346	419.6	329	71	
30	3.9	-0.046	708	342	372	348	352	424.4	396	72	
40	3.1	-0.044	743	323	369	346	351	426.5	387	71	
50	2.6	-0.039	725	308	371	358	355	423.3	319	71	
60	2.2	-0.033	675	300	374	362	366	415.3	275	72	
67	2.1	-0.030	637	300	374	360	368	408.1	257	72	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/7/2017
Run No.: 2


Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	11.7
2x4 Crib Weight (lb):	8.4
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	7.0	
Fuel Density (lb/ft ³ , Dry Basis):	28.98	OK
Loading Density (lb/ft ³ , Wet Basis):	6.51	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.68 - 2.1

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	0.9	2"x 4"	20.1	20.2	19.7	0.75
2	1.2	2"x 4"	23.2	22.6	22.6	0.98
3	1.3	2"x 4"	23.8	23.4	23.2	1.05
4	1.4	2"x 4"	23.9	22.1	22.7	1.14
5	1.5	2"x 4"	22.3	22.8	20.2	1.23

Spacer Readings (Dry Basis %)			
20.2	12.6		
19.7	19.2		
15.1	17.0		
16.7	18.9		
19.9	19.8		
13.9	13.0		
18.5	15.0		
17.0			
12.2			
17.3			
16.8			
16.7			
12.6			

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 2

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 07-Feb-17
 Beginning Clock Time: 12:33
 Total Sampling Time: 220 min
 Recording Interval: 10 min
 Background Sample Volume: 0 cubic feet
 Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)
 Barometric Pressure: Begin Middle End Average
29.89 29.89 29.89 29.89 "Hg
 OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.260 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99
 Avg. Tunnel Velocity: 17.88 ft/sec
 Initial Tunnel Flow: 192.2 scfm
 Average Tunnel Flow: 200.6 scfm
 Post-Test Leak Check (1): 0.000 cfm @ 12 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ 11 in. Hg
 Average Test Piece Fuel Moisture: 22.19 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.048	0.080	0.082	0.068	0.044	0.070	0.080	0.060	0.095
Temp:	89	89	89	89	89	89	89	89	89
V _{strav}	17.73 ft/sec				V _{scnt} 20.85 ft/sec				F _p 0.851

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.03	75	1.85	0.67	76	1.3	105	0.090			8.4		631	299	375	359	370	407	N/A	327	71	71	70	70	71	-0.038	2.81	0.23
10	1.699	1.698	0.17	0.17	1.44	76	2.29	1.22	77	1.3	90	0.090	106	107	7.6	-0.8	590	331	358	318	326	385	N/A	270	73	73	73	73	71	-0.034	3.17	0.91
20	3.399	3.403	0.17	0.17	1.43	77	2.29	1.20	78	1.3	86	0.090	106	107	7.1	-0.5	502	349	337	287	295	354	N/A	215	73	73	73	73	71	-0.027	3.41	1.41
30	5.097	5.108	0.17	0.17	1.42	79	2.29	1.20	79	1.3	84	0.100	100	101	6.7	-0.4	438	344	318	268	276	329	N/A	198	72	72	73	73	71	-0.024	4.28	1.85
40	6.796	6.810	0.17	0.17	1.41	80	2.31	1.19	80	1.4	82	0.100	99	101	6.2	-0.5	402	336	307	257	264	313	N/A	191	72	72	72	72	70	-0.022	4.78	2.26
50	8.492	8.508	0.17	0.17	1.41	81	2.33	1.18	81	1.4	82	0.100	99	100	5.7	-0.5	390	329	305	255	264	309	N/A	195	72	72	72	72	70	-0.022	5.99	1.73
60	10.186	10.195	0.17	0.17	1.43	81	2.28	1.15	81	1.5	82	0.100	99	100	5.0	-0.7	388	324	307	258	264	308	N/A	196	72	72	72	72	70	-0.021	5.04	3.23
70	11.894	11.861	0.17	0.17	1.42	82	2.31	1.13	82	1.6	81	0.100	99	98	4.3	-0.7	377	319	312	261	266	307	N/A	197	72	72	72	72	70	-0.021	5.50	3.78
80	13.596	13.512	0.17	0.17	1.41	82	2.34	1.17	82	1.7	82	0.100	99	97	3.5	-0.8	378	315	320	270	273	311	N/A	201	72	72	72	72	70	-0.021	5.80	4.23
90	15.291	15.193	0.17	0.17	1.40	82	2.37	1.15	82	1.8	82	0.100	99	99	2.8	-0.7	387	311	333	286	292	322	N/A	198	72	72	72	72	70	-0.021	5.78	4.34
100	16.979	16.860	0.17	0.17	1.39	82	2.4	1.13	82	1.9	81	0.100	98	98	2.2	-0.6	396	309	344	299	306	331	N/A	193	72	72	72	72	71	-0.020	5.59	4.22
110	18.664	18.518	0.17	0.17	1.39	82	2.41	1.13	82	1.9	81	0.100	98	98	1.8	-0.4	403	308	348	304	314	335	N/A	185	72	72	72	72	70	-0.019	4.95	3.95
120	20.350	20.178	0.17	0.17	1.39	82	2.4	1.13	82	1.9	80	0.100	98	98	1.7	-0.1	404	307	347	308	314	336	N/A	174	71	71	71	71	70	-0.018	4.52	3.69
130	22.037	21.840	0.17	0.17	1.40	82	2.4	1.14	82	1.9	80	0.100	98	98	1.5	-0.2	400	306	346	307	312	334	N/A	170	70	70	71	71	69	-0.017	4.65	3.71
140	23.726	23.505	0.17	0.17	1.40	82	2.4	1.14	82	1.9	80	0.100	98	98	1.4	-0.1	398	305	344	305	311	333	N/A	170	70	70	71	71	70	-0.016	4.78	3.84
150	25.413	25.169	0.17	0.17	1.40	82	2.4	1.14	82	1.9	80	0.090	103	103	1.2	-0.2	398	303	342	302	308	331	N/A	173	71	71	71	71	70	-0.017	4.65	3.98
160	27.101	26.833	0.17	0.17	1.40	82	2.4	1.14	82	1.8	80	0.100	98	98	1.0	-0.2	408	302	332	297	303	328	N/A	177	71	71	71	71	69	-0.017	6.83	1.17
170	28.789	28.500	0.17	0.17	1.39	82	2.4	1.14	82	1.9	80	0.100	98	98	0.9	-0.1	421	300	328	294	304	329	N/A	179	70	70	71	71	70	-0.017	6.82	1.15
180	30.477	30.163	0.17	0.17	1.39	82	2.4	1.14	82	1.8	80	0.090	104	103	0.7	-0.2	427	300	327	296	306	331	N/A	178	71	71	71	71	70	-0.016	7.00	1.08
190	32.164	31.828	0.17	0.17	1.40	82	2.4	1.14	82	1.8	81	0.100	98	98	0.6	-0.1	435	301	329	299	311	335	N/A	182	71	71	71	71	70	-0.017	7.30	1.03
200	33.851	33.493	0.17	0.17	1.39	82	2.41	1.14	82	1.8	81	0.100	98	98	0.4	-0.2	439	303	334	304	315	339	N/A	183	71	71	71	71	70	-0.017	7.13	1.23
210	35.538	35.159	0.17	0.17	1.38	83	2.41	1.14	82	1.9	80	0.100	98	98	0.2	-0.2	440	305	338	307	318	342	N/A	182	71	71	71	71	71	-0.017	6.98	1.25
220	37.226	36.825	0.17	0.17	1.40	83	2.41	1.14	83	1.8	80	0.100	98	98	0.0	-0.2	439	308	338	307	319	342	N/A	182	71	71	71	71	71	-0.018	6.99	1.38
Avg/Tot	37.226	36.825	0.17	0.17	1.34	81		1.13	81		83	0.098	100	100								64.6			71	72	72	70	-0.021			

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
 Model: Viva L
 Project No.: 0138WS017E
 Tracking No.: 2233
 Run: 2
 Test Date: 02/07/17

Burn Rate	0.86 kg/hr dry
Average Tunnel Temperature	83 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.88 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	12034.9 dscf/hour
Average Delta p	0.098 inches H2O
Total Time of Test	220 minutes

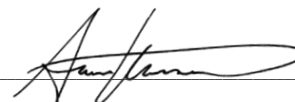
	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	37.226 cubic feet	36.825 cubic feet	10.186 cubic feet
Average Gas Meter Temperature	70 degrees Fahrenheit	81 degrees Fahrenheit	81 degrees Fahrenheit	81 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	35.818 dscf	35.624 dscf	9.801 dscf
Total Particulates - m _n	0 mg	150 mg	150.4 mg	49.6 mg
Particulate Concentration (dry-standard) - C _p /C _s	0.000000 grams/dscf	0.00419 grams/dscf	0.00422 grams/dscf	0.00506 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	184.80 grams	186.30 grams	60.91 grams
Particulate Emission Rate	0.00 grams/hour	50.40 grams/hour	50.81 grams/hour	60.91 grams/hour
Emissions Factor		58.60 g/kg	59.08 g/kg	48.26 g/kg
Difference from Average Total Particulate Emissions		0.75 grams	0.75 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	185.55 grams
Particulate Emission Rate	50.60 grams/hour
Emissions Factor	58.84 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	60.91 grams
Particulate Emission Rate	60.91 grams/hour
Emissions Factor	48.26 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/07/17
Run: 2
Control #: 0138WS017E
Test Duration: 220
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	57.2%	61.9%
Combustion Efficiency	73.9%	73.9%
Heat Transfer Efficiency	77%	83.7%

Output Rate (kJ/h)	9,646	9,150	(Btu/h)
Burn Rate (kg/h)	0.85	1.87	(lb/h)
Input (kJ/h)	16,852	15,986	(Btu/h)

Test Load Weight (dry kg)	3.12	6.87	dry lb
MC wet (%)	18.16		
MC dry (%)	22.19		
Particulate (g)	n/a		
CO (g)	1,117		
Test Duration (h)	3.67		

Emissions	Particulate	CO
g/MJ Output	N/A	31.59
g/kg Dry Fuel	N/A	358.23
g/h	N/A	304.74
lb/MM Btu Output	N/A	73.43

Air/Fuel Ratio (A/F)	15.43
----------------------	-------

VERSION:

2.2

12/14/2009

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 2
 Model: VIVA L Tracking Number: 2233 Date: ~~2/6/2017~~ 2/7/17
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

opa 14min

Secondary: Fixed

Tertiary/Pilot: Fixed

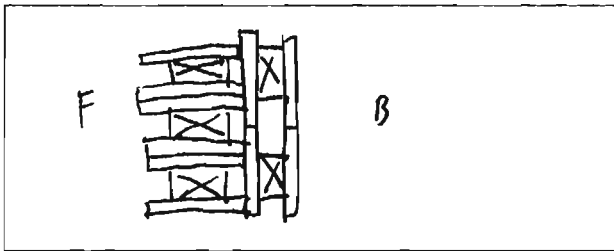
Fan: MA

Preburn Notes

Time	Notes
	None

Test Notes

Sketch test fuel configuration:



Start up procedures & Timeline:

Bypass: MA
 Fuel loaded by: 0:25
 Door closed at: 0:30
 Primary air: Startup via Air 4:30
Set from 4:50-5:00

Notes: _____

Time	Notes
	None

Technician Signature: [Signature]

Date: 2/7/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 2
 Model: VIVA L Tracking Number: 2233 Date: 2/16/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 12:33 Booth #: E1

Stop Time: 16:16

Stack Gas Leak Check:

Initial: 0 Final: 0

Sample Train Leak Check:

A: 0 @ 12 "Hg
 B: 0 @ 1 "Hg

Calibrations: Span Gas CO₂: 16.74 CO(%): 4.20 CO(ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>1:11</u>	<u>4:15</u>		
CO ₂	<u>0.00</u>	<u>16.74</u>		
CO(%)	<u>0.060</u>	<u>4.164</u>		
CO(ppm)	<u>0</u>	<u>-</u>		

Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10.0 Final: 10.0

Pitot Tube Leak Test: Initial: 0 Final: 0

Stack Diameter (in): 6

Induced Draft: 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in Series:

Date: 2/16 Initials: A

	Initial	Middle	Ending
P _b (in/Hg)	<u>28.89</u>	<u>28.89</u>	<u>29.89</u>
RH (%)	<u>24.4</u>	<u>24.4</u>	<u>24.5</u>
Ambient (°F)	<u>71.9</u>	<u>70</u>	<u>70</u>

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
<u>0.024</u>	<u>0.048</u>	<u>89</u>
<u>0.040</u>	<u>0.080</u>	
<u>0.041</u>	<u>0.082</u>	
<u>0.034</u>	<u>0.068</u>	
<u>0.022</u>	<u>0.044</u>	
<u>0.035</u>	<u>0.070</u>	
<u>0.040</u>	<u>0.080</u>	
<u>0.030</u>	<u>0.060</u>	
Center:		
<u>0.045</u>	<u>0.095</u>	<u>89</u>

Background Filter Volume: 0

Technician Signature: [Signature]

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
<u>-0.26</u>	

Date: 2/16/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 2

Model: VIVA L Tracking Number: 2233 Date: 2/8/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel

Calibration: Cal Value (1) = 12% Actual Reading 12.6
 Cal Value (2) = 22% Actual Reading 22.0

Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8</u> in	<u>19.7</u>	7	<u>8</u> in	<u>20.6</u>
2	<u>8</u> in	<u>18.9</u>	8	<u>8</u> in	<u>20.2</u>
3	<u>8</u> in	<u>22.2</u>	9	<u>8</u> in	<u>19.2</u>
4	<u>8</u> in	<u>22.9</u>	10	<u>8</u> in	<u>19.1</u>
5	<u>8</u> in	<u>22.8</u>	11	<u>8</u> in	<u>19.2</u>
6	<u>8</u> in	<u>24.3</u>	12	<u>8</u> in	<u>19.2</u>

Total Pre-Burn Fuel Weight: 9.3 Pre-Burn Fuel Average Moisture: 22.91

Time (clock): 10:00 Room Temperature (F): 71 Initials: SK

Test Fuel

Firebox Volume (ft³): 1.24 Test Fuel Piece Length (in): 2 @ 10.5", 3 @ 12.5"
 Load Weight Range (lb): 8.2-9.5 Total Wet Fuel Load Weight (lb): _____

Fuel Type & Amount: 2 x 4: 5 4 x 4: _____
 Weight (with spacers): 8.4 Weight (with spacers): _____

Piece:	Weight (lbs):	Moisture Readings (%DB):				Fuel Type:
1	<u>6.4</u>	<u>20.1</u>	<u>20.2</u>	<u>19.7</u>	<u>2x4</u>	
2	<u>1.2</u>	<u>23.2</u>	<u>22.6</u>	<u>22.6</u>	<u>4x4</u>	
3	<u>1.3</u>	<u>23.8</u>	<u>23.4</u>	<u>23.2</u>	<u>4x4</u>	
4	<u>1.4</u>	<u>23.4</u>	<u>22.1</u>	<u>22.7</u>	<u>4x4</u>	
5	<u>1.5</u>	<u>22.3</u>	<u>22.8</u>	<u>20.2</u>	<u>4x4</u>	
6	_____	_____	_____	_____	_____	
7	_____	_____	_____	_____	_____	

Spacer Moisture Readings (%DB)

<u>20.2</u>	<u>12.9</u>	<u>12.2</u>	<u>12.6</u>	<u>18.9</u>	_____	_____
<u>19.7</u>	<u>13.9</u>	<u>17.3</u>	<u>12.6</u>	<u>19.8</u>	_____	_____
<u>15.1</u>	<u>16.5</u>	<u>16.8</u>	<u>12.2</u>	<u>13.0</u>	_____	_____
<u>16.7</u>	<u>17.0</u>	<u>16.7</u>	<u>17.0</u>	<u>15.0</u>	_____	_____

Time (clock): 10:00 Room Temperature (F): 71 Initials: SK

Technician Signature: _____

Date: 2/8/17

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 3

Wood Heater Preburn Data - ASTM E2780

Run: **3**

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/8/2017
 ginning Clock Time: 12:57

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>8</u>		
Total Preburn Weight (lb):	<u>8.8</u>		
Fuel Moisture Readings (% DB):	<u>21.7</u>	<u>20.2</u>	<u>20.2</u>
	<u>18.6</u>	<u>19.5</u>	<u>20.1</u>
	<u>19.6</u>	<u>18.9</u>	<u>19.3</u>
	<u>19.7</u>	<u>19.1</u>	
Avg Preburn Moisture (% DB):	<u>19.72</u>		

Coal Bed Range (lb): 1.6 (min) 2.1 (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	8.4	-0.062	573	325	331	341	332	325.7	479	69	
10	7.4	-0.05	581	355	329	313	311	342.8	322	69	
20	6.4	-0.05	617	341	329	310	305	351.8	346	68	
30	5.5	-0.05	660	317	333	320	311	362.1	353	69	
40	4.6	-0.048	681	294	338	331	320	373.3	340	69	
50	3.7	-0.047	685	277	340	342	327	385.9	332	68	
60	3	-0.047	692	270	345	350	334	387.1	331	69	
70	2.5	-0.043	687	269	348	355	337	363.3	306	68	
80	2.2	-0.037	639	272	354	350	345	392	265	69	
83	2.1	-0.034	625	274	357	351	347	390.8	259	68	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/8/2017
Run No.: 3

Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	10.5
2x4 Crib Weight (lb):	8.2
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	6.9	
Fuel Density (lb/ft ³ , Dry Basis):	29.82	OK
Loading Density (lb/ft ³ , Wet Basis):	6.36	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.64 - 2.05

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1.1	2"x 4"	19.4	19.1	19.5	0.92
2	1.1	2"x 4"	19.4	19.0	19.1	0.92
3	1.2	2"x 4"	20.3	19.4	19.1	1.00
4	1.2	2"x 4"	20.5	19.7	20.2	1.00
5	1.1	2"x 4"	19.8	21.6	21.3	0.91

Spacer Readings (Dry Basis %)			
17.8			
12.2			
14.6			
8.8			
19.1			
17.6			
17.7			
19.9			
14.3			
16.1			

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 3

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 08-Feb-17
 Beginning Clock Time: 14:42

Total Sampling Time: 170 min
 Recording Interval: 10 min

Background Sample Volume: 0 cubic feet

Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average
29.83 29.8 29.77 29.80 "Hg

OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.260 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.69 ft/sec
 Initial Tunnel Flow: 187.2 scfm
 Average Tunnel Flow: 196.2 scfm
 Post-Test Leak Check (1): 0.000 cfm @ -12 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ -11 in. Hg
 Average Test Piece Fuel Moisture: 19.83 Dry Basis %

Technician Signature: 

Velocity Traverse Data													
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center				
Initial dP	0.052	0.074	0.078	0.052	0.044	0.070	0.074	0.062	0.097	"H2O			
Temp:	90	90	90	90	90	90	90	90	90	*F			
V _{strav}		17.42			ft/sec		V _{scnt}		21.10		ft/sec	F _p	0.826

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft²)	Gas Meter 2 (ft²)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.41	73	0.61	0.11	74	-0.4	100	0.095			8.2		619	274	358	351	350	390	N/A	313	67	68	67	68	69	-0.045	4.02	0.37
10	1.697	1.670	0.17	0.17	1.44	73	2.29	1.18	74	1.3	92	0.102	100	100	7.0	-1.2	620	313	342	320	316	382	N/A	343	70	70	71	70	68	-0.049	9.82	1.15
20	3.393	3.341	0.17	0.17	1.44	75	2.28	1.16	76	1.3	92	0.102	100	100	6.0	-1	648	336	333	305	301	385	N/A	348	71	70	72	70	68	-0.050	10.03	1.74
30	5.091	5.011	0.17	0.17	1.43	76	2.28	1.16	77	1.3	92	0.100	101	101	4.9	-1.1	672	334	326	312	305	390	N/A	344	71	70	73	70	68	-0.050	11.11	1.99
40	6.789	6.682	0.17	0.17	1.43	78	2.29	1.16	78	1.3	94	0.101	100	100	3.8	-1.1	707	323	326	324	312	398	N/A	389	71	70	73	70	69	-0.054	12.37	2.39
50	8.490	8.355	0.17	0.17	1.43	79	2.29	1.16	79	1.3	97	0.101	100	100	2.7	-1.1	752	310	331	338	323	411	N/A	416	72	71	74	71	69	-0.055	12.86	0.42
60	10.194	10.029	0.17	0.17	1.43	80	2.27	1.16	80	1.3	95	0.100	100	101	2.0	-0.7	768	300	341	352	335	419	N/A	364	72	71	74	71	69	-0.049	9.79	0.45
70	11.901	11.706	0.17	0.17	1.43	80	2.27	1.16	81	1.3	91	0.099	101	101	1.7	-0.3	714	293	354	365	343	414	N/A	290	72	72	73	72	68	-0.040	8.54	0.42
80	13.611	13.385	0.17	0.17	1.43	81	2.27	1.17	81	1.3	87	0.099	100	100	1.4	-0.3	645	292	359	365	347	402	N/A	261	71	73	73	73	68	-0.035	7.51	0.88
90	15.323	15.065	0.17	0.17	1.44	81	2.26	1.16	82	1.3	85	0.103	98	98	1.3	-0.1	585	300	357	360	343	389	N/A	240	71	73	72	73	69	-0.032	7.18	1.18
100	17.037	16.747	0.17	0.17	1.44	81	2.27	1.16	81	1.3	83	0.102	99	99	1.1	-0.2	540	310	354	354	336	379	N/A	225	70	73	71	73	69	-0.030	6.93	1.44
110	18.750	18.428	0.17	0.17	1.44	81	2.26	1.17	81	1.3	82	0.099	100	100	1.0	-0.1	510	320	349	348	329	371	N/A	216	70	73	71	73	69	-0.027	6.65	1.47
120	20.465	20.111	0.17	0.17	1.45	81	2.27	1.17	81	1.3	81	0.102	99	99	0.8	-0.2	486	329	346	338	322	364	N/A	211	69	73	71	73	68	-0.027	6.4	1.58
130	22.181	21.795	0.17	0.17	1.44	81	2.27	1.17	81	1.3	80	0.099	100	100	0.7	-0.1	467	336	343	329	316	358	N/A	207	69	73	70	73	68	-0.026	6.23	1.3
140	23.897	23.479	0.17	0.17	1.44	81	2.27	1.17	81	1.3	80	0.099	100	100	0.5	-0.2	454	339	340	325	313	354	N/A	204	69	73	70	73	67	-0.025	6.43	1.26
150	25.611	25.163	0.17	0.17	1.44	80	2.26	1.17	81	1.3	79	0.101	99	99	0.4	-0.1	447	339	337	324	310	351	N/A	202	69	72	70	72	67	-0.025	6.24	1.45
160	27.327	26.845	0.17	0.17	1.44	80	2.26	1.17	81	1.3	79	0.101	99	99	0.2	-0.2	441	338	336	319	309	349	N/A	201	69	72	70	72	68	-0.025	6.17	1.49
170	29.043	28.528	0.17	0.17	1.44	80	2.26	1.17	80	1.3	79	0.102	99	99	0.0	-0.2	439	335	334	317	307	346	N/A	201	69	72	69	72	67	-0.025	6.38	1.4
Avg/Tot	29.043	28.528	0.17	0.17	1.38	79		1.11	79		87	0.100	100	100								44.0				72	71	72	68	-0.037		

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
 Model: Viva L
 Project No.: 0138WS017E
 Tracking No.: 2233
 Run: 3
 Test Date: 02/08/17

Burn Rate	1.107 kg/hr dry
Average Tunnel Temperature	87 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.69 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11769.6 dscf/hour
Average Delta p	0.100 inches H2O
Total Time of Test	170 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	29.043 cubic feet	28.528 cubic feet	10.194 cubic feet
Average Gas Meter Temperature	68 degrees Fahrenheit	79 degrees Fahrenheit	79 degrees Fahrenheit	79 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	27.969 dscf	27.600 dscf	9.817 dscf
Total Particulates - m _t	0 mg	3.5 mg	2.6 mg	2.6 mg
Particulate Concentration (dry-standard) - C _i /C _s	0.000000 grams/dscf	0.00013 grams/dscf	0.00009 grams/dscf	0.00026 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	4.17 grams	3.14 grams	3.12 grams
Particulate Emission Rate	0.00 grams/hour	1.47 grams/hour	1.11 grams/hour	3.12 grams/hour
Emissions Factor		1.33 g/kg	1.00 g/kg	1.33 g/kg
Difference from Average Total Particulate Emissions		0.52 grams	0.52 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	3.66 grams
Particulate Emission Rate	1.29 grams/hour
Emissions Factor	1.17 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	3.12 grams
Particulate Emission Rate	3.12 grams/hour
Emissions Factor	1.33 grams/kg
7.5% of Average Total Particulate Emissions	0.27 grams


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/08/17
Run: 3
Control #: 0138WS017E
Test Duration: 170
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	70.8%	76.6%
Combustion Efficiency	89.9%	89.9%
Heat Transfer Efficiency	79%	85.2%

Output Rate (kJ/h)	15,377	14,587	(Btu/h)
Burn Rate (kg/h)	1.10	2.42	(lb/h)
Input (kJ/h)	21,709	20,593	(Btu/h)

Test Load Weight (dry kg)	3.10	6.84	dry lb
MC wet (%)	16.55		
MC dry (%)	19.83		
Particulate (g)	N/A		
CO (g)	434		
Test Duration (h)	2.83		

Emissions	Particulate	CO
g/MJ Output	N/A	9.97
g/kg Dry Fuel	N/A	139.86
g/h	N/A	153.27
lb/MM Btu Output	N/A	23.16

Air/Fuel Ratio (A/F)	13.12
----------------------	-------

VERSION:

2.2

12/14/2009

Client: RAIS Project Number: 0138WS017E Run Number: 3

Model: VIVA L Tracking Number: 2233 Date: 2/8/2017 2/8/17

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

Secondary: Fixed

15min Open

Tertiary/Pilot: Fixed

Fan: NA

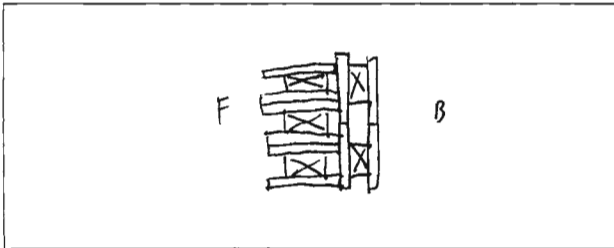
Preburn Notes

Time	Notes
15 min	set air to test setting
55min	knock-ed down preburn load, added 0.7 lbs of wood

Test Notes

Sketch test fuel configuration:

Start up procedures & Timeline:



Bypass: NA
 Fuel loaded by: 35 sec
 Door closed at: 45 sec
 Primary air: Startup V.A.I: 4:30
Set from 4:50-5:00

Notes:

Time	Notes
	<u>None</u>

Technician Signature: _____

Date: 2/8/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 3

Model: VIVA L Tracking Number: 2233 Date: 2/6/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 14:42

Booth #: E /

Stop Time: 17:32

Stack Gas Leak Check:

Initial: 0 Final: 0

Sample Train Leak Check:

A: 0 @ -12 "Hg

B: 0 @ -11 "Hg

Calibrations: Span Gas CO₂: 16.74 CO(%): 4.20 CO(ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>9:07</u>	<u>9:09</u>	<u>17:41</u>	<u>17:43</u>
CO ₂	<u>0.00</u>	<u>16.75</u>	<u>0.06</u>	<u>16.87</u>
CO(%)	<u>0.000</u>	<u>4.200</u>	<u>0.021</u>	<u>4.261</u>
CO(ppm)	<u>1</u>	<u>N/A</u>	<u>3</u>	<u>N/A</u>

Air Velocity (ft/min): Initial: 50 Final: 250

Scale Audit (lbs): Initial: 10.0 Final: 10.0

Pitot Tube Leak Test: Initial: 0 Final: 0

Stack Diameter (in): 6

Induced Draft: 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in Series:

Date: 2/2 Initials: A

	Initial	Middle	Ending
P _b (in/Hg)	<u>29.83</u>	<u>29.80</u>	<u>29.77</u>
RH (%)	<u>25.6</u>	<u>24.8</u>	<u>23.8</u>
Ambient (°F)	<u>70.1</u>	<u>70.3</u>	<u>69.9</u>

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
<u>0.026</u>	<u>0.052</u>	<u>90</u>
<u>0.037</u>	<u>0.074</u>	
<u>0.039</u>	<u>0.078</u>	
<u>0.026</u>	<u>0.052</u>	
<u>0.022</u>	<u>0.044</u>	
<u>0.035</u>	<u>0.070</u>	
<u>0.037</u>	<u>0.074</u>	
<u>0.031</u>	<u>0.062</u>	
Center:		
<u>-</u>	<u>0.097</u>	<u>90</u>

Background Filter Volume: N/A

Technician Signature: [Signature]

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
<u>-0.26</u>	<u>-0.26</u>

Date: 2/8/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 3
 Model: VIVA L Tracking Number: 2233 Date: 2/8/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel

Calibration: Cal Value (1) = 12% Actual Reading 12.0
 Cal Value (2) = 22% Actual Reading 22.0

Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8</u> in	<u>21.7</u>	7	<u>8</u> in	<u>18.9</u>
2	<u> </u> in	<u>18.6</u>	8	<u> </u> in	<u>19.1</u>
3	<u> </u> in	<u>19.6</u>	9	<u> </u> in	<u>20.2</u>
4	<u> </u> in	<u>19.7</u>	10	<u> </u> in	<u>20.1</u>
5	<u> </u> in	<u>20.2</u>	11	<u> </u> in	<u>19.3</u>
6	<u> </u> in	<u>19.5</u>	12	<u> </u> in	<u> </u>

Total Pre-Burn Fuel Weight: 8.8 Pre-Burn Fuel Average Moisture: 19.72
 Time (clock): 12:30 Room Temperature (F): 70 Initials:

Test Fuel

Firebox Volume (ft³): 1.29 Test Fuel Piece Length (in): 10.5
 Load Weight Range (lb): 8.2-9.9 Total Wet Fuel Load Weight (lb): 8.2

Fuel Type & Amount: 2 x 4: 5 4 x 4:
 Weight (with spacers): 8.2 Weight (with spacers):

Piece:	Weight (lbs):	Moisture Readings (%DB):				Fuel Type:
1	<u>1.1</u>	<u>19.4</u>	<u>19.1</u>	<u>19.5</u>	<u>2x4</u>	
2	<u>1.1</u>	<u>19.4</u>	<u>19.0</u>	<u>19.1</u>	<u> </u>	
3	<u>1.2</u>	<u>20.3</u>	<u>19.4</u>	<u>19.1</u>	<u> </u>	
4	<u>1.2</u>	<u>20.5</u>	<u>19.7</u>	<u>20.2</u>	<u> </u>	
5	<u>1.1</u>	<u>19.8</u>	<u>21.6</u>	<u>21.3</u>	<u> </u>	
6	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>	
7	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>	

Spacer Moisture Readings (%DB) (All spacers cut from single 2x4)

<u>17.8</u>	<u>19.1</u>	<u>19.3</u>	<u> </u>	<u> </u>	<u> </u>
<u>12.2</u>	<u>17.6</u>	<u>16.1</u>	<u> </u>	<u> </u>	<u> </u>
<u>14.6</u>	<u>17.7</u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
<u>8.8</u>	<u>19.9</u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>

Time (clock): 12:30 Room Temperature (F): 70 Initials:

Technician Signature: [Signature] Date: 2/8/17

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 4

Wood Heater Preburn Data - ASTM E2780

Run: 4

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/9/2017
 Beginning Clock Time: 9:15

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>8.0</u>		
Total Preburn Weight (lb):	<u>8.3</u>		
	<u>21.7</u>	<u>20.2</u>	<u>19.1</u>
Fuel Moisture Readings (% DB):	<u>22.4</u>	<u>19.4</u>	<u>19.6</u>
	<u>21.9</u>	<u>22.6</u>	<u>21.7</u>
	<u>19.9</u>	<u>20.4</u>	
Avg Preburn Moisture (% DB):	<u>20.81</u>		

Coal Bed Range (lb): 1.6 (min) 2.1 (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	8.8	-0.041	440	155	232	268	251	269.2	315	68	
0	7.6	-0.052	462	258	271	259	251	300.3	381	68	
10	6.6	-0.048	530	304	297	270	258	331.9	325	68	
20	5.6	-0.05	598	306	299	293	281	355.3	349	69	
30	4.7	-0.045	653	297	306	316	300	374.4	322	69	
40	4.0	-0.045	676	289	313	327	314	383.7	313	68	
50	3.1	-0.047	695	283	324	337	322	392.1	340	69	
60	2.5	-0.041	707	280	339	350	333	401.6	306	70	
70	2.0	-0.036	687	278	345	361	341	402.5	271	70	
72	2.0	-0.035	678	277	345	358	341	399.9	263	70	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/9/2017
Run No.: 4

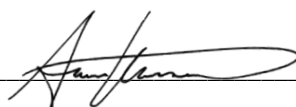
Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	10.5
2x4 Crib Weight (lb):	8.2
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	6.922	
Fuel Density (lb/ft ³ , Dry Basis):	29.56	OK
Loading Density (lb/ft ³ , Wet Basis):	6.36	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.64 - 2.05

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1.1	2"x 4"	23.6	23.0	21.5	0.90
2	1.1	2"x 4"	19.9	22.7	24.5	0.90
3	1.2	2"x 4"	19.2	19.0	19.1	1.01
4	1.2	2"x 4"	19.9	22.4	21.0	0.99
5	1.1	2"x 4"	19.7	19.6	19.1	0.92

Spacer Readings (Dry Basis %)			
8.1	13.4		
8.7	8.9		
9.3	14.1		
8.8	8.8		
16.7	12.8		
17.9	12.9		
17.0	17.1		
12.2	17.0		
17.0	14.4		
12.8	17.6		

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 4

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 09-Feb-17
 Beginning Clock Time: 10:27

Total Sampling Time: 190 min
 Recording Interval: 10 min

Background Sample Volume: 0 cubic feet

Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average
29.51 29.51 29.50 29.51 "Hg

OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.270 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.58 ft/sec.
 Initial Tunnel Flow: 185.4 scfm
 Average Tunnel Flow: 192.1 scfm
 Post-Test Leak Check (1): 0.000 cfm @ 12 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ 9 in. Hg
 Average Test Piece Fuel Moisture: 20.95 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.048	0.070	0.076	0.058	0.044	0.076	0.076	0.056	0.098
Temp:	92	92	92	92	93	93	93	93	93
V _{strav}	17.54 ft/sec				V _{scnt} 21.39 ft/sec				F _p 0.820

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.03	73	0.04	0.27	73	0.0	106	0.098			8.2		669	277	345	356	343	398.0	N/A	341	68	68	68	68	70	-0.048	4.05	0.24
10	1.673	1.661	0.17	0.17	1.40	74	2.23	1.15	74	1.3	94	0.102	99	99	7.2	-1.0	638	311	338	319	308	382.8	N/A	328	71	71	72	72	70	-0.047	8.55	0.46
20	3.356	3.327	0.17	0.17	1.39	76	2.21	1.14	76	1.3	93	0.098	101	101	6.4	-0.8	647	331	333	304	293	381.6	N/A	311	72	72	73	73	71	-0.045	8.98	0.36
30	5.039	4.994	0.17	0.17	1.39	77	2.20	1.14	78	1.3	93	0.098	101	101	5.7	-0.7	665	327	318	297	291	379.6	N/A	309	72	72	73	73	70	-0.044	9.85	0.69
40	6.725	6.663	0.17	0.17	1.39	79	2.21	1.14	79	1.3	96	0.098	101	101	4.7	-1.0	680	317	318	303	298	383.2	N/A	375	73	73	74	74	70	-0.051	12.74	0.88
50	8.413	8.335	0.17	0.17	1.38	80	2.21	1.14	81	1.3	98	0.098	101	101	3.6	-1.1	715	307	330	320	312	396.8	N/A	382	73	73	74	74	70	-0.052	11.52	3.9
60	10.103	10.006	0.17	0.17	1.38	81	2.21	1.14	82	1.3	99	0.100	100	100	2.6	-1.0	741	297	345	336	328	409.4	N/A	386	73	73	75	75	70	-0.053	11.86	2.4
70	11.794	11.680	0.17	0.17	1.38	82	2.21	1.14	82	1.3	96	0.096	102	102	1.9	-0.7	754	289	357	357	344	420.2	N/A	329	74	74	75	75	71	-0.044	9.09	0.44
80	13.489	13.357	0.17	0.17	1.39	82	2.22	1.14	83	1.3	92	0.098	101	100	1.6	-0.3	692	284	364	368	352	412.0	N/A	269	74	74	75	75	71	-0.036	7.79	0.49
90	15.185	15.036	0.17	0.17	1.39	83	2.22	1.15	83	1.3	90	0.098	100	100	1.4	-0.2	630	284	364	366	350	398.8	N/A	245	73	73	74	74	71	-0.033	7.32	0.6
100	16.883	16.716	0.17	0.17	1.39	83	2.22	1.15	84	1.3	87	0.097	101	100	1.2	-0.2	575	290	361	359	346	386.2	N/A	227	73	73	74	74	71	-0.029	6.7	1.02
110	18.581	18.398	0.17	0.17	1.39	83	2.21	1.15	84	1.3	85	0.100	99	99	1.1	-0.1	532	299	353	350	338	374.4	N/A	215	73	73	73	73	70	-0.027	6.54	0.95
120	20.282	20.081	0.17	0.17	1.40	83	2.21	1.14	83	1.3	85	0.099	100	100	1.0	-0.1	500	309	346	339	328	364.4	N/A	210	72	72	73	73	70	-0.025	6.82	0.91
130	21.982	21.763	0.17	0.17	1.39	83	2.22	1.14	83	1.3	84	0.100	99	99	0.8	-0.2	480	316	341	332	321	358.0	N/A	203	72	72	72	72	70	-0.024	6.44	1.05
140	23.681	23.446	0.17	0.17	1.40	83	2.21	1.15	83	1.3	84	0.102	98	98	0.7	-0.1	466	321	337	327	318	353.8	N/A	201	72	72	72	72	70	-0.024	6.69	1.08
150	25.382	25.128	0.17	0.17	1.40	83	2.21	1.15	83	1.3	84	0.096	101	101	0.6	-0.1	457	323	335	325	315	351.0	N/A	196	72	72	72	72	70	-0.023	6.38	1.22
160	27.081	26.810	0.17	0.17	1.39	83	2.21	1.14	83	1.3	83	0.098	100	100	0.4	-0.2	448	324	332	320	312	347.2	N/A	195	72	72	72	72	70	-0.023	6.37	1.3
170	28.782	28.494	0.17	0.17	1.39	83	2.22	1.15	83	1.3	83	0.100	99	99	0.3	-0.1	442	324	330	319	310	345.0	N/A	195	72	72	72	72	70	-0.023	6.24	1.34
180	30.484	30.178	0.17	0.17	1.40	83	2.22	1.14	83	1.3	83	0.100	99	99	0.1	-0.2	439	324	329	315	309	343.2	N/A	194	72	72	72	72	70	-0.023	6.06	1.46
190	32.183	31.861	0.17	0.17	1.39	83	2.22	1.15	83	1.3	83	0.105	96	97	0.0	-0.1	437	324	329	312	307	341.8	N/A	195	72	72	72	72	70	-0.023	5.94	1.33
Avg/Tot	32.183	31.861	0.17	0.17	1.32	81		1.10	81		90	0.099	100	100								56.2			72	73	73	70	-0.035			

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
Model: Viva L
Project No.: 0138WS017E
Tracking No.: 2233
Run: 4
Test Date: 02/09/17

Burn Rate	0.991 kg/hr dry
Average Tunnel Temperature	90 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.58 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11523.4 dscf/hour
Average Delta p	0.099 inches H2O
Total Time of Test	190 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	32.183 cubic feet	31.861 cubic feet	10.103 cubic feet
Average Gas Meter Temperature	70 degrees Fahrenheit	81 degrees Fahrenheit	81 degrees Fahrenheit	81 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	30.577 dscf	30.422 dscf	9.599 dscf
Total Particulates - m _n	0 mg	2.4 mg	1.8 mg	0.9 mg
Particulate Concentration (dry-standard) - C _p /C _s	0.000000 grams/dscf	0.00008 grams/dscf	0.00006 grams/dscf	0.00009 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	2.86 grams	2.16 grams	1.08 grams
Particulate Emission Rate	0.00 grams/hour	0.90 grams/hour	0.68 grams/hour	1.08 grams/hour
Emissions Factor		0.91 g/kg	0.69 g/kg	0.51 g/kg
Difference from Average Total Particulate Emissions		0.35 grams	0.35 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	2.51 grams
Particulate Emission Rate	0.79 grams/hour
Emissions Factor	0.80 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	1.08 grams
Particulate Emission Rate	1.08 grams/hour
Emissions Factor	0.51 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/09/17
Run: 4
Control #: 0138WS017E
Test Duration: 190
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	72.2%	78.0%
Combustion Efficiency	91.2%	91.2%
Heat Transfer Efficiency	79%	85.5%

Output Rate (kJ/h)	13,889	13,175	(Btu/h)
Burn Rate (kg/h)	0.97	2.14	(lb/h)
Input (kJ/h)	19,244	18,255	(Btu/h)

Test Load Weight (dry kg)	3.08	6.78	dry lb
MC wet (%)	17.32		
MC dry (%)	20.95		
Particulate (g)	N/A		
CO (g)	376		
Test Duration (h)	3.17		

Emissions	Particulate	CO
g/MJ Output	N/A	8.54
g/kg Dry Fuel	N/A	122.08
g/h	N/A	118.59
lb/MM Btu Output	N/A	19.84

Air/Fuel Ratio (A/F)	13.68
----------------------	-------

VERSION:

2.2

12/14/2009

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 4
 Model: VIVA L Tracking Number: 2233 Date: 2/8/2017 2/9/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

Secondary: Fixed

Open 13mn

Tertiary/Pilot: Fixed

Fan: N/A

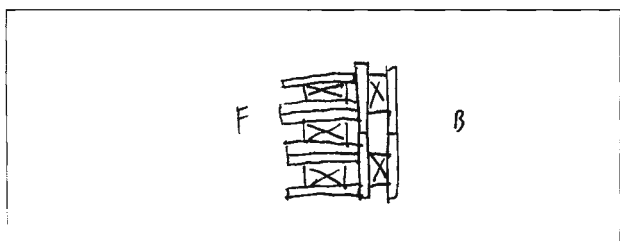
Preburn Notes

Time	Notes
0:00	Reduced air to test setting (logger ET = 10:00)
72:00	PB END, coal bed 2.0

Test Notes

Sketch test fuel configuration:

Start up procedures & Timeline:



Bypass: N/A
 Fuel loaded by: 0:20
 Door closed at: 0:25
 Primary air: Set to start-up until 4:30
High until 4:50
Set from 4:50-5:00

Notes: _____

Time	Notes
	<u>N/A</u>

Technician Signature: [Signature]

Date: 2/9/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 4
 Model: VIVA L Tracking Number: 2233 Date: 2/6/2017 2/9/2017
 Test Crew: S. Button, A. Kravitz SB
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 10:27 Booth #: E1

Stop Time: 13:37

Stack Gas Leak Check:

Initial: 0 Final: 0

Sample Train Leak Check:

A: 0 @ 12 "Hg
 B: 0 @ 9 "Hg

Calibrations: Span Gas CO₂: 16.74 CO(%): 4.20 CO(ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	8:15	8:17	19:09	19:05
CO ₂	0.00	16.75	0.02	16.66
CO(%)	0.000	4.201	0.007	4.122
CO(ppm)	0	N/A		

Air Velocity (ft/min): Initial: <50 Final: 550
 Scale Audit (lbs): Initial: 10.0 Final: 10.0
 Pitot Tube Leak Test: Initial: 0 Final: 0
 Stack Diameter (in): 6"
 Induced Draft: 0
 % Smoke Capture: 100%
 Flue Pipe Cleaned Prior to First Test in Series:
 Date: 2/2 Initials: A

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
0.024	0.048	42
0.035	0.070	
0.038	0.076	
0.029	0.058	
0.022	0.044	43
0.038	0.076	
0.038	0.076	
0.028	0.056	
Center:		
-	0.048	43

	Initial	Middle	Ending
P _b (in/Hg)	29.51	29.51	29.50
RH (%)	29.7	26.5	34.6
Ambient (°F)	69.4	72.8	70.5

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
-0.27	-0.27

Background Filter Volume: N/A

Technician Signature: [Signature]

Date: 2/10/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 4
 Model: VIVA L Tracking Number: 2233 Date: ~~2/0/2017~~ 2/9/2017
 Test Crew: S. Button, A. Kravitz 58
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel

Calibration: Cal Value (1) = 12% Actual Reading 12.6
 Cal Value (2) = 22% Actual Reading 22.6

Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8</u> in	<u>21.7</u>	7	<u>8</u> in	<u>19.4</u>
2	<u>8</u> in	<u>22.4</u>	8	<u>8</u> in	<u>20.2</u>
3	<u>8</u> in	<u>21.9</u>	9	<u>8</u> in	<u>19.1</u>
4	<u>8</u> in	<u>14.9</u>	10	<u>8</u> in	<u>14.6</u>
5	<u>8</u> in	<u>20.4</u>	11	<u>8</u> in	<u>21.7</u>
6	<u>8</u> in	<u>22.6</u>	12	<u>8</u> in	<u>21.7</u>

Total Pre-Burn Fuel Weight: 8.3 Pre-Burn Fuel Average Moisture: 20.81
 Time (clock): 0930 Room Temperature (F): 68 Initials: A

Test Fuel

Firebox Volume (ft³): 1.29 Test Fuel Piece Length (in): 16.5
 Load Weight Range (lb): 8.2-9.4 Total Wet Fuel Load Weight (lb): 8.2

Fuel Type & Amount: 2 x 4: 5 4 x 4: _____
 Weight (with spacers): 8.2 Weight (with spacers): _____

Piece:	Weight (lbs):	Moisture Readings (%DB):				Fuel Type:
1	<u>1.2</u>	<u>19.2</u>	<u>19.0</u>	<u>19.1</u>	<u>2x4</u>	
2	<u>1.2</u>	<u>19.9</u>	<u>22.4</u>	<u>21.0</u>	<u>2x4</u>	
3	<u>1.1</u>	<u>23.6</u>	<u>23.0</u>	<u>21.5</u>	<u>2x4</u>	
4	<u>1.1</u>	<u>19.9</u>	<u>22.7</u>	<u>24.5</u>	<u>2x4</u>	
5	<u>1.1</u>	<u>19.7</u>	<u>19.6</u>	<u>19.1</u>	<u>2x4</u>	
6	_____	_____	_____	_____	_____	
7	_____	_____	_____	_____	_____	

Spacer Moisture Readings (%DB)

<u>8.1</u>	<u>16.7</u>	<u>17.6</u>	<u>14.1</u>	<u>17.1</u>	_____	_____
<u>8.7</u>	<u>17.9</u>	<u>12.8</u>	<u>8.8</u>	<u>17.0</u>	_____	_____
<u>9.3</u>	<u>17.0</u>	<u>13.4</u>	<u>12.8</u>	<u>14.4</u>	_____	_____
<u>8.8</u>	<u>12.2</u>	<u>8.9</u>	<u>12.9</u>	<u>17.6</u>	_____	_____

Time (clock): 0930 Room Temperature (F): 68 Initials: A

Technician Signature: [Signature] Date: 2/9/17

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 5

Wood Heater Preburn Data - ASTM E2780

Run: **5**

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/9/2017
 Beginning Clock Time: 14:18

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>8.0</u>		
Total Preburn Weight (lb):	<u>8.3</u>		
	<u>20.8</u>	<u>19.9</u>	<u>24.6</u>
Fuel Moisture Readings (% DB):	<u>19.7</u>	<u>22.2</u>	<u>23.8</u>
	<u>24.3</u>	<u>18.6</u>	<u>20.1</u>
	<u>22.1</u>	<u>19.9</u>	
Avg Preburn Moisture (% DB):	<u>21.45</u>		

Coal Bed 1.6 2.1
 Range (lb): (min) (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	7.9	-0.057	579	387	328	319	321	386.9	440	71	
10	7.1	-0.042	568	403	331	314	311	385.4	278	72	
20	6.2	-0.046	576	381	320	310	306	378.6	307	71	
30	5.2	-0.043	613	354	325	325	322	387.7	298	71	
40	4.5	-0.042	651	333	327	331	330	394.5	293	71	
50	3.7	-0.044	674	317	329	335	334	397.7	316	72	
60	3.0	-0.043	692	303	337	344	337	402.8	303	71	
70	2.5	-0.04	692	292	346	354	344	405.7	289	72	
80	2.2	-0.035	666	286	347	358	343	400.0	259	72	
83	2.1	-0.034	651	285	347	357	340	396.0	252	72	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/9/2017
Run No.: 5

Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	10.5
2x4 Crib Weight (lb):	8.2
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	6.843	
Fuel Density (lb/ft ³ , Dry Basis):	29.32	OK
Loading Density (lb/ft ³ , Wet Basis):	6.36	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.64 - 2.05

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1.1	2"x 4"	20.9	22.5	22.8	0.90
2	1.1	2"x 4"	23.3	21.2	21.3	0.90
3	1.2	2"x 4"	22.4	23.9	21.1	0.98
4	1.2	2"x 4"	22.1	21.7	21.1	0.99
5	1.1	2"x 4"	21.4	22.5	20.1	0.91

Spacer Readings (Dry Basis %)			
19.3	14.6		
14.8	12.8		
19.1	19.5		
18.3	9.9		
11.7	16.0		
8.9	13.3		
20.1	15.0		
14.1	18.8		
13.6	12.7		
20.4	14.9		

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 5
 Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 09-Feb-17
 Beginning Clock Time: 15:41
 Total Sampling Time: 200 min
 Recording Interval: 10 min
 Background Sample Volume: 0 cubic feet
 Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)
 Barometric Pressure: Begin Middle End Average
29.53 29.56 29.61 29.57 "Hg
 OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.270 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99
 Avg. Tunnel Velocity: 17.72 ft/sec
 Initial Tunnel Flow: 185.6 scfm
 Average Tunnel Flow: 194.1 scfm
 Post-Test Leak Check (1): 0.000 cfm @ 12 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ 9 in. Hg
 Average Test Piece Fuel Moisture: 21.89 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.048	0.070	0.076	0.058	0.044	0.076	0.076	0.056	0.098
Temp:	92	92	92	92	93	93	93	93	93
V _{strav}	17.53 ft/sec				V _{scnt} 21.38 ft/sec				F _p 0.820

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data				
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.03	77	1.88	0.17	0.18	77.0	108	0.097			8.2		645	285	347	356	341	394.8	N/A	313	70	70	70	70	72	-0.045	3.89	0.29
10	1.685	1.673	0.17	0.17	1.40	77	2.26	0.17	1.16	78.0	96	0.099	102	101	7.2	-1.0	613	316	340	319	307	379.0	N/A	315	73	73	74	74	72	-0.046	9.35	1.09
20	3.370	3.345	0.17	0.17	1.39	79	2.25	0.17	1.14	79.0	93	0.100	101	100	6.4	-0.8	608	336	343	302	296	377.0	N/A	293	74	74	74	74	71	-0.044	9.62	0.92
30	5.055	5.017	0.17	0.17	1.38	80	2.24	0.17	1.14	80.0	93	0.098	102	101	5.5	-0.9	631	333	340	300	297	380.2	N/A	320	74	74	75	75	71	-0.047	11.45	2.13
40	6.741	6.691	0.17	0.17	1.38	81	2.25	0.17	1.15	81.0	95	0.101	100	100	4.6	-0.9	661	323	333	308	304	385.8	N/A	354	74	74	75	75	71	-0.051	13.13	0.63
50	8.430	8.367	0.17	0.17	1.38	82	2.24	0.17	1.15	82.0	98	0.103	99	99	3.6	-1.0	702	312	332	321	311	395.6	N/A	408	74	74	75	75	70	-0.056	14.11	1.61
60	10.120	10.045	0.17	0.17	1.39	82	2.25	0.17	1.15	83.0	99	0.099	102	102	2.7	-0.9	744	302	335	333	322	407.2	N/A	403	74	74	75	75	71	-0.055	13.91	0.95
70	11.812	11.723	0.17	0.17	1.39	83	2.25	0.17	1.15	84.0	95	0.103	99	99	2.0	-0.7	760	293	340	349	332	414.8	N/A	343	74	74	75	75	71	-0.049	10.34	0.16
80	13.507	13.404	0.17	0.17	1.39	83	2.25	0.17	1.15	84.0	92	0.102	100	100	1.7	-0.3	714	287	347	347	343	409.8	N/A	272	74	74	74	74	72	-0.039	8.77	0.31
90	15.202	15.087	0.17	0.17	1.39	83	2.24	0.17	1.16	84.0	87	0.106	97	97	1.5	-0.2	646	286	353	361	344	398.0	N/A	239	73	73	73	73	70	-0.034	7.13	1.15
100	16.900	16.772	0.17	0.17	1.39	83	2.24	0.17	1.15	84.0	85	0.103	99	99	1.4	-0.1	585	292	350	352	335	382.8	N/A	220	72	72	73	73	70	-0.031	7.15	1.17
110	18.596	18.457	0.17	0.17	1.40	83	2.24	0.17	1.15	83.0	84	0.100	100	100	1.2	-0.2	540	298	347	341	329	371.0	N/A	207	72	72	72	72	70	-0.027	6.64	1.51
120	20.295	20.141	0.17	0.17	1.39	83	2.25	0.17	1.15	83.0	84	0.102	99	99	1.1	-0.1	503	303	343	334	320	360.6	N/A	200	72	72	72	72	70	-0.025	6.72	1.38
130	21.991	21.826	0.17	0.17	1.40	83	2.24	0.17	1.16	83.0	84	0.101	99	100	0.9	-0.2	478	309	339	327	317	354.0	N/A	192	72	72	72	72	70	-0.024	6.77	1.35
140	23.689	23.512	0.17	0.17	1.40	83	2.25	0.17	1.15	83.0	84	0.098	101	101	0.8	-0.1	464	314	335	321	315	349.8	N/A	190	72	72	73	73	71	-0.023	6.34	1.48
150	25.386	25.197	0.17	0.17	1.40	83	2.25	0.17	1.15	83.0	84	0.105	98	98	0.7	-0.1	450	316	332	315	311	344.8	N/A	188	72	72	73	73	71	-0.022	6.18	1.62
160	27.085	26.881	0.17	0.17	1.40	83	2.25	0.17	1.16	83.0	83	0.101	99	100	0.6	-0.1	441	316	330	311	308	341.2	N/A	183	72	72	73	73	71	-0.021	6.25	1.72
170	28.782	28.565	0.17	0.17	1.39	83	2.24	0.17	1.15	84.0	83	0.099	100	101	0.4	-0.2	431	316	328	308	306	337.8	N/A	183	72	72	73	73	71	-0.021	5.99	1.93
180	30.480	30.250	0.17	0.17	1.40	84	2.24	0.17	1.15	84.0	84	0.100	100	100	0.3	-0.1	423	316	325	305	303	334.4	N/A	180	72	72	73	73	71	-0.021	6.16	1.86
190	32.178	31.935	0.17	0.17	1.40	84	2.25	0.17	1.15	84.0	83	0.102	99	99	0.2	-0.1	419	316	323	304	301	332.6	N/A	180	72	72	73	73	72	-0.020	6.39	1.68
200	33.877	33.619	0.17	0.17	1.40	84	2.24	0.17	1.15	84	83	0.100	100	100	0.0	-0.2	415	315	321	300	300	330	N/A	179	72	72	73	73	71	-0.021	4.86	3.22
Avg/Tot	33.877	33.619	0.17	0.17	1.33	82		0.17	1		89	0.101	100	100								64.6				73	73	73	71	-0.034		

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
 Model: Viva L
 Project No.: 0138WS017E
 Tracking No.: 2233
 Run: 5
 Test Date: 02/09/17

Burn Rate	0.931 kg/hr dry
Average Tunnel Temperature	89 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.72 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11648.0 dscf/hour
Average Delta p	0.101 inches H2O
Total Time of Test	200 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	33.877 cubic feet	33.619 cubic feet	10.120 cubic feet
Average Gas Meter Temperature	71 degrees Fahrenheit	82 degrees Fahrenheit	1 degrees Fahrenheit	82 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	32.181 dscf	37.662 dscf	9.613 dscf
Total Particulates - m _n	0 mg	2.8 mg	3.1 mg	1.3 mg
Particulate Concentration (dry-standard) - C _i /C _s	0.000000 grams/dscf	0.00009 grams/dscf	0.00008 grams/dscf	0.00014 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	3.38 grams	3.20 grams	1.58 grams
Particulate Emission Rate	0.00 grams/hour	1.01 grams/hour	0.96 grams/hour	1.58 grams/hour
Emissions Factor		1.09 g/kg	1.03 g/kg	0.77 g/kg
Difference from Average Total Particulate Emissions		0.09 grams	0.09 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	3.29 grams
Particulate Emission Rate	0.99 grams/hour
Emissions Factor	1.06 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	1.58 grams
Particulate Emission Rate	1.58 grams/hour
Emissions Factor	0.77 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/09/17
Run: 5
Control #: 0138WS017E
Test Duration: 200
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	72.6%	78.4%
Combustion Efficiency	91.0%	91.0%
Heat Transfer Efficiency	80%	86.2%

Output Rate (kJ/h)	13,167	12,490	(Btu/h)
Burn Rate (kg/h)	0.92	2.02	(lb/h)
Input (kJ/h)	18,141	17,208	(Btu/h)

Test Load Weight (dry kg)	3.05	6.73	dry lb
MC wet (%)	17.96		
MC dry (%)	21.89		
Particulate (g)	N/A		
CO (g)	381		
Test Duration (h)	3.33		

Emissions	Particulate	CO
g/MJ Output	N/A	8.68
g/kg Dry Fuel	N/A	124.84
g/h	N/A	114.32
lb/MM Btu Output	N/A	20.18

Air/Fuel Ratio (A/F)	12.82
----------------------	-------

VERSION:

2.2

12/14/2009

Client: RAIS Project Number: 0138WS017E Run Number: 5
 Model: VIVA L Tracking Number: 2233 Date: ~~2/6/2017~~ 2/9/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

13 mm open

Secondary: Fixed

Tertiary/Pilot: Fixed

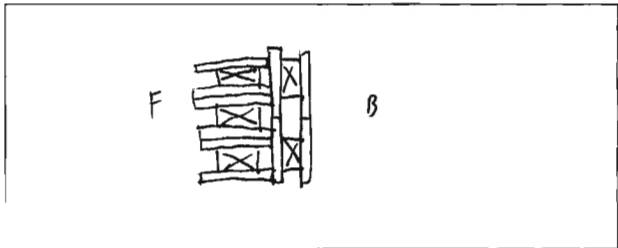
Fan: NA

Preburn Notes

Time	Notes
0:00	Began PB @ test setting (logger ET=11:00)
83:00	End PB, cowl bec = 2.1

Test Notes

Sketch test fuel configuration:



Start up procedures & Timeline:

Bypass: NA
 Fuel loaded by: 0:25
 Door closed at: 0:35
 Primary air: Startup air until 4:30
High 4:30-4:50
Slowly set to test 4:50-5:00
 Notes: _____

Time	Notes
	None

Technician Signature: [Signature]

Date: 2/9/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 5
 Model: VIVA L Tracking Number: 2233 Date: 2/6/2017 2/9/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 15:41 Booth #: E1

Stop Time: 19:01

Stack Gas Leak Check:

Initial: 0 Final: 0

Sample Train Leak Check:

A: 0 @ 17 "Hg
 B: 0 @ 9 "Hg

Calibrations: Span Gas CO₂: 16.74 CO(%): 4.20 CO(ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	8:15	8:17	19:04	19:05
CO ₂	0.00	16.75	0.09	16.66
CO(%)	0.000	4.201	0.007	4.129
CO(ppm)	6			

Air Velocity (ft/min): Initial: 450 Final: 450

Scale Audit (lbs): Initial: 10.0 Final: 10.0

Pitot Tube Leak Test: Initial: 0 Final: 0

Stack Diameter (in): 6

Induced Draft: 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in Series:

Date: 2/2 Initials: A

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
0.024	0.048	92
0.035	0.070	↓
0.038	0.076	↓
0.029	0.058	↓
0.022	0.044	93
0.038	0.076	↓
0.038	0.076	↓
0.028	0.056	↓
Center:		
-	0.098	93

	Initial	Middle	Ending
P _b (in/Hg)	29.53	29.56 36.21	29.61
RH (%)	35.1	36.2	35.7
Ambient (°F)	71.0	72.8	73.0

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
-0.27	-0.27

Background Filter Volume: NA

Technician Signature: [Signature]

Date: 2/16/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 5
 Model: VIVA L Tracking Number: 2233 Date: 2/9/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel

Calibration: Cal Value (1) = 12% Actual Reading 2.0
 Cal Value (2) = 22% Actual Reading 22.12

Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8</u> in	<u>20.8</u>	7	<u>9</u> in	<u>22.2</u>
2	<u>8</u> in	<u>19.7</u>	8	<u>9</u> in	<u>19.9</u>
3	<u>8</u> in	<u>24.3</u>	9	<u>9</u> in	<u>24.6</u>
4	<u>8</u> in	<u>22.1</u>	10	<u>9</u> in	<u>23.8</u>
5	<u>8</u> in	<u>19.9</u>	11	<u>9</u> in	<u>20.1</u>
6	<u>8</u> in	<u>18.6</u>	12	<u>9</u> in	<u>20.1</u>

Total Pre-Burn Fuel Weight: 8.4 Pre-Burn Fuel Average Moisture: 21.45
 Time (clock): 14:00 Room Temperature (F): 70 Initials: A

Test Fuel

Firebox Volume (ft³): 1.29 Test Fuel Piece Length (in): 10.5
 Load Weight Range (lb): 8.2-9.1 Total Wet Fuel Load Weight (lb): 8.2

Fuel Type & Amount: 2 x 4: 8.5 4 x 4: _____
 Weight (with spacers): 8.2 Weight (with spacers): _____

Piece:	Weight (lbs):	Moisture Readings (%DB):				Fuel Type:
1	<u>1.2</u>	<u>22.4</u>	<u>23.9</u>	<u>21.1</u>	<u>21.1</u>	<u>2x4</u>
2	<u>1.2</u>	<u>22.1</u>	<u>21.7</u>	<u>21.1</u>	<u>21.1</u>	<u>2x4</u>
3	<u>1.1</u>	<u>20.9</u>	<u>22.5</u>	<u>22.8</u>	<u>22.8</u>	<u>2x4</u>
4	<u>1.1</u>	<u>23.3</u>	<u>21.2</u>	<u>21.3</u>	<u>21.3</u>	<u>2x4</u>
5	<u>1.1</u>	<u>21.4</u>	<u>22.5</u>	<u>20.1</u>	<u>20.1</u>	<u>2x4</u>
6	_____	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____	_____

Spacer Moisture Readings (%DB)

<u>19.3</u>	<u>11.7</u>	<u>20.4</u>	<u>19.5</u>	<u>15.0</u>	_____	_____
<u>14.8</u>	<u>8.9</u>	<u>20.1</u>	<u>19.9</u>	<u>14.8</u>	_____	_____
<u>19.1</u>	<u>14.1</u>	<u>17.6</u>	<u>16.0</u>	<u>12.7</u>	_____	_____
<u>18.3</u>	<u>13.6</u>	<u>12.8</u>	<u>13.3</u>	<u>14.9</u>	_____	_____

Time (clock): 14:00 Room Temperature (F): 70 Initials: A

Technician Signature: [Signature] Date: 2/9/17

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 6

Wood Heater Preburn Data - ASTM E2780

Run: **6**

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/10/2017
 Beginning Clock Time: 8:54

Preburn Fuel Data		
Fuel Piece Lengths (in.):	<u>8.0</u>	
Total Preburn Weight (lb):	<u>8.3</u>	
	<u>18.7</u>	<u>22.8</u>
Fuel Moisture Readings (% DB):	<u>20.3</u>	<u>19.6</u>
	<u>19.3</u>	<u>19.3</u>
	<u>25.4</u>	<u>19.5</u>
	<u>24.9</u>	<u>19.4</u>
Avg Preburn Moisture (% DB):	<u>20.92</u>	

Coal Bed 1.7 2.1
 Range (lb): (min) (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	8.6	-0.044	454	130	225	261	255	265.0	309	68	
10	7.2	-0.064	452	234	259	255	247	289.4	480	68	
20	5.8	-0.054	575	297	293	286	273	344.6	369	68	
30	4.6	-0.051	636	301	309	313	310	373.8	348	68	
40	3.7	-0.049	681	293	326	332	329	392.2	337	68	
50	3.0	-0.046	700	285	339	346	342	402.4	319	68	
60	2.3	-0.044	694	280	348	358	348	405.7	309	68	
70	1.9	-0.041	667	280	350	359	361	403.4	292	68	
74	1.7	-0.041	658	280	352	358	359	401.5	281	68	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/10/2017
Run No.: 6

Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	10.5
2x4 Crib Weight (lb):	8.3
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	7.008	
Fuel Density (lb/ft ³ , Dry Basis):	29.12	OK
Loading Density (lb/ft ³ , Wet Basis):	6.43	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.66 - 2.075

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1.2	2"x 4"	23.7	23.1	22.9	0.97
2	1.1	2"x 4"	19.8	22.4	22.6	0.90
3	1.1	2"x 4"	22.5	22.5	22.5	0.90
4	1.1	2"x 4"	23.1	23.3	23.3	0.89
5	1.2	2"x 4"	23.7	22.5	22.5	0.98

Spacer Readings (Dry Basis %)			
7.6	9.4		
18.3	10.2		
6.8	7.6		
8.0	11.3		
6.9	8.8		
8.8	9.6		
11.2	7.9		
14.3			
8.2			
12.1			
11.3			
9.7			
13.1			

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 6

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 10-Feb-17
 Beginning Clock Time: 10:09

Total Sampling Time: 180 min
 Recording Interval: 10 min

Background Sample Volume: 0 cubic feet

Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average
29.96 29.98 29.99 29.98 "Hg

OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.270 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.24 ft/sec
 Initial Tunnel Flow: 188.0 scfm
 Average Tunnel Flow: 190.8 scfm
 Post-Test Leak Check (1): 0.000 cfm @ 12 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ 9 in. Hg
 Average Test Piece Fuel Moisture: 22.69 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.056	0.076	0.074	0.056	0.044	0.072	0.072	0.056	0.103
Temp:	90	90	90	90	89	89	89	89	90
V _{strav}	17.46 ft/sec				V _{scnt} 21.70 ft/sec				F _p 0.805

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.52	72	1.14	0.78	73	1.3	105	0.102			8.3		654	280	353	362	363	402.4	N/A	327	68	68	68	68	69	-0.050	4.07	0.29
10	1.672	1.661	0.17	0.17	1.43	72	2.29	1.17	73	1.3	95	0.100	101	101	7.1	-1.2	645	316	346	322	323	390.4	N/A	353	70	70	72	72	68	-0.051	9.84	1.26
20	3.354	3.328	0.17	0.17	1.41	74	2.27	1.16	75	1.3	95	0.101	100	100	6.1	-1.0	664	338	341	305	307	391.0	N/A	336	71	71	73	73	69	-0.050	10.26	1
30	5.036	4.995	0.17	0.17	1.41	76	2.28	1.16	77	1.3	97	0.099	101	101	5.0	-1.1	689	335	332	307	308	394.2	N/A	370	72	72	73	73	70	-0.053	11.86	0.96
40	6.720	6.665	0.17	0.17	1.41	78	2.28	1.16	78	1.3	100	0.101	100	100	4.0	-1.0	718	326	331	320	317	402.4	N/A	411	73	73	74	74	70	-0.056	13.29	0.65
50	8.406	8.334	0.17	0.17	1.41	79	2.27	1.17	80	1.3	104	0.100	101	101	2.9	-1.1	760	314	335	337	328	414.8	N/A	435	74	74	75	75	70	-0.058	13.36	1.01
60	10.095	10.007	0.17	0.17	1.41	80	2.27	1.17	81	1.3	101	0.103	99	99	2.1	-0.8	783	303	341	352	338	423.4	N/A	378	74	74	76	76	71	-0.053	11.42	0.17
70	11.797	11.684	0.17	0.17	1.42	81	2.26	1.16	82	1.3	95	0.100	101	100	1.7	-0.4	725	296	350	367	350	417.6	N/A	284	74	74	75	75	71	-0.040	3.49	3.3
80	13.495	13.362	0.17	0.17	1.42	82	2.26	1.17	83	1.3	91	0.101	99	99	1.5	-0.2	614	294	352	355	347	392.4	N/A	254	74	74	75	75	71	-0.036	7.61	0.62
90	15.196	15.043	0.17	0.17	1.42	82	2.26	1.17	83	1.3	89	0.096	102	102	1.3	-0.2	565	300	350	352	351	383.6	N/A	234	74	74	74	74	71	-0.032	6.75	0.93
100	16.897	16.725	0.17	0.17	1.43	83	2.26	1.17	83	1.3	87	0.101	99	99	1.1	-0.2	528	311	350	349	348	377.2	N/A	221	73	73	74	74	71	-0.029	7.28	0.83
110	18.598	18.407	0.17	0.17	1.42	83	2.26	1.17	84	1.3	87	0.102	98	98	1.0	-0.1	509	320	348	341	339	371.4	N/A	219	73	73	74	74	71	-0.028	7.06	0.86
120	20.303	20.090	0.17	0.17	1.43	83	2.26	1.17	84	1.3	86	0.099	100	100	0.8	-0.2	497	326	346	338	336	368.6	N/A	216	73	73	73	73	71	-0.027	6.79	1.06
130	22.007	21.775	0.17	0.17	1.43	83	2.27	1.17	84	1.3	85	0.100	99	99	0.7	-0.1	484	331	345	335	330	365.0	N/A	212	72	72	73	73	71	-0.027	6.4	1.22
140	23.710	23.458	0.17	0.17	1.42	83	2.26	1.17	84	1.3	85	0.099	100	100	0.5	-0.2	472	334	342	330	326	360.8	N/A	210	72	72	73	73	72	-0.026	6.29	1.3
150	25.413	25.141	0.17	0.17	1.43	83	2.27	1.17	84	1.3	86	0.100	100	99	0.4	-0.1	462	335	339	326	321	356.6	N/A	206	72	72	73	73	72	-0.025	6.31	1.15
160	27.117	26.825	0.17	0.17	1.43	83	2.27	1.17	84	1.3	85	0.101	99	99	0.2	-0.2	453	337	337	326	317	354.0	N/A	203	72	72	73	73	71	-0.025	5.07	1.26
170	28.821	28.509	0.17	0.17	1.42	84	2.27	1.17	84	1.3	85	0.100	99	99	0.1	-0.1	439	339	334	317	314	348.6	N/A	198	73	73	73	73	72	-0.025	5.79	1.11
180	30.524	30.192	0.17	0.17	1.42	84	2.26	1.17	84	1.3	85	0.099	100	100	0.0	-0.1	428	342	331	314	314	345.8	N/A	194	73	73	73	73	72	-0.023	5.92	1.08
Avg/Tot	30.524	30.192	0.17	0.17	1.37	80		1.15	81		92	0.100	100	100								56.6				72	73	73	71	-0.038		

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
Model: Viva L
Project No.: 0138WS017E
Tracking No.: 2233
Run: 6
Test Date: 02/10/17

Burn Rate	1.060 kg/hr dry
Average Tunnel Temperature	92 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.24 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11445.8 dscf/hour
Average Delta p	0.100 inches H2O
Total Time of Test	180 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	30.524 cubic feet	30.192 cubic feet	10.095 cubic feet
Average Gas Meter Temperature	71 degrees Fahrenheit	80 degrees Fahrenheit	81 degrees Fahrenheit	80 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	29.497 dscf	29.295 dscf	9.755 dscf
Total Particulates - m _n	0 mg	2.5 mg	2.1 mg	0.6 mg
Particulate Concentration (dry-standard) - C _p /C _s	0.000000 grams/dscf	0.00008 grams/dscf	0.00007 grams/dscf	0.00006 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	2.91 grams	2.46 grams	0.70 grams
Particulate Emission Rate	0.00 grams/hour	0.97 grams/hour	0.82 grams/hour	0.70 grams/hour
Emissions Factor		0.92 g/kg	0.77 g/kg	0.31 g/kg
Difference from Average Total Particulate Emissions		0.22 grams	0.22 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	2.69 grams
Particulate Emission Rate	0.90 grams/hour
Emissions Factor	0.84 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	0.70 grams
Particulate Emission Rate	0.70 grams/hour
Emissions Factor	0.31 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/10/17
Run: 6
Control #: 0138WS017E
Test Duration: 180
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	71.9%	77.7%
Combustion Efficiency	91.7%	91.7%
Heat Transfer Efficiency	78%	84.8%

Output Rate (kJ/h)	14,568	13,820	(Btu/h)
Burn Rate (kg/h)	1.02	2.25	(lb/h)
Input (kJ/h)	20,268	19,226	(Btu/h)

Test Load Weight (dry kg)	3.07	6.76	dry lb
MC wet (%)	18.50		
MC dry (%)	22.69		
Particulate (g)	N/A		
CO (g)	356		
Test Duration (h)	3.00		

Emissions	Particulate	CO
g/MJ Output	N/A	8.14
g/kg Dry Fuel	N/A	115.93
g/h	N/A	118.61
lb/MM Btu Output	N/A	18.92

Air/Fuel Ratio (A/F)	13.70
----------------------	-------

VERSION:

2.2

12/14/2009

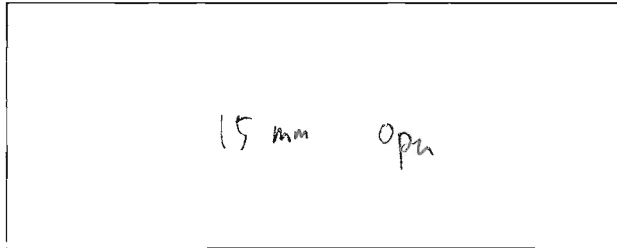
ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 6
 Model: VIVA L Tracking Number: 2233 Date: 2/10/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:



Secondary:

Fixed

Tertiary/Pilot:

Fixed

Fan:

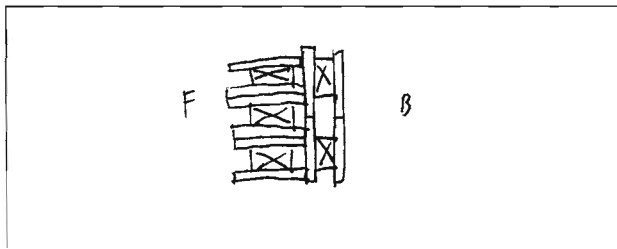
NA

Preburn Notes

Time	Notes
0:00	Air set to test settings
24:00	PB End

Test Notes

Sketch test fuel configuration:



Start up procedures & Timeline:

Bypass: NA
 Fuel loaded by: 30:00 0:30
 Door closed at: 0:35
 Primary air: Startup until 4:30
set from 4:50 - 5:00

Notes:

Time	Notes
	<u>None</u>

Technician Signature: [Signature]

Date: 2/10/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 6
 Model: VIVA L Tracking Number: 2233 Date: 2/10/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 10:09 Booth #: E1

Stop Time: 13:09

Stack Gas Leak Check:

Initial: 0 Final: 0

Sample Train Leak Check:

A: 0 @ 12 "Hg
 B: 0 @ 9 "Hg

Calibrations: Span Gas CO₂: 16.74 CO(%): 4.20 CO(ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>8:30</u>	<u>8:35</u>		
CO ₂	<u>0.00</u>	<u>16.75</u>	<u>See Run #67 Data</u>	
CO(%)	<u>0.000</u>	<u>4.201</u>		
CO(ppm)	<u>0</u>			

Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10.0 Final: 10.0

Pitot Tube Leak Test: Initial: 0 Final: 0

Stack Diameter (in): 6"

Induced Draft: 0

% Smoke Capture: 100%

Flue Pipe Cleaned Prior to First Test in Series:

Date: 2/2/17 Initials: AK

	Initial	Middle	Ending
P _b (in/Hg)	<u>29.96</u>	<u>29.98</u>	<u>29.99</u>
RH (%)	<u>31.6</u>	<u>30.1</u>	<u>28.9</u>
Ambient (°F)	<u>69.1</u>	<u>69.9</u>	<u>71.6</u>

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
<u>0.028</u>	<u>0.056</u>	<u>90</u>
<u>0.038</u>	<u>0.076</u>	
<u>0.037</u>	<u>0.074</u>	
<u>0.028</u>	<u>0.056</u>	
<u>0.022</u>	<u>0.044</u>	<u>89</u>
<u>0.036</u>	<u>0.072</u>	
<u>0.036</u>	<u>0.072</u>	
<u>0.028</u>	<u>0.056</u>	
Center:		
<u>-</u>	<u>0.103</u>	<u>90</u>

Background Filter Volume: N/A

Technician Signature: [Signature]

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
<u>-0.27</u>	<u>-0.27</u>

Date: 2/10/17

ASTM E2780 Wood Heater Run Sheets

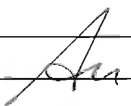
Client: RAIS Project Number: 0138WS017E Run Number: 6
 Model: VIVA L Tracking Number: 2233 Date: 2/10/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel					
Calibration:		Cal Value (1) = 12%	Actual Reading	<u>12%</u>	
		Cal Value (2) = 22%	Actual Reading	<u>22%</u>	
Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8</u> in	<u>18.7</u>	7	<u>8</u> in	<u>19.6</u>
2	<u> </u> in	<u>20.3</u>	8	<u> </u> in	<u>19.7</u>
3	<u> </u> in	<u>19.3</u>	9	<u> </u> in	<u>19.3</u>
4	<u> </u> in	<u>25.4</u>	10	<u> </u> in	<u>19.5</u>
5	<u> </u> in	<u>24.9</u>	11	<u> </u> in	<u>15.4</u>
6	<u> </u> in	<u>22.8</u>	12	<u> </u> in	<u> </u>
Total Pre-Burn Fuel Weight:		<u>8.3</u>	Pre-Burn Fuel Average Moisture:		<u>20.92</u>
Time (clock):		<u>0830</u>	Room Temperature (F):		<u>65</u> Initials: <u>SK</u>

Test Fuel					
Firebox Volume (ft³):		<u>1.29</u>	Test Fuel Piece Length (in):		<u>16.5</u>
Load Weight Range (lb):		<u>8.2-9.9</u>	Total Wet Fuel Load Weight (lb):		<u>8.3</u>
Fuel Type & Amount:		2 x 4: <u>5</u>	4 x 4: <u> </u>		
Weight (with spacers):		<u>8.3</u>	Weight (with spacers):		<u> </u>
Piece:	Weight (lbs):	Moisture Readings (%DB):			Fuel Type:
1	<u>1.2</u>	<u>23.7</u>	<u>23.1</u>	<u>22.9</u>	<u>2x4</u>
2	<u>1.1</u>	<u>19.8</u>	<u>22.4</u>	<u>22.6</u>	<u>2x4</u>
3	<u>1.1</u>	<u>22.5</u>	<u>22.5</u>	<u>22.5</u>	<u>2x4</u>
4	<u>1.1</u>	<u>23.1</u>	<u>23.3</u>	<u>23.3</u>	<u>2x4</u>
5	<u>1.2</u>	<u>23.2</u>	<u>22.5</u>	<u>22.5</u>	<u>2x4</u>
6	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
7	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
Spacer Moisture Readings (%DB)					
<u>7.6</u>	<u>6.9</u>	<u>8.2</u>	<u>13.1</u>	<u>11.3</u>	<u> </u>
<u>18.3</u>	<u>8.8</u>	<u>12.1</u>	<u>9.4</u>	<u>8.8</u>	<u> </u>
<u>6.8</u>	<u>11.2</u>	<u>11.3</u>	<u>10.2</u>	<u>9.6</u>	<u> </u>
<u>8.0</u>	<u>14.3</u>	<u>9.7</u>	<u>7.6</u>	<u>7.9</u>	<u> </u>
Time (clock):		<u>9:00</u>	Room Temperature (F):		<u>65 F</u> Initials: <u>SB</u>

Technician Signature:  Date: 2/10/17

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 7

Wood Heater Preburn Data - ASTM E2780

Run: 7

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/10/2017
 Beginning Clock Time: 14:44

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>8.0</u>		
Total Preburn Weight (lb):	<u>8.7</u>		
	<u>22.3</u>	<u>20.9</u>	<u>19.0</u>
Fuel Moisture Readings (% DB):	<u>20.0</u>	<u>22.0</u>	<u>21.6</u>
	<u>19.8</u>	<u>22.0</u>	<u>21.3</u>
	<u>20.8</u>	<u>18.6</u>	
Avg Preburn Moisture (% DB):	<u>20.75</u>		

Coal Bed Range (lb): 1.7 (min) 2.1 (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	8.9	-0.052	597	320	336	364	357	394.7	356	72	
10	7.7	-0.057	607	373	336	332	323	394.2	396	70	
20	6.3	-0.059	656	370	331	333	329	403.7	403	70	
30	5.1	-0.058	702	346	339	350	351	417.5	407	71	
40	4.0	-0.062	756	325	350	366	359	431.3	451	71	
50	3.1	-0.056	762	309	361	381	370	436.6	393	71	
60	2.4	-0.054	735	301	376	397	404	442.6	387	71	
68	2.1	-0.047	697	303	394	407	397	439.7	335	71	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/10/2017
Run No.: 7


Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	10.5
2x4 Crib Weight (lb):	8.4
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	7.097	
Fuel Density (lb/ft ³ , Dry Basis):	30.13	OK
Loading Density (lb/ft ³ , Wet Basis):	6.51	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.68 - 2.1

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1.2	2"x 4"	22.8	23.0	22.5	0.98
2	1.2	2"x 4"	22.7	22.5	22.7	0.98
3	1.2	2"x 4"	23.0	23.1	23.5	0.97
4	1.1	2"x 4"	23.1	23.2	23.9	0.89
5	1.2	2"x 4"	22.6	21.2	22.1	0.98

Spacer Readings (Dry Basis %)			
8.0	8.9		
8.4	9.8		
7.0	11.2		
7.4	8.0		
13.2	8.8		
8.2	7.7		
9.9	8.0		
8.0	11.5		
11.5	7.8		
7.8	10.3		

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: 7
 Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 10-Feb-17
 Beginning Clock Time: 14:53
 Total Sampling Time: 150 min
 Recording Interval: 10 min
 Background Sample Volume: 0 cubic feet
 Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)
 Barometric Pressure: Begin Middle End Average
30.02 30.07 30.09 30.06 "Hg
 OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.270 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99
 Avg. Tunnel Velocity: 17.53 ft/sec
 Initial Tunnel Flow: 188.3 scfm
 Average Tunnel Flow: 192.8 scfm
 Post-Test Leak Check (1): 0.000 cfm @ 12 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ 9 in. Hg
 Average Test Piece Fuel Moisture: 22.79 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.056	0.076	0.074	0.056	0.044	0.072	0.072	0.056	0.103
Temp:	90	90	90	90	89	89	89	89	90
V _{strav}	17.44 ft/sec				V _{scnt} 21.68 ft/sec				F _p 0.805

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.03	76	1.68	0.40	78	1.0	112	0.104			8.4		688	302	396	408	397	438.2	N/A	365	69	69	70	70	71	-0.053	3.35	0.2
10	1.686	1.668	0.17	0.17	1.43	77	2.31	1.18	78	1.4	102	0.104	100	100	7.1	-1.3	680	342	380	359	351	422.4	N/A	411	73	73	74	74	71	-0.060	10.94	0.67
20	3.374	3.337	0.17	0.17	1.42	78	2.30	1.17	79	1.3	104	0.100	102	102	5.7	-1.4	719	358	366	338	332	422.6	N/A	452	74	74	75	75	70	-0.064	12.34	0.99
30	5.061	5.005	0.17	0.17	1.41	79	2.29	1.17	80	1.4	106	0.104	100	100	4.4	-1.3	764	348	354	345	338	429.8	N/A	473	74	74	75	75	70	-0.065	13.63	1.07
40	6.749	6.676	0.17	0.17	1.42	80	2.30	1.17	81	1.3	108	0.110	97	98	3.1	-1.3	802	332	350	356	347	437.4	N/A	499	75	75	76	76	70	-0.066	14.16	0.31
50	8.439	8.347	0.17	0.17	1.41	80	2.29	1.16	82	1.4	103	0.104	100	100	2.2	-0.9	806	316	353	375	357	441.4	N/A	426	75	75	75	75	71	-0.059	11.33	0.14
60	10.133	10.020	0.17	0.17	1.43	81	2.26	1.17	83	1.4	99	0.100	101	101	1.7	-0.5	755	307	363	393	375	438.6	N/A	349	74	74	75	75	70	-0.049	8.57	0.06
70	11.834	11.694	0.17	0.17	1.43	82	2.25	1.17	83	1.4	95	0.103	100	100	1.4	-0.3	675	303	380	403	388	429.8	N/A	304	75	75	75	75	71	-0.044	7.47	0.4
80	13.538	13.370	0.17	0.17	1.44	83	2.25	1.17	84	1.4	92	0.101	101	100	1.2	-0.2	613	307	389	397	394	420.0	N/A	283	74	74	74	74	72	-0.039	7.3	0.59
90	15.243	15.048	0.17	0.17	1.43	83	2.25	1.17	84	1.4	91	0.103	100	99	1.0	-0.2	571	314	388	387	396	411.2	N/A	270	74	74	74	74	71	-0.037	7.19	0.81
100	16.948	16.727	0.17	0.17	1.43	83	2.26	1.17	84	1.4	90	0.104	99	99	0.8	-0.2	541	322	384	377	390	402.8	N/A	260	74	74	74	74	71	-0.035	6.83	0.98
110	18.655	18.407	0.17	0.17	1.43	84	2.26	1.17	85	1.4	89	0.102	100	100	0.6	-0.2	522	327	381	373	371	394.8	N/A	251	73	73	74	74	71	-0.035	6.64	0.98
120	20.362	20.088	0.17	0.17	1.44	84	2.26	1.17	85	1.4	88	0.101	100	100	0.5	-0.1	505	330	371	361	353	384.0	N/A	245	73	73	74	74	72	-0.034	6.13	1
130	22.071	21.769	0.17	0.17	1.44	84	2.26	1.17	85	1.4	88	0.100	101	101	0.3	-0.2	487	332	356	349	340	372.8	N/A	244	73	73	74	74	71	-0.033	5.79	1.27
140	23.779	23.450	0.17	0.17	1.44	84	2.26	1.17	85	1.4	88	0.103	99	99	0.1	-0.2	473	333	348	337	331	364.4	N/A	240	73	73	73	73	72	-0.033	5.85	1.2
150	25.488	25.131	0.17	0.17	1.44	84	2.26	1.17	84	1.4	88	0.105	98	98	0.0	-0.1	461	337	340	328	324	358.0	N/A	237	73	73	74	74	71	-0.032	5.76	1.11
Avg/Tot	25.488	25.131	0.17	0.17	1.34	81		1.12	83		96	0.103	100	100								80.2				74	74	74	71	-0.046		

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
Model: Viva L
Project No.: 0138WS017E
Tracking No.: 2233
Run: 7
Test Date: 02/10/17

Burn Rate	1.288 kg/hr dry
Average Tunnel Temperature	96 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.53 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11570.5 dscf/hour
Average Delta p	0.103 inches H2O
Total Time of Test	150 minutes

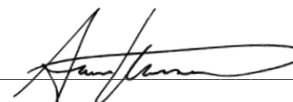
	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	25.488 cubic feet	25.131 cubic feet	10.133 cubic feet
Average Gas Meter Temperature	71 degrees Fahrenheit	81 degrees Fahrenheit	83 degrees Fahrenheit	81 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	24.646 dscf	24.385 dscf	9.798 dscf
Total Particulates - m _n	0 mg	2.1 mg	1.9 mg	0.5 mg
Particulate Concentration (dry-standard) - C _p /C _s	0.000000 grams/dscf	0.00009 grams/dscf	0.00008 grams/dscf	0.00005 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	2.46 grams	2.25 grams	0.59 grams
Particulate Emission Rate	0.00 grams/hour	0.99 grams/hour	0.90 grams/hour	0.59 grams/hour
Emissions Factor		0.77 g/kg	0.70 g/kg	0.24 g/kg
Difference from Average Total Particulate Emissions		0.11 grams	0.11 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	2.36 grams
Particulate Emission Rate	0.94 grams/hour
Emissions Factor	0.73 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	0.59 grams
Particulate Emission Rate	0.59 grams/hour
Emissions Factor	0.24 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/10/17
Run: 7
Control #: 0138WS017E
Test Duration: 150
Output Category: II

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	73.0%	78.9%
Combustion Efficiency	94.9%	94.9%
Heat Transfer Efficiency	77%	83.1%

Output Rate (kJ/h)	17,951	17,028	(Btu/h)
Burn Rate (kg/h)	1.24	2.74	(lb/h)
Input (kJ/h)	24,594	23,331	(Btu/h)

Test Load Weight (dry kg)	3.10	6.84	dry lb
MC wet (%)	18.56		
MC dry (%)	22.79		
Particulate (g)	N/A		
CO (g)	224		
Test Duration (h)	2.50		

Emissions	Particulate	CO
g/MJ Output	N/A	4.99
g/kg Dry Fuel	N/A	72.19
g/h	N/A	89.63
lb/MM Btu Output	N/A	11.60

Air/Fuel Ratio (A/F)	13.46
----------------------	-------

VERSION:

2.2

12/14/2009

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 7
 Model: VIVA L Tracking Number: 2233 Date: 2/10/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

Open 22 min

Secondary: Fixed

Tertiary/Pilot: Fixed

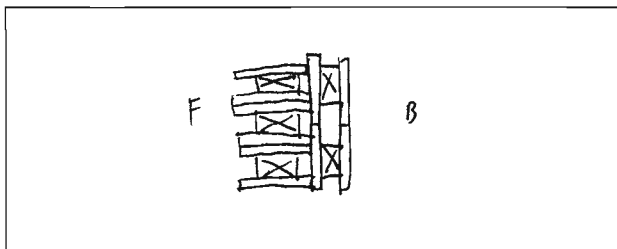
Fan: N/A

Preburn Notes

Time	Notes
0:00	Air set to test setting
68:00	PB End

Test Notes

Sketch test fuel configuration:



Start up procedures & Timeline:

Bypass: NA

Fuel loaded by: 0:25

Door closed at: 0:35

Primary air: Startup VIVA L 4:00

set from 4:50 - 5:00

Notes: _____

Time	Notes
	<u>None</u>

Technician Signature: *[Signature]*

Date: 2/10/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 7
 Model: VIVA L Tracking Number: 2233 Date: 2/10/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel

Calibration: Cal Value (1) = 12% Actual Reading 12.6
 Cal Value (2) = 22% Actual Reading 72.0

Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8</u> in	<u>22.3</u>	7	<u>8</u> in	<u>22.0</u>
2	<u>8</u> in	<u>20.0</u>	8	<u>8</u> in	<u>18.6</u>
3	<u>8</u> in	<u>19.8</u>	9	<u>8</u> in	<u>19.0</u>
4	<u>8</u> in	<u>20.8</u>	10	<u>8</u> in	<u>21.6</u>
5	<u>8</u> in	<u>20.9</u>	11	<u>8</u> in	<u>21.3</u>
6	<u>8</u> in	<u>22.0</u>	12	<u>8</u> in	<u>22.0</u>

Total Pre-Burn Fuel Weight: 8.7 Pre-Burn Fuel Average Moisture: 20.75
 Time (clock): 13:00 Room Temperature (F): 67 Initials: AS

Test Fuel

Firebox Volume (ft³): 1.22 Test Fuel Piece Length (in): 10.5
 Load Weight Range (lb): 8.2-9.1 Total Wet Fuel Load Weight (lb): 8.4

Fuel Type & Amount: 2 x 4: 5 4 x 4: 0
 Weight (with spacers): 8.4 Weight (with spacers): 0

Piece:	Weight (lbs):	Moisture Readings (%DB):			Fuel Type:
1	<u>1.2</u>	<u>22.8</u>	<u>23.0</u>	<u>22.5</u>	<u>2x4</u>
2	<u>1.2</u>	<u>22.7</u>	<u>22.5</u>	<u>22.7</u>	<u>2x4</u>
3	<u>1.2</u>	<u>23.0</u>	<u>23.1</u>	<u>23.5</u>	<u>2x4</u>
4	<u>1.1</u>	<u>23.1</u>	<u>23.2</u>	<u>23.9</u>	<u>2x4</u>
5	<u>1.2</u>	<u>22.6</u>	<u>21.2</u>	<u>22.1</u>	<u>2x4</u>
6	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
7	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>

Spacer Moisture Readings (%DB)

<u>8.0</u>	<u>13.2</u>	<u>11.5</u>	<u>11.5</u>	<u>8.0</u>	<u> </u>	<u> </u>
<u>8.4</u>	<u>8.2</u>	<u>7.8</u>	<u>8.0</u>	<u>11.2</u>	<u> </u>	<u> </u>
<u>7.0</u>	<u>9.9</u>	<u>10.3</u>	<u>7.7</u>	<u>9.8</u>	<u> </u>	<u> </u>
<u>7.4</u>	<u>8.0</u>	<u>7.8</u>	<u>8.8</u>	<u>8.9</u>	<u> </u>	<u> </u>

Time (clock): 13:30 Room Temperature (F): 65 Initials: SB

Technician Signature: [Signature] Date: 2/10/17

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Run 8

Wood Heater Preburn Data - ASTM E2780

Run: **8**

Technician Signature: 

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 2/13/2017
 Beginning Clock Time: 10:37

Preburn Fuel Data			
Fuel Piece Lengths (in.):	<u>8.0</u>		
Total Preburn Weight (lb):	<u>9.5</u>		
	<u>21.2</u>	<u>19.2</u>	<u>22.4</u>
Fuel Moisture Readings (% DB):	<u>19.4</u>	<u>18.6</u>	
	<u>23.6</u>	<u>24.2</u>	
	<u>22.1</u>	<u>22.1</u>	
	<u>18.4</u>	<u>21</u>	
Avg Preburn Moisture (% DB):	<u>21.11</u>		

Coal Bed Range (lb): 1.7 (min) 2.1 (max)

Elapsed Time (min)	Scale (lb)	Stack Draft (in H ₂ O)	Temperatures (°F)							Stack	Ambient
			FB Top	FB Bottom	FB Back	FB Left	FB Right	Avg. Firebox Surface			
0	8.9	-0.062	457	211	257	272	264	292.5	424	70	
10	7.4	-0.067	582	277	280	277	287	340.7	476	69	
20	5.8	-0.069	678	297	301	312	327	382.9	497	70	
30	4.1	-0.071	761	300	330	349	364	420.7	547	71	
40	2.8	-0.066	782	304	360	387	398	446.2	511	70	
50	2.0	-0.059	754	317	390	430	420	462.1	433	71	
60	1.7	-0.051	673	348	413	434	413	456.0	364	71	

Wood Heater Test Fuel Data - ASTM E2780

Manufacturer: RAIS
Model: Viva L
Tracking No.: 2233
Project No.: 0138WS017E
Test Date: 2/13/2017
Run No.: 8

Firebox Volume (ft ³):	1.29
Fuel Piece Length (in):	10.5
2x4 Crib Weight (lb):	8.3
4x4 Crib Weight (lb):	0

Total Fuel Weight (Dry Basis, lb):	6.995	
Fuel Density (lb/ft ³ , Dry Basis):	29.00	OK
Loading Density (lb/ft ³ , Wet Basis):	6.43	OK
2x4 Percentage:	N/A	N/A

Coal Bed Range (20-25%): 1.66 - 2.075

Test Fuel Piece	Weight (lb)	Size	Readings (Dry Basis %)			Dry Weight (lb)
1	1.2	2"x 4"	19.8	21.1	21.2	0.99
2	1.1	2"x 4"	22.6	22.4	21.8	0.90
3	1.1	2"x 4"	21.5	20.3	21.9	0.91
4	1.1	2"x 4"	21.0	21.3	19.7	0.91
5	1.1	2"x 4"	20.1	22.1	19.3	0.91

Spacer Readings (Dry Basis %)			
11.4	14.4		
14.8	13.6		
12.7	12.4		
11.2	13.6		
14.0	12.3		
15.8	12.7		
14.3	13.7		
15.5	12.1		
16.4			
14.5			
16.4			
17.0			

Technician Signature: 

Wood Heater Test Data - ASTM E2780 / ASTM E2515

Run: **8**

Manufacturer: RAIS
 Model: Viva L
 Tracking No.: 2233
 Project No.: 0138WS017E
 Test Date: 13-Feb-17
 Beginning Clock Time: 11:38

Total Sampling Time: 110 min
 Recording Interval: 10 min
 Background Sample Volume: 0 cubic feet

Meter Box Y Factor: 0.984 (1) 0.99 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average
30.29 30.27 30.24 30.27 "Hg

OMNI Equipment Numbers: 296-T55, 185, 340, 431, 335, 336, 594, 410, 559, 209, 132, 23, 592, 283A

PM Control Modules: 335/336
 Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Dilution Tunnel H2O: 2.00 percent
 Dilution Tunnel Static: -0.270 "H2O
 Tunnel Area: 0.19635 ft2
 Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.00 ft/sec
 Initial Tunnel Flow: 186.1 scfm
 Average Tunnel Flow: 184.9 scfm
 Post-Test Leak Check (1): 0.000 cfm @ -11 in. Hg
 Post-Test Leak Check (2): 0.000 cfm @ -9 in. Hg
 Average Test Piece Fuel Moisture: 21.07 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
Initial dP	0.048	0.080	0.074	0.060	0.048	0.074	0.076	0.058	0.062
Temp:	119	119	119	119	119	119	119	119	119
	V _{strav} 17.45 ft/sec				V _{scnt} 17.18 ft/sec				F _p 1.015

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H₂O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H₂O)	Meter 2 Temp (°F)	Meter 2 Vacuum ("Hg)	Dilution Tunnel (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface Temp	Catalyst Exit Temp	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H₂O)	CO₂ (%)	CO (%)
0	0.000	0.000			0.46	75	0.93	0.03	77	1.3	115	0.066			8.3		666	350	414	430	414	454.8	N/A	375	70	70	71	71	72	-0.054	2.85	0.25
10	1.677	1.667	0.17	0.17	1.44	76	2.32	1.20	77	1.4	110	0.057	103	104	6.8	-1.5	673	398	389	367	365	438.4	N/A	456	74	74	75	75	71	-0.065	11.45	0.76
20	3.359	3.340	0.17	0.17	1.42	77	2.32	1.18	79	1.4	117	0.061	100	101	5.2	-1.6	731	412	379	353	352	445.4	N/A	505	75	75	77	77	72	-0.069	12.96	0.97
30	5.039	5.011	0.17	0.17	1.41	79	2.33	1.17	81	1.4	126	0.058	103	104	3.6	-1.6	797	399	385	371	371	464.6	N/A	570	77	77	80	80	73	-0.074	14.82	0.63
40	6.715	6.678	0.17	0.17	1.40	81	2.35	1.17	83	1.4	125	0.060	101	102	2.2	-1.4	825	383	398	408	394	481.6	N/A	526	79	79	80	80	73	-0.069	12.7	0.34
50	8.392	8.341	0.17	0.17	1.40	83	2.36	1.16	84	1.4	113	0.058	101	102	1.4	-0.8	785	373	411	444	425	487.6	N/A	412	79	79	80	80	74	-0.056	8.02	0.05
60	10.072	10.007	0.17	0.17	1.40	84	2.36	1.16	85	1.4	102	0.066	94	94	1.1	-0.3	687	374	427	450	422	472.0	N/A	360	78	78	79	79	72	-0.051	7.14	0.42
70	11.784	11.676	0.17	0.17	1.43	84	2.29	1.16	86	1.4	98	0.065	96	95	0.9	-0.2	619	381	423	429	412	452.8	N/A	334	77	77	78	78	73	-0.047	6.63	0.58
80	13.487	13.348	0.17	0.17	1.43	85	2.29	1.17	86	1.4	96	0.061	98	98	0.7	-0.2	573	390	403	409	407	436.4	N/A	323	76	76	76	76	72	-0.044	6.57	0.68
90	15.192	15.022	0.17	0.17	1.44	85	2.29	1.16	86	1.4	93	0.054	104	104	0.4	-0.3	544	397	391	393	398	424.6	N/A	313	75	75	75	75	71	-0.045	6.65	0.7
100	16.899	16.696	0.17	0.17	1.44	84	2.28	1.17	86	1.4	93	0.060	99	99	0.2	-0.2	522	404	383	377	393	415.8	N/A	303	75	75	75	75	71	-0.042	6.49	0.77
110	18.606	18.369	0.17	0.17	1.44	84	2.29	1.17	85	1.4	92	0.056	103	102	0.0	-0.2	506	415	380	373	390	412.8	N/A	297	74	74	74	74	71	-0.041	6.1	0.89
Avg/Tot	18.606	18.369	0.17	0.17	1.34	81		1.08	83		107	0.060	100	100								42.0			76	77	77	72	-0.055			

Wood Heater Test Results - ASTM E2780 / ASTM E2515

Manufacturer: RAIS
Model: Viva L
Project No.: 0138WS017E
Tracking No.: 2233
Run: 8
Test Date: 02/13/17

Burn Rate	1.731 kg/hr dry
Average Tunnel Temperature	107 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.00 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11092.4 dscf/hour
Average Delta p	0.060 inches H2O
Total Time of Test	110 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	0.000 cubic feet	18.606 cubic feet	18.369 cubic feet	10.072 cubic feet
Average Gas Meter Temperature	72 degrees Fahrenheit	81 degrees Fahrenheit	83 degrees Fahrenheit	81 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	0.000 dscf	18.113 dscf	17.930 dscf	9.805 dscf
Total Particulates - m _n	0 mg	2.4 mg	2.5 mg	0.9 mg
Particulate Concentration (dry-standard) - C _p /C _s	0.000000 grams/dscf	0.00013 grams/dscf	0.00014 grams/dscf	0.00009 grams/dscf
Total Particulate Emissions - E _T	0.00 grams	2.69 grams	2.84 grams	1.02 grams
Particulate Emission Rate	0.00 grams/hour	1.47 grams/hour	1.55 grams/hour	1.02 grams/hour
Emissions Factor		0.85 g/kg	0.89 g/kg	0.38 g/kg
Difference from Average Total Particulate Emissions		0.07 grams	0.07 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E _T	2.77 grams
Particulate Emission Rate	1.51 grams/hour
Emissions Factor	0.87 grams/kg
First Hour Emissions	
Total Particulate Emissions - E _T	1.02 grams
Particulate Emission Rate	1.02 grams/hour
Emissions Factor	0.38 grams/kg


QUALITY CHECKS	
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Stove Surface ΔT	OK

Technician Signature: _____



OMNI-Test Laboratories

Manufacturer: RAIS
Model: Viva L
Date: 02/13/17
Run: 8
Control #: 0138WS017E
Test Duration: 110
Output Category: III

Technicians: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	71.7%	77.5%
Combustion Efficiency	95.5%	95.5%
Heat Transfer Efficiency	75%	81.2%

Output Rate (kJ/h)	24,096	22,857	(Btu/h)
Burn Rate (kg/h)	1.70	3.74	(lb/h)
Input (kJ/h)	33,609	31,882	(Btu/h)

Test Load Weight (dry kg)	3.11	6.86	dry lb
MC wet (%)	17.41		
MC dry (%)	21.07		
Particulate (g)	N/A		
CO (g)	199		
Test Duration (h)	1.83		

Emissions	Particulate	CO
g/MJ Output	N/A	4.51
g/kg Dry Fuel	N/A	64.12
g/h	N/A	108.79
lb/MM Btu Output	N/A	10.49

Air/Fuel Ratio (A/F)	13.39
----------------------	-------

VERSION:

2.2

12/14/2009

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 8

Model: VIVA L Tracking Number: 2233 Date: 2/13/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Run Notes

Air Control Settings

Primary:

Fully open

Secondary: N/A - Fixed

Tertiary/Pilot: Fixed

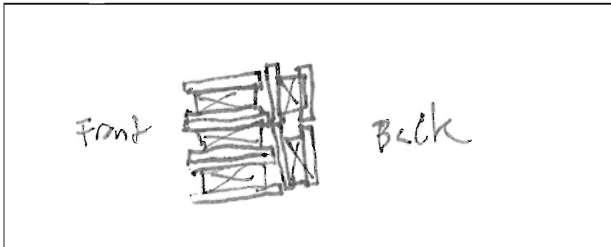
Fan: N/A

Preburn Notes

Time	Notes
_____	N/A

Test Notes

Sketch test fuel configuration:



Start up procedures & Timeline:

Bypass: N/A
 Fuel loaded by: 30 second
 Door closed at: 40 second
 Primary air: Started air for 4 min then set to High
 Notes: N/A

Time	Notes
_____	N/A

Technician Signature: [Signature]

Date: 2/13/2017

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 8
 Model: VIVA L Tracking Number: 2233 Date: 2/13/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Supplemental Data

Start Time: 11:38 Booth #: E1
 Stop Time: 13:28

Stack Gas Leak Check:

Initial: 0 Final: 0

Sample Train Leak Check:

A: 0 @ 1 "Hg
 B: 0 @ 1 "Hg

Calibrations: Span Gas CO₂: 16.74 CO(%): 4.20 CO(ppm): 500

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>10:01</u>	<u>10:05</u>	<u>13:30</u>	<u>13:30</u>
CO ₂	<u>0.00</u>	<u>16.75</u>	<u>0.14</u>	<u>16.50</u>
CO(%)	<u>0.000</u>	<u>4.199</u>	<u>0.001</u>	<u>4.190</u>
CO(ppm)	<u>0</u>	<u>-</u>	<u>0</u>	<u>-</u>

Air Velocity (ft/min): Initial: 250 Final: 250
 Scale Audit (lbs): Initial: 10.0 Final: 10.0
 Pitot Tube Leak Test: Initial: 0 Final: 0
 Stack Diameter (in): 6"
 Induced Draft: 0
 % Smoke Capture: 100%
 Flue Pipe Cleaned Prior to First Test in Series:
 Date: 2/2/17 Initials: A

Tunnel Traverse		
Microtector Reading	dP (in H ₂ O)	T(°F)
<u>0.024</u>	<u>0.048</u>	<u>119</u>
<u>0.040</u>	<u>0.030</u>	<u>119</u>
<u>0.037</u>	<u>0.074</u>	<u>119</u>
<u>0.030</u>	<u>0.060</u>	<u>119</u>
<u>0.024</u>	<u>0.048</u>	<u>119</u>
<u>0.037</u>	<u>0.041</u>	<u>119</u>
<u>0.038</u>	<u>0.076</u>	<u>119</u>
<u>0.029</u>	<u>0.058</u>	<u>119</u>
Center:		
<u>0.031</u>	<u>0.062</u>	<u>119</u>

	Initial	Middle	Ending
P _b (in/Hg)	<u>30.29</u>	<u>30.27</u>	<u>30.24</u>
RH (%)	<u>19.9</u>	<u>18.5</u>	<u>18.9</u>
Ambient (°F)	<u>72</u>	<u>73</u>	<u>74</u>

Background Filter Volume: N/A

Tunnel Static Pressure (in H ₂ O):	
Beginning of Test	End of Test
<u>-0.27</u>	<u>-0.27</u>

Technician Signature: [Signature]

Date: 2/13/2017

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 8
 Model: VIVA L Tracking Number: 2233 Date: 2/13/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

Wood Heater Fuel Data

Fuel: Douglas fir, untreated and air dried, standard grade or better dimensional lumber

Pre-Burn Fuel					
Calibration:		Cal Value (1) = 12%	Actual Reading <u>12%</u>		
		Cal Value (2) = 22%	Actual Reading <u>22%</u>		
Piece:	Length:	Reading:	Piece:	Length:	Reading:
1	<u>8"</u> in	<u>21.2</u>	7	<u>8"</u> in	<u>18.6</u>
2	<u> </u> in	<u>19.4</u>	8	<u> </u> in	<u>24.2</u>
3	<u> </u> in	<u>23.6</u>	9	<u> </u> in	<u>22.1</u>
4	<u> </u> in	<u>22.1</u>	10	<u> </u> in	<u>21.0</u>
5	<u> </u> in	<u>18.4</u>	11	<u> </u> in	<u>22.4</u>
6	<u> </u> in	<u>19.2</u>	12	<u> </u> in	<u> </u>
Total Pre-Burn Fuel Weight: <u>9.5 lbs</u>		Pre-Burn Fuel Average Moisture: <u>21.1</u>			
Time (clock): <u>9:50</u>		Room Temperature (F): <u>65</u>		Initials: <u>SB</u>	

Test Fuel					
Firebox Volume (ft ³): <u>1.29 ft³</u>		Test Fuel Piece Length (in): <u>16.5</u>			
Load Weight Range (lb): <u>8.2 - 9.9</u>		Total Wet Fuel Load Weight (lb): <u>8.3</u>			
Fuel Type & Amount: 2 x 4: <u>5</u>		4 x 4: <u>∅</u>			
Weight (with spacers): <u>8.3</u>		Weight (with spacers): <u>∅</u>			
Piece:	Weight (lbs):	Moisture Readings (%DB):			Fuel Type:
1	<u>1.2</u>	<u>19.8</u>	<u>21.1</u>	<u>21.2</u>	<u>2x4</u>
2	<u>1.1</u>	<u>22.6</u>	<u>22.4</u>	<u>21.8</u>	<u>2x4</u>
3	<u>1.1</u>	<u>21.5</u>	<u>20.3</u>	<u>21.9</u>	<u>2x4</u>
4	<u>1.1</u>	<u>21.0</u>	<u>21.3</u>	<u>19.7</u>	<u>2x4</u>
5	<u>1.1</u>	<u>20.1</u>	<u>22.1</u>	<u>19.3</u>	<u>2x4</u>
6	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
7	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
Spacer Moisture Readings (%DB)					
<u>11.4</u>	<u>14.0</u>	<u>16.4</u>	<u>14.4</u>	<u>12.3</u>	<u> </u>
<u>14.8</u>	<u>15.8</u>	<u>14.5</u>	<u>13.6</u>	<u>12.7</u>	<u> </u>
<u>12.7</u>	<u>14.3</u>	<u>16.4</u>	<u>12.4</u>	<u>13.7</u>	<u> </u>
<u>16.2</u>	<u>15.5</u>	<u>17.0</u>	<u>13.6</u>	<u>12.1</u>	<u> </u>
Time (clock): <u>10:15</u>		Room Temperature (F): <u>65</u>		Initials: <u>SB</u>	

Technician Signature: [Signature] Date: 2/13/2017

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Section 4

Quality Assurance/Quality Control

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 Viva L Series at RAIS A/S 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.

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Sample Analysis

Analysis Worksheets
Tared Filter, Probe, and O-Ring Data

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS _____ **Equipment Numbers:** _____
Model: Viva L _____
Tracking No.: 2233 _____
Project No.: 0138WS017E _____
Run #: 1 _____
Date: 2/6/17 _____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D21	158.8	121.6	37.2
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total **Total Particulate, mg:** 37.2

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D22	128.4	124.2	4.2
C. Rear filter catch	Filter	D23	121.4	120.7	0.7
D. Probe catch*	Probe	16	114269.9	114269.1	0.8
E. Filter seals catch*	Seals	R417	3293.9	3293.3	0.6

Sub-Total **Total Particulate, mg:** 6.3

Train 1 Aggregate **Total Particulate, mg:** 43.5

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D24	164.1	121.7	42.4
B. Rear filter catch	Filter	D25	123.8	122.9	0.9
C. Probe catch*	Probe	17	114563.3	114562.9	0.4
D. Filter seals catch*	Seals	R418	3324.4	3324.0	0.4

Total Particulate, mg: 44.1

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg: 0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: 

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 1

Model: VIVA L Tracking Number: 2233 Date: 2/6/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

S. Button

Date/Time in Dessicator:

2/6/17 - 17:25

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/10/17 11:30</u>	Date/Time: <u>2/13/17 2:00</u>	Date/Time:	Date/Time:	Date/Time:
R/H %: <u>12.4</u>	R/H %: <u>7.9</u>	R/H %:	R/H %:	R/H %:
Temp: <u>72.6</u>	Temp: <u>65.3</u>	Temp:	Temp:	Temp:
200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit:	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.0</u>	2 g Audit: <u>1999.9</u>	2 g Audit:	2 g Audit:	2 g Audit:
100 g Audit: <u>99998.3</u>	100 g Audit: <u>99998.3</u>	100 g Audit:	100 g Audit:	100 g Audit:
Initials: <u>S</u>	Initials: <u>SB</u>	Initials:	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	D21	121.6	158.9	158.8			
	Rear Filter							
	Probe	<u>N/A</u>						
	O-Ring Set							
A (Remainder)	Front Filter	D22	124.2	128.6	128.4			
	Rear Filter	D23	120.7	121.6	121.4			
	Probe	16	114269.1	114270.0	114269.9			
	O-Ring Set	R417	3293.3	3294.0	3293.9			
B	Front Filter	D24	121.7	164.3	164.1			
	Rear Filter	D25	122.9	123.9	123.8			
	Probe	17	114562.9	114563.5	114563.3			
	O-Ring Set	R418	3324.0	3324.6	3324.4			
BG	Filter	<u>N/A</u>						

Technician Signature: [Signature]

Date: 2/14/17

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS _____ Equipment Numbers: _____
 Model: Viva L _____
 Tracking No.: 2233 _____
 Project No.: 0138WS017E _____
 Run #: 2 _____
 Date: 2/7/17 _____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D26	169.5	119.9	49.6
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total **Total Particulate, mg:** 49.6

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D27	218.0	122.4	95.6
C. Rear filter catch	Filter	D28	125.4	123.9	1.5
D. Probe catch*	Probe	21	114396.0	114393.4	2.6
E. Filter seals catch*	Seals	R419	3344.5	3343.8	0.7

Sub-Total **Total Particulate, mg:** 100.4

Train 1 Aggregate **Total Particulate, mg:** 150.0

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D29	266.5	120.9	145.6
B. Rear filter catch	Filter	D30	124.8	123.4	1.4
C. Probe catch*	Probe	22	114349.7	114347.1	2.6
D. Filter seals catch*	Seals	R420	3308.8	3308.0	0.8

Total Particulate, mg: 150.4

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg: 0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: 

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 2
 Model: VIVA L Tracking Number: 2233 Date: 2/6/2017 2/7/17
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

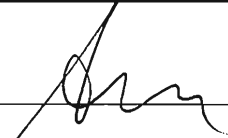
A. Kravitz

Date/Time in Dessicator:

2/7/17

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/6/17 11:30</u>	Date/Time: <u>2/13/17 8:40</u>	Date/Time:	Date/Time:	Date/Time:
R/H %: <u>12.4</u>	R/H %: <u>7.9</u>	R/H %:	R/H %:	R/H %:
Temp: <u>77.6</u>	Temp: <u>65.3</u>	Temp:	Temp:	Temp:
200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit:	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.9</u>	2 g Audit: <u>1999.9</u>	2 g Audit:	2 g Audit:	2 g Audit:
100 g Audit: <u>99998.3</u>	100 g Audit: <u>99998.7</u>	100 g Audit:	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials: <u>SB</u>	Initials:	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	<u>D26</u>	<u>119.9</u>	<u>189.6</u>	<u>169.5</u>			
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	<u>D27</u>	<u>122.4</u>	<u>218.1</u>	<u>218.0</u>			
	Rear Filter	<u>D28</u>	<u>123.9</u>	<u>125.6</u>	<u>125.4</u>			
	Probe	<u>21</u>	<u>114393.4</u>	<u>114396.32</u>	<u>114396.0</u>			
	O-Ring Set	<u>R419</u>	<u>3343.8</u>	<u>3344.6</u>	<u>3344.5</u>			
B	Front Filter	<u>D29</u>	<u>120.9</u>	<u>266.7</u>	<u>266.5</u>			
	Rear Filter	<u>D30</u>	<u>123.4</u>	<u>125.0</u>	<u>124.8</u>			
	Probe	<u>22</u>	<u>114347.1</u>	<u>114349.8</u>	<u>114349.7</u>			
	O-Ring Set	<u>R420</u>	<u>3308.0</u>	<u>3308.9</u>	<u>3308.8</u>			
BG	Filter							

Technician Signature: 

Date: 2/14/17

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS	Equipment Numbers: _____
Model: Viva L	_____
Tracking No.: 2233	_____
Project No.: 0138WS017E	_____
Run #: 3	_____
Date: 2/8/17	_____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D31	126.5	123.9	2.6
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total	Total Particulate, mg:	2.6
-----------	-------------------------------	-----

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D32	120.7	120.4	0.3
C. Rear filter catch	Filter	D33	123.1	123.0	0.1
D. Probe catch*	Probe	29	114280.4	114280.2	0.2
E. Filter seals catch*	Seals	R421	3524.6	3524.3	0.3

Sub-Total	Total Particulate, mg:	0.9
-----------	-------------------------------	-----

Train 1 Aggregate	Total Particulate, mg:	3.5
-------------------	-------------------------------	-----

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D34	125.5	123.7	1.8
B. Rear filter catch	Filter	D35	120.0	120.6	-0.6
C. Probe catch*	Probe	30	114335.1	114334.8	0.3
D. Filter seals catch*	Seals	R422	4554.5	4553.4	1.1

Total Particulate, mg:	2.6
------------------------	-----

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg:	0.0
------------------------	-----

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: _____

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 3

Model: VIVA L Tracking Number: 2233 Date: 2/13/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

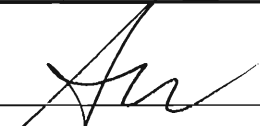
A. Kravitz

Date/Time in Dessicator:

2/8/17

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/10 11:00</u>	Date/Time: <u>2/13 08:10</u>	Date/Time: <u>2/14 15:00</u>	Date/Time:	Date/Time:
R/H %: <u>8.5</u>	R/H %: <u>7.9</u>	R/H %: <u>9.5</u>	R/H %:	R/H %:
Temp: <u>73.5</u>	Temp: <u>65.3</u>	Temp: <u>70.7</u>	Temp:	Temp:
200 mg Audit: <u>9999.3</u>	200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.8</u>	2 g Audit: <u>1999.9</u>	2 g Audit: <u>1999.9</u>	2 g Audit:	2 g Audit:
100 g Audit: <u>100.1</u>	100 g Audit: <u>100.0</u>	100 g Audit: <u>100.5</u>	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials: <u>A</u>	Initials: <u>A</u>	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	D31	123.9	126.6	126.5	-		
	Rear Filter	D32						
	Probe	29						
	O-Ring Set							
A (Remainder)	Front Filter	D32	120.4	120.7	120.7	-		
	Rear Filter	D33	123.0	123.1	123.1	-		
	Probe	29	114280.2	114280.5	114280.4	-		
	O-Ring Set	R421	3524.3	3524.7	3524.6	-		
B	Front Filter	D34	123.7	125.7	125.5	-		
	Rear Filter	D35	120.6	120.0	120.0	-		
	Probe	30	114334.8	114335.4	114335.0	114335.1		
	O-Ring Set	R422	4553.4	4554.7	4554.4	4554.5		
BG	Filter							

Technician Signature: 

Date: 2/14/17

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS _____ **Equipment Numbers:** _____
Model: Viva L _____
Tracking No.: 2233 _____
Project No.: 0138WS017E _____
Run #: 4 _____
Date: 2/9/17 _____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D36	123.7	122.8	0.9
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total **Total Particulate, mg:** 0.9

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D37	124.2	124.0	0.2
C. Rear filter catch	Filter	D38	120.8	120.9	-0.1
D. Probe catch*	Probe	34	115869.2	115868.4	0.8
E. Filter seals catch*	Seals	R423	3606.6	3606.0	0.6

Sub-Total **Total Particulate, mg:** 1.5

Train 1 Aggregate **Total Particulate, mg:** 2.4

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D39	123.4	122.2	1.2
B. Rear filter catch	Filter	D40	124.2	124.0	0.2
C. Probe catch*	Probe	58	117068.3	117068.0	0.3
D. Filter seals catch*	Seals	R424	3314.7	3314.6	0.1

Total Particulate, mg: 1.8

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg: 0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: 

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 4
 Model: VIVA L Tracking Number: 2233 Date: 2/6/2017 2/9/2017
 Test Crew: S. Button, A. Kravitz 58
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

A. Kravitz

Date/Time in Dessicator:

2/9/17

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/14 1500</u>	Date/Time: <u>2/15 1000</u>	Date/Time: <u>2/16 1200</u>	Date/Time:	Date/Time:
R/H %: <u>9.5</u>	R/H %: <u>9.0</u>	R/H %: <u>6.8</u>	R/H %:	R/H %:
Temp: <u>76.3</u>	Temp: <u>71.4</u>	Temp: <u>68.9</u>	Temp:	Temp:
200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.6</u>	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.9</u>	2 g Audit: <u>1999.9</u>	2 g Audit: <u>1999.8</u>	2 g Audit:	2 g Audit:
100 g Audit: <u>19995.5</u>	100 g Audit: <u>19999.4</u>	100 g Audit: <u>19998.5</u>	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials: <u>A</u>	Initials: <u>A</u>	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	D36	122.8	123.8	123.87	-		
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	D37	124.0	124.2	124.2	-		
	Rear Filter	D38	120.9	120.8	120.8	-		
	Probe	34	115868.4	115868.8	115869.2	115869.2		
	O-Ring Set	R423	3606.0	3606.7	3306.6	-		
B	Front Filter	D39	122.2	123.3	123.4	-		
	Rear Filter	D40	124.0	124.1	124.2	-		
	Probe	58	117068.0	117068.0	117068.3	117068.3		
	O-Ring Set	R424	3314.6	3314.7	3314.7	-		
BG	Filter							

Technician Signature: A. Kravitz

Date: 3/9/17

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS _____ **Equipment Numbers:** _____
Model: Viva L _____
Tracking No.: 2233 _____
Project No.: 0138WS017E _____
Run #: 5 _____
Date: 2/9/17 _____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D14	122.7	121.4	1.3
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total **Total Particulate, mg:** 1.3

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D15	123.2	122.9	0.3
C. Rear filter catch	Filter	D16	124.4	124.2	0.2
D. Probe catch*	Probe	59	117789.3	117789.1	0.2
E. Filter seals catch*	Seals	R425	3419.8	3419.0	0.8

Sub-Total **Total Particulate, mg:** 1.5

Train 1 Aggregate **Total Particulate, mg:** 2.8

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D17	122.6	121.2	1.4
B. Rear filter catch	Filter	D18	121.4	121.4	0.0
C. Probe catch*	Probe	62	117663.2	117662.4	0.8
D. Filter seals catch*	Seals	R426	3343.5	3342.6	0.9

Total Particulate, mg: 3.1

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg: 0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: 

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 5
 Model: VIVA L Tracking Number: 2233 Date: 2/6/2017 2/9/2017
 Test Crew: S. Button, A. Kravitz
 OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:


A. Kravitz

Date/Time in Dessicator:

2/9/17

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/14 1506</u>	Date/Time: <u>2/15/17 1000</u>	Date/Time: <u>2/16 1200</u>	Date/Time:	Date/Time:
R/H %: <u>9.5</u>	R/H %: <u>40</u>	R/H %: <u>6.8</u>	R/H %:	R/H %:
Temp: <u>20.3</u>	Temp: <u>71.4</u>	Temp: <u>68.4</u>	Temp:	Temp:
200 mg Audit: <u>200.6</u>	200 mg Audit: <u>200.6</u>	200 mg Audit: <u>200.6</u>	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.1</u>	2 g Audit: <u>1999.9</u>	2 g Audit: <u>1999.8</u>	2 g Audit:	2 g Audit:
100 g Audit: <u>9999.5</u>	100 g Audit: <u>9999.5</u>	100 g Audit: <u>9999.5</u>	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials: <u>A</u>	Initials: <u>A</u>	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	<u>D14</u>	<u>121.4</u>	<u>122.8</u>	<u>122.7</u>	-		
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	<u>D15</u>	<u>122.9</u>	<u>123.2</u>	<u>123.2</u>	-		
	Rear Filter	<u>D16</u>	<u>124.2</u>	<u>124.4</u>	<u>124.4</u>	-		
	Probe	<u>59</u>	<u>117789.1</u>	<u>117786.7</u>	<u>117789.3</u>	<u>117789.3</u>		
	O-Ring Set	<u>R425</u>	<u>3419.5</u>	<u>3419.6</u>	<u>3419.8</u>	-		
B	Front Filter	<u>D17</u>	<u>121.2</u>	<u>122.7</u>	<u>122.6</u>	-		
	Rear Filter	<u>D18</u>	<u>121.4</u>	<u>121.4</u>	<u>121.4</u>	-		
	Probe	<u>62</u>	<u>117662.4</u>	<u>117662.6</u>	<u>117663.1</u>	<u>117663.2</u>		
	O-Ring Set	<u>R426</u>	<u>3342.6</u>	<u>3343.4</u>	<u>3343.5</u>	-		
BG	Filter							

Technician Signature: 

Date: 2/16/17

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS _____ **Equipment Numbers:** _____
Model: Viva L _____
Tracking No.: 2233 _____
Project No.: 0138WS017E _____
Run #: 6 _____
Date: 2/10/17 _____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D19	124.3	123.7	0.6
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total **Total Particulate, mg:** **0.6**

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D20	121.3	120.8	0.5
C. Rear filter catch	Filter	D82	123.3	123.1	0.2
D. Probe catch*	Probe	66	118461.1	118461.1	0.0
E. Filter seals catch*	Seals	R427	4333.7	4332.5	1.2

Sub-Total **Total Particulate, mg:** **1.9**

Train 1 Aggregate **Total Particulate, mg:** **2.5**

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D83	122.0	120.7	1.3
B. Rear filter catch	Filter	D84	123.1	123.1	0.0
C. Probe catch*	Probe	67	117768.6	117768.5	0.1
D. Filter seals catch*	Seals	R428	3360.0	3359.3	0.7

Total Particulate, mg: **2.1**

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg: **0.0**

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: 

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 6

Model: VIVA L Tracking Number: 2233 Date: 2/10/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

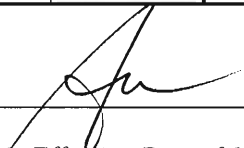
A. Kravitz

Date/Time in Dessicator:

2/10/17

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/14 1500</u>	Date/Time: <u>2/15 1000</u>	Date/Time:	Date/Time:	Date/Time:
R/H %: <u>9.5</u>	R/H %: <u>9.0</u>	R/H %:	R/H %:	R/H %:
Temp: <u>70.3</u>	Temp: <u>71.7</u>	Temp:	Temp:	Temp:
200 mg Audit: <u>260.0</u>	200 mg Audit: <u>260.6</u>	200 mg Audit:	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1949.9</u>	2 g Audit: <u>1949.9</u>	2 g Audit:	2 g Audit:	2 g Audit:
100 g Audit: <u>99998.5</u>	100 g Audit: <u>99998.5</u>	100 g Audit:	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials:	Initials:	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	<u>D19</u>	<u>123.7</u>	<u>124.2</u>	<u>124.3</u>			
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	<u>D20</u>	<u>120.8</u>	<u>121.3</u>	<u>121.3</u>			
	Rear Filter	<u>D82</u>	<u>123.1</u>	<u>123.2</u>	<u>123.3</u>			
	Probe	<u>66</u>	<u>118461.1</u>	<u>118460.9</u>	<u>118461.1</u>			
	O-Ring Set	<u>R427</u>	<u>4332.5</u>	<u>4333.6</u>	<u>4333.7</u>			
B	Front Filter	<u>D83</u>	<u>120.7</u>	<u>122.0</u>	<u>122.0</u>			
	Rear Filter	<u>D84</u>	<u>123.1</u>	<u>123.0</u>	<u>123.1</u>			
	Probe	<u>67</u>	<u>117768.5</u>	<u>117768.4</u>	<u>117768.6</u>			
	O-Ring Set	<u>R428</u>	<u>3359.3</u>	<u>3359.9</u>	<u>33560.0</u>			
BG	Filter							

Technician Signature: 

Date: 2/15/17

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 7

Model: VIVA L Tracking Number: 2233 Date: 2/10/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

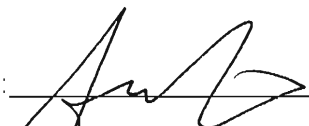
A. Kravitz

Date/Time in Dessicator:

2/10/17 17:40

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/10 1500</u>	Date/Time: <u>2/15 1000</u>	Date/Time: <u>2/16 1200</u>	Date/Time:	Date/Time:
R/H %: <u>1.5</u>	R/H %: <u>6.0</u>	R/H %: <u>6.8</u>	R/H %:	R/H %:
Temp: <u>70.3</u>	Temp: <u>71.4</u>	Temp: <u>68.9</u>	Temp:	Temp:
200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.1</u>	2 g Audit: <u>1999.6</u>	2 g Audit: <u>1999.8</u>	2 g Audit:	2 g Audit:
100 g Audit: <u>99998.5</u>	100 g Audit: <u>99998.4</u>	100 g Audit: <u>99998.5</u>	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials: <u>A</u>	Initials: <u>A</u>	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	<u>D85</u>	<u>124.8</u>	<u>125.3</u>	<u>125.3</u>	-		
	Rear Filter							
	Probe	<u>2^A</u>	<u>X^A</u>					
	O-Ring Set							
A (Remainder)	Front Filter	<u>D86</u>	<u>121.1</u>	<u>121.3</u>	<u>121.4</u>	-		
	Rear Filter	<u>D87</u>	<u>123.2</u>	<u>123.0</u>	<u>123.1</u>	-		
	Probe	<u>2</u>	<u>115017.3</u>	<u>115017.1</u>	<u>115017.3</u>	-		
	O-Ring Set	<u>R429</u>	<u>4330.5</u>	<u>4331.8</u>	<u>4331.9</u>	-		
B	Front Filter	<u>D88</u>	<u>123.8</u>	<u>125.0</u>	<u>125.1</u>	-		
	Rear Filter	<u>D89</u>	<u>120.9</u>	<u>120.5</u>	<u>120.6</u>	-		
	Probe	<u>14</u>	<u>114552.3</u>	<u>114552.2</u>	<u>114552.6</u>	<u>114552.6</u>		
	O-Ring Set	<u>R430</u>	<u>3301.8</u>	<u>3302.4</u>	<u>3302.4</u>	-		
BG	Filter							

Technician Signature: 

Date: 2/16/17

Wood Heater Lab Data - ASTM E2780 / ASTM E2515

Manufacturer: RAIS _____ **Equipment Numbers:** _____
Model: Viva L _____
Tracking No.: 2233 _____
Project No.: 0138WS017E _____
Run #: 8 _____
Date: 2/13/17 _____

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D90	123.5	122.6	0.9
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

Sub-Total **Total Particulate, mg:** 0.9

TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	D91	125.5	124.2	1.3
C. Rear filter catch	Filter	D92	121.4	121.2	0.2
D. Probe catch*	Probe	18	114404.0	114404.0	0.0
E. Filter seals catch*	Seals	R431	4099.8	4099.8	0.0

Sub-Total **Total Particulate, mg:** 1.5

Train 1 Aggregate **Total Particulate, mg:** 2.4

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	D93	124.0	121.9	2.1
B. Rear filter catch	Filter	D94	123.9	123.9	0.0
C. Probe catch*	Probe	27	114280.1	114280.0	0.1
D. Filter seals catch*	Seals	R432	3354.7	3354.4	0.3

Total Particulate, mg: 2.5

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter				0.0

Total Particulate, mg: 0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and seals, negative numbers for filters are assumed to be part of the seal weight.

Component	Equations:
A. Front filter catch	Final (mg) - Tare (mg) = Particulate, mg
B. Rear filter catch	Final (mg) - Tare (mg) = Particulate, mg
C. Probe catch	Final (mg) - Tare (mg) = Particulate, mg

Technician Signature: 

ASTM E2780 Wood Heater Run Sheets

Client: RAIS Project Number: 0138WS017E Run Number: 8

Model: VIVA L Tracking Number: 2233 Date: 2/13/2017

Test Crew: S. Button, A. Kravitz

OMNI Equipment ID numbers: 296-T55, 185, 340, 431, 355 336, 594, 410, 559, 209, 132, 23, 592, 283A

ASTM E2515 Lab Sheet

Assembled By:

S. Button

Date/Time in Dessicator:

2/13/2017 13:40

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: <u>2/14 15:00</u>	Date/Time: <u>2/15 10:00</u>	Date/Time:	Date/Time:	Date/Time:
R/H %: <u>4.5</u>	R/H %: <u>1.0</u>	R/H %:	R/H %:	R/H %:
Temp: <u>70.3</u>	Temp: <u>71.4</u>	Temp:	Temp:	Temp:
200 mg Audit: <u>200.0</u>	200 mg Audit: <u>200.0</u>	200 mg Audit:	200 mg Audit:	200 mg Audit:
2 g Audit: <u>1999.9</u>	2 g Audit: <u>1999.9</u>	2 g Audit:	2 g Audit:	2 g Audit:
100 g Audit: <u>19996.5</u>	100 g Audit: <u>9999.7</u>	100 g Audit:	100 g Audit:	100 g Audit:
Initials: <u>A</u>	Initials: <u>A</u>	Initials:	Initials:	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	<u>D90</u>	<u>122.6</u>	<u>123.4</u>	<u>123.5</u>			
	Rear Filter							
	Probe	<u>N/A</u>						
	O-Ring Set							
A (Remainder)	Front Filter	<u>D91</u>	<u>124.2</u>	<u>125.6</u>	<u>125.5</u>			
	Rear Filter	<u>D92</u>	<u>121.2</u>	<u>121.3</u>	<u>121.4</u>			
	Probe	<u>18</u>	<u>114404.0</u>	<u>114407.0</u>	<u>114404.0</u>			
	O-Ring Set	<u>R431</u>	<u>4099.8</u>	<u>4099.8</u>	<u>4099.8</u>			
B	Front Filter	<u>D93</u>	<u>121.9</u>	<u>124.0</u>	<u>124.0</u>			
	Rear Filter	<u>D94</u>	<u>123.9</u>	<u>123.9</u>	<u>123.9</u>			
	Probe	<u>27</u>	<u>114280.0</u>	<u>114280.1</u>	<u>114280.1</u>			
	O-Ring Set	<u>R432</u>	<u>3354.4</u>	<u>3354.7</u>	<u>3354.7</u>			
BG	Filter	<u>N/A</u>						

Technician Signature: 

Date: 2/15/17

Tare Sheet: (check one)

Probes _____

47mm Filters

100mm Filters _____

O-Ring Pair _____

Prepared By: A. Kravitz

Balance ID #: 244

Thermohygrometer ID #: 592

Audit Weight ID #/Mass: 131 / 500.0 mg

Placed in Dessicator: Date: <u>2/8/17</u> Time: <u>10:00</u>	Date: <u>2/9/17</u> Time: <u>12:30</u> RH %: <u>8.3</u> T (°F): <u>72.3</u> Audit: <u>500.1</u>	Date: <u>2/9/17</u> Time: <u>18:30</u> RH %: <u>8.5</u> T (°F): <u>70.3</u> Audit: <u>500.1</u>	Date: _____ Time: _____ RH %: _____ T (°F): _____ Audit: _____	Date: _____ Time: _____ RH %: _____ T (°F): _____ Audit: _____	Date Used	Project Number	Run No.
	ID #						
D82	123.1	123.1			2/10/17	0138WS017E	6
D83	120.6	120.7			↓	↓	↓
D84	123.0	123.1			↓	↓	↓
D85	124.7	124.8			↓	↓	7
D86	121.0	121.1			↓	↓	↓
D87	123.1	123.2			↓	↓	↓
D88	123.7	123.8			↓	↓	↓
D89	121.0	120.9			↓	↓	↓
D90	122.5	122.6			2/13/17		8
D91	124.2	124.2			↓	↓	↓
D92	121.2	121.2			↓	↓	↓
D93	121.9	121.9			↓	↓	↓
D94	123.8	123.9			↓	↓	↓
D95	121.0	121.0					
D96	121.8	121.7					
D97	123.1	123.1					
D98	121.0	121.0					
D99	123.8	123.9					
D100	122.8	122.7					
D101	120.6	120.6					
Initials: <u>AK</u>	Initials: <u>A</u>	Initials: _____	Initials: _____				

Final Technician Signature: _____
Control No. P-SFDP-0002.xls, Effective date: 2/1/2017

Date: 2/9/17

Evaluator signature: _____ 2/9/17

Tare Sheet: Probes ___ 47mm Filters 100mm Filters ___ O-Ring Pair ___

Date/time Placed in Dessicator: 12/16/16 11:06

Thermohyrometer ID #: 592

Prepared By: A. Kravitz

Analytical Balance ID #: 23

Audit Weight ID #/Mass: 131 / 5000 mg

ID #	Date: [2/19/16] Time: 15:00 RH %: 3.8 T (°F): 63.3 Audit: 500.1	Date: 2/1/17 Time: 09:00 RH %: 4.4 T (°F): 66.7 Audit: 500.1	Date: Time: RH %: T (°F): Audit:	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
D21	121.7	121.6			2/6/17	13865017E	1
D22	124.3	124.2			↓	↓	↓
D23	120.8	120.7			↓	↓	↓
D24	121.9	121.7			↓	↓	↓
D25	123.0	122.9			↓	↓	↓
D26	120.0	119.9			2/7/17	↓	2
D27	122.5	122.4			↓	↓	↓
D28	124.0	123.9			↓	↓	↓
D29	121.0	120.9			↓	↓	↓
D30	123.4	123.4			↓	↓	↓
D31	123.8	123.9			2/8/17	↓	3
D32	120.4	120.4			↓	↓	↓
D33	123.0	123.0			↓	↓	↓
D34	123.6	123.7			↓	↓	↓
D35	120.6	120.6			↓	↓	↓
D36	122.7, 122.0	122.8			2/9/17	↓	4
D37	124.0	124.0			↓	↓	↓
D38	121.0	120.9			↓	↓	↓
D39	123.3	122.2			↓	↓	↓
D40	124.1	124.0			↓	↓	↓
	Initials: <u>A</u>	Initials: <u>A</u>	Initials:	Initials:			

Final Technician Signature: [Signature]
Control No. P-SFDP-0001.xls, Effective Date: 9/9/2015

Date: 2/1/17

Evaluator signature: [Signature] 3/9/2017

Tare Sheet: Probes ___ 47mm Filters 100mm Filters ___ O-Ring Pair ___

Date/time Placed in Dessicator: 12/16/16 10:00

Thermohygrometer ID #: 137 592

Prepared By: A. Kowitz

Analytical Balance ID #: 23

Audit Weight ID #/Mass: 131 / 500.0 mg

ID #	Date: 12/19/16 Time: 15:00 RH %: 3.8 T (°F): 83.3 Audit: 500.1	Date: 1/5/17 Time: 10:00 RH %: 6.3 T (°F): 64.7 Audit: 500.1	Date: Time: RH %: T (°F): Audit:	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
D1	124.0	123.9			1/5/17	048606002N	1
D2	121.5	121.4			↓	↓	↓
D3	122.3	122.3			↓	↓	↓
D4	123.4	123.3			↓	↓	↓
D5	121.6	121.5			↓	↓	2
D6	121.6	121.5			↓	↓	↓
D7	121.1	120.9			↓	↓	↓
D8	121.8	121.7			↓	↓	↓
D9	123.2	123.0			1/10/17	0135P031E.REV001	1
D10	123.0	122.9			↓	↓	↓
D11	121.1	121.0			↓	↓	↓
D12	121.4	121.3			↓	↓	↓
D13	123.9	123.9			↓	↓	↓
D14	121.5	121.4			2/9/17	0138W5017E	5
D15	123.0	122.9			↓	↓	↓
D16	124.4	124.2			↓	↓	↓
D17	121.4	121.3			↓	↓	↓
D18	121.5	121.4			↓	↓	↓
D19	123.7	123.7			2/10/17	↓	6
D20	120.8	120.8			↓	↓	↓

Initials: AK Initials: AK Initials: Initials:

Final Technician Signature: [Signature]
Control No. P-SFDP-0001.xls, Effective date: 9/9/2015

Date: 1/5/17

Evaluator signature: [Signature] 3/9/2017

Tare Sheet: (check one)

Probes

47mm Filters _____

100mm Filters _____

O-Ring Pair _____

Prepared By: A. Kowitz

Balance ID #: 244

Thermohygrometer ID #: 592

Audit Weight ID #/Mass: 283A 190.4983

Placed in Dessicator:	Date: <u>2/9/17</u>	Date: <u>2/10/17</u>	Date: _____	Date: _____	Date Used	Project Number	Run No.
Date: <u>2/8/17</u>	Time: <u>12:30</u>	Time: <u>1000</u>	Time: _____	Time: _____			
Time: <u>11:00</u>	RH %: <u>8.7</u>	RH %: <u>9.7</u>	RH %: _____	RH %: _____			
	T (°F): <u>72.3</u>	T (°F): <u>73.2</u>	T (°F): _____	T (°F): _____			
ID #	Audit: <u>99998.3</u>	Audit: <u>99998.3</u>	Audit: _____	Audit: _____			
2	115017.2	115017.3			2/10/17	6138WS017E	7
14	114552.3	114552.3			↓	↓	↓
18	114404.0	114404.0			2/13/17	↓	8
27	114280.1	114280.0			↓	↓	8
35	114331.6	114331.7					
38	114152.9	114153.8					
53	118274.3	118274.3					
56	118614.4	118614.4					
64	118223.9	118223.9					
65	117096.6	117096.4					
68	116810.0	116810.1					
69	117374.7	117374.7					
Initials: <u>A</u>	Initials: <u>A</u>	Initials: _____	Initials: _____	Initials: _____			

Final Technician Signature: _____
 Control No. P-SFDP-0002.xls, Effective date: 2/1/2017

Date: 2/10/17

Evaluator signature: _____ 3/9/2017

Tare Sheet: Probes 47mm Filters 100mm Filters O-Ring Pair

Date/time Placed in Dessicator: 1/28/17

Thermohygrometer ID #: 592

Prepared By: A. Kravitz

Analytical Balance ID #: 23

Audit Weight ID #/Mass: 283A / 100g

ID #	Date: 1/28 2/1/17 Time: 0900 RH %: 4.4 T (°F): 86.7 Audit: 99.9985	Date: 2/2/17 Time: 0830 RH %: 3.7 T (°F): 70.9 Audit: 99.9980	Date: 2/1/17 Time: 1630 RH %: 2.0 T (°F): 78.9 Audit: 99.9982	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
16	114270.4	114269.2	114269.1		2/1/17	138WS017E	1
17	114563.9	114563.0	114562.9		↓	↓	↓
21	114394.4	114393.5	114393.4		2/7/17	↓	2
22	114348.2	114347.2	114347.1		↓	↓	↓
29	114281.4	114280.3	114280.2		2/8/17	↓	3
30	114335.8	114334.9	114334.8		↓	↓	↓
34	115869.4	115868.5	115868.4		2/9/17	↓	4
58	117069.4	117068.1	117068.0		↓	↓	↓
59	117790.9	117789.3	117789.1		↓	↓	5
62	117664.5	117662.5	117662.4		↓	↓	↓
66	118462.9	118461.3	118461.1		2/10/17	↓	6
67	117769.4	117768.4	117768.5		↓	↓	↓

Initials: A Initials: A Initials: A Initials:

Final Technician Signature: [Signature] Control No. P-SFDP-0001.xls, Effective date: 9/9/2015

Date: 2/2/17

Evaluator signature: [Signature] 2/9/2017

Tare Sheet: Probes 47mm Filters 100mm Filters O-Ring Pair ✓

Date/time Placed in Dessicator: 12/16/16 11:00

Thermohyrometer ID #: 592

Prepared By: A. Kravitz

Analytical Balance ID #: 23

Audit Weight ID #/Mass: 282A / 134 / 2000.0 / 500.0 mg

ID #	Date: 1/9/17 Time: 10:00 RH %: 3.8 T (°F): 65.7 Audit: 500.1 1999.9	Date: 1/9/17 Time: 16:00 RH %: 3.1 T (°F): 71.6 Audit: 2000.0	Date: Time: RH %: T (°F): Audit:	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
R415	3287.9	3287.9			1/10/17	013540031E.REV001	1
R416	3305.9	3306.0			↓	↓	↓
R417	3293.2	3263.3			2/6/17	0138w5017E	1
R418	3324.0	3324.0			↓	↓	1
R419 R419	3343.7	3343.8			2/7/17	↓	2
R420	3307.9	3308.0			↓	↓	↓
R421	3544.2	3524.3			2/8/17	↓	3
R422	4553.3	4553.4			↓	↓	↓
R423	3606.1	3606.0			2/9/17	↓	4
R424	3314.5	3314.6			↓	↓	↓
R425	3414.1	3414.0			↓	↓	5
R426	3342.6	3342.6			↓	↓	↓
R427	4332.5	4332.5			2/10/17	↓	6
R428	3359.2	3359.3			↓	↓	↓
R429	4330.4	4330.5			↓	↓	7
R430	3301.8	3301.8			↓	↓	↓
R431	4094.6	4094.8			2/13/17	↓	8
R432	3354.2	3354.4			↓	↓	8
R433	3353.5	3353.5					
R434	3321.8	3321.8					

Initials: A Initials: A Initials: Initials:

Final Technician Signature: [Signature]
Control No. P-SFDP-0001.xls, Effective date: 9/9/2015

Date: 1/9/17

Evaluator signature: [Signature] 3/9/2017 [Signature]

Calibrations

Methods EPA 28R, ASTM E2515, ASTM E2780

ID #	Lab Name/Purpose	Log Name	Attachment Type
23	Scale-Analytical Balance	Mettler Analytical Balance	Calibration Certificate
132	10 lb Weight	Weight Standard, 10 lb.	Calibration Certificate
185	Platform Scale	Weigh-Tronix Platform Scale	Calibration Certificate
209	Barometer	Barometer – Princo	Equipment Record
283A	Calibration Weights	Troemner Metric Weight Standards	Calibration Certificate
296-T55	Tape Measure	DeWalt 16' Tape Measure	Calibration Log
335	Sample Box / Dry Gas Meter	Apex Automated Emissions Sampling Box	Calibration Log
336	Sample Box / Dry Gas Meter	Apex Automated Emissions Sampling Box	Calibration Log
340	Wood Moisture Meter	Moisture Meter - Delmhorst	See Test Run Notes
410	Microtector	Dwyer Microtector	Calibration Certificate
431	Moisture Meter Calibrator	Delmhorst Moisture Content Calibrator	Calibration Log
559	Vaneometer	Dwyer Vaneometer	Equipment Record
592	Thermohygrometer	Omega Digital Thermohygrometer	Calibration Log
594	Combustion Gas Analyzer	ZRE Combustion Gas Analyzer	Equipment Record

Certificate of Calibration

Certificate Number: **632003**



JJ Calibrations, Inc.

7007 SE Lake Rd
Portland, OR 97267-2105
Phone 503.786.3005
FAX 503.786.2994

Omni-Test Laboratories
13327 NE Airport Way
Portland, OR 97230

OnSite

PO: **160104**

Order Date: **09/27/2016**

Authorized By: **N/A**

Calibrated on: **09/27/2016**

*Recommended Due: **03/27/2017**

Environment: **20 °C 44 % RH**

* As Received: **Out of Tolerance**

* As Returned: **Within Tolerance**

Action Taken: **Adjusted**

Technician: **123**



Property #: **OMNI-00023**
User: **N/A**
Department: **N/A**
Make: **Mettler**
Model: **AE200**
Serial #: **E17657**
Description: **Scale, 205g**
Procedure: **DCN 500818/500887**
Accuracy: **±0.0004g ±1 LSD**

Remarks: * Many factors may cause the unit to drift out of calibration before the recommended due date. Any reported error is the absolute value between the reference and the unit. Uncertainties include the effects of the unit.

Standards Used

Std ID	Manufacturer	Model	Nomenclature	Due Date	Trace ID
723A	Rice Lake	1mg-200g (Class 0)	Mass Set	12/01/2016	603626

Measurement Data


Parameter	Measurement Description	Range	Unit	Reference	Min	Max	*Error	UUT	Uncertainty
Before	Force								Accredited = U
			g	0.00100	0.0005	0.0015	0.0000	0.0010 g	5.7E-04 U
			g	0.01000	0.0095	0.0105	0.0000	0.0100 g	5.7E-04 U
			g	0.10000	0.0995	0.1005	0.0000	0.1000 g	5.7E-04 U
			g	0.50000	0.4995	0.5005	0.0000	0.5000 g	5.7E-04 U
			g	1.00000	0.9995	1.0005	0.0000	1.0000 g	5.7E-04 U
			g	40.00000	39.9995	40.0005	0.0005	40.0005 g	5.7E-04 U
			g	80.00000	79.9995	80.0005	0.0005	80.0005 g	5.7E-04 U
			g	120.00000	119.9995	120.0005	0.0008	120.0008 g	5.7E-04 U
			g	160.00000	159.9995	160.0005	0.0010	160.0010 g	5.8E-04 U
	g	200.00000	199.9995	200.0005	0.0012	200.0012 g	5.7E-04 U		
After									Accredited = U
			g	0.00100	0.0005	0.0015	0.0000	0.0010 g	5.7E-04 U
			g	0.01000	0.0095	0.0105	0.0000	0.0100 g	5.7E-04 U
			g	0.10000	0.0995	0.1005	0.0000	0.1000 g	5.7E-04 U
			g	0.50000	0.4995	0.5005	0.0000	0.5000 g	5.7E-04 U
			g	1.00000	0.9995	1.0005	0.0000	1.0000 g	5.7E-04 U
			g	40.00000	39.9995	40.0005	0.0001	40.0001 g	5.7E-04 U
			g	80.00000	79.9995	80.0005	0.0002	80.0002 g	5.7E-04 U
			g	120.00000	119.9995	120.0005	0.0002	120.0002 g	5.7E-04 U
			g	160.00000	159.9995	160.0005	0.0003	160.0003 g	5.8E-04 U
	g	200.00000	199.9995	200.0005	0.0003	200.0003 g	5.7E-04 U		

JJ Calibrations, Inc. certifies that this instrument has been calibrated in accordance with the JJ Calibrations Quality Assurance Manual with the stated procedure using standards that are traceable to the National Institute of Standards and Technology (NIST), or other National Measurement Institutes (NMI's), or by using natural physical constants, intrinsic standards or ratio calibration techniques. The quality system and this certificate are in compliance with ANSI/NCSL Z540-1-1994, ISO/IEC 17025-2005, ISO 10012-1, the ISO 9000 family and QS 9000. The expanded uncertainties of measurements for this calibration are based upon 95% (2 sigma) confidence limits. Unless otherwise stated, a test accuracy ratio (TAR) of 4:1, if achievable, is maintained. The results reported herein apply only to the calibration of the item described above. This report may not be reproduced, except in full, without prior written consent of JJ Calibrations, Inc.
JJ Calibrations, Inc. quality system has been assessed and accredited to ISO/IEC 17025:2005.



Reviewer

3 Issued 10/04/2016 Rev # 15



Inspector

SCALE WEIGHT CALIBRATION DATA SHEET

Weight to be calibrated: 10 lb

ID Number: 132

Standard Calibration Weight: 10 lb

ID Number: 255

Scale Used: MTW-150K

ID Number: 353

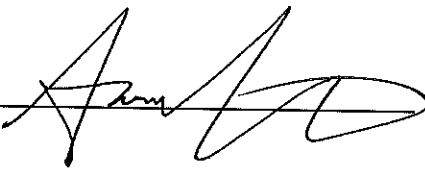
Date: 2/19/13

By: A. Kravitz

Standard Weight (A) (Lb.)	Weight Verified (B) (Lb.)	Difference (A - B)	% Error
10.0	10.0	0.0	Ø

*Acceptable tolerance is 1%.

This calibration is traceable to NIST using calibrated standard weights.

Technician signature:  Date: 2/19/13



QUALITY CONTROL SERVICES

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



OMNI-Test Laboratories, Inc.
13327 NE Airport Way
Portland, OR 97230

Report Number: OMNE0321676161011

A2LA ACCREDITED CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Scale	Weigh-Tronix	WI-127 1000x0.1lb	21676	185	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
lbs	0.1	QC033	10/11/16	10/27/15	10/2017

FUNCTIONAL CHECKS

SHIFT TEST		LINEARITY		REPEATABILITY		ENVIRONMENTAL CONDITIONS
Test Wt: 500	Tol: 0.5	Test Wt: HB44	Tol: HB44	Test Wt: 200	Tol: 0.2	<input type="checkbox"/> Good <input checked="" type="checkbox"/> Fair <input type="checkbox"/> Poor
As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>		As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>		As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>		Temperature: 20.3°C
As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>		As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>		As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>		

CALIBRATION DATA

Standard	As-Found	As-Left	Expanded Uncertainty
1000	1000.1	1000.1	0.12
700	700.1	700.1	0.12
500	500.0	500.0	0.08
200	200.0	200.0	0.08
100	100.0	100.0	0.05
50	50.0	50.0	0.05

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Avoirdupois Cast W	Rice Lake	25 and 50lb	PWO990-CA	11/4/15	11/2017	20152112

Permanent Information Concerning this Equipment:

Comments/Information Concerning this Calibration

Report prepared/reviewed by: S. King Date: 10-11-16

Technician: S. King

Signature: 

THIS CERTIFICATE SHALL NOT BE REPRODUCED, EXCEPT IN FULL, 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 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.

OMNI-Test Laboratories, Inc.
Beaverton, OR (503) 643-3788

Equipment Record

Name: Fortin Type Mercurial Barometer

Type of Equipment: Barometer

S/N: 0674 **OMNI ID #:** OMNI-00209

Manufacturer: PRINCO Instruments, Inc.

Is Manufacturer's manual available in the equipment file? : Yes, if not why? _____

Date Received: June 2000 **Date Placed in Service:** June 2000

Condition When Received: : New 9 Used 9 Reconditioned

Location: Lab

Location of Calibration Procedures: All PRINCO Fortin mercurial barometers have scales which are set at the time of manufacture to a near zero correction by comparison with a Fortin type mercurial barometer whose scales were calibrated traceable to NIST. If the barometer is not abused an any way , it should never go out of calibration.

Location of Dates/Results of Calibrations: If the barometer is not abused an any way , it should never go out of calibration. The barometer currently hangs on the wall and is never moved.

Location of Maintenance Procedures: Maintenance is performed on an "as needed" basis.

Dates / Results of Maintenance: Regularly scheduled maintenance is not required. Pre-service and post-service maintenance is conducted per QA Manual Section 5.3.5. To date, maintenance has not been required beyond the in-service maintenance prescribed in QA Manual Section 5.3.5.

Any Planned Maintenance? : No, if yes what: _____

Equipment History of any damage, malfunction, modification and/or repair (including a statement on the suitability of the equipment for testing): To date, this instrument has not been damaged, has not malfunctioned, has not been modified, and has not been repaired.

Certificate of Calibration

Certificate Number: **543402**



JJ Calibrations, Inc.

7007 SE Lake Rd
Portland, OR 97267-2105
Phone 503.786.3005
FAX 503.786.2994

Omni-Test Laboratories
13327 NE Airport Way
Portland, OR 97230

PO: OTL-13-031
Order Date: 09/27/2013
Authorized By: N/A



Property #: **OMNI-00283A**
User: **N/A**
Department: **N/A**
Make: **Troemner Inc**
Model: **1mg-100g (Class F)**
Serial #: **47883**
Description: **Mass Set, 21 Pc.**
Procedure: **DCN 500901**
Accuracy: **Class F**

Calibrated on: **10/09/2013**
*Recommended Due: **10/09/2018**
Environment: **20 °C 41 % RH**
As Received: **Other - See Remarks**
As Returned: **Within Tolerance**
Action Taken: **Calibrated**
Technician: **34**

Remarks: * Any number of factors may cause the calibration item to drift out of calibration before the recommended interval has expired

Changed set from a Class 4 to a Class F per Jeremy Clark.
Received missing 1g weight.
Refer to attachment for measurement results.

Standards Used

<u>Std ID</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Nomenclature</u>	<u>Due Date</u>	<u>Trace ID</u>
432A	Sartorius	C-44	Microbalance 5.1g	03/11/2014	517747
479A	Sartorius	MC210S	Scale, 210g	02/22/2014	517755
503A	Rice Lake	1mg-200g (Class O)	Mass Set	12/07/2013	517746
723A	Rice Lake	1mg-200g (Class O)	Mass Set	09/05/2014	540048

JJ Calibrations, Inc. certifies that this instrument has been calibrated in accordance with the JJ Calibrations Quality Assurance Manual with the stated procedure using standards that are traceable to the National Institute of Standards and Technology (NIST), or other National Measurement Institutes (NMI's), or by using natural physical constants, intrinsic standards or ratio calibration techniques. The quality system and this certificate are in compliance with ANSI/NCSL Z540-1-1994, ISO/IEC 17025-2005, ISO 10012-1, the ISO 9000 family and QS 9000. The expanded uncertainties of measurements for this calibration are based upon 95% (2 sigma) confidence limits. Unless otherwise stated, a test accuracy ratio (TAR) of 4:1, if achievable, is maintained. The results reported herein apply only to the calibration of the item described above. This report may not be reproduced, except in full, without prior written consent of JJ Calibrations, Inc.

JJ Calibrations, Inc. quality system has been assessed and accredited to ISO/IEC 17025:2005.

Reviewer

3 Issued 10/11/2013

Rev # 14

Inspector

OMNI-Test Laboratories, Inc.

Thermal Metering System Calibration Y Factor

Manufacturer: APEX
 Model: XC-60-EP
 Serial Number: 606001
 OMNI Tracking No.: OMNI-00335
 Calibrated Orifice: Yes

Date	7/7/2016	Acceptable Deviation (5%)	Deviation
y Factor	0.999	0.04995	0.015
Acceptance	Acceptable		

Average Gas Meter y Factor 0.984
--

Orifice Meter dH@ N/A

Acceptable y Deviation	0.020
Maximum y Deviation	0.006
Acceptable dH@ Deviation	N/A
Maximum dH@ Deviation	N/A
Acceptance	Acceptable

Calibration Date: 01/03/17
 Calibrated by: B. Davis
 Calibration Frequency: Six months
 Next Calibration Due: 7/3/2017
 Instrument Range: 1.000 cfm
 Standard Temp.: 68 oF
 Standard Press.: 29.92 "Hg
 Barometric Press., Pb: 30.24 "Hg
 Signature/Date: [Signature] 1/6/2017

Standard Calibrator	Model	Standard Test Meter
	S/N	OMNI-00001
	Calib. Date	27-Oct-16
	Calib. Value	0.9823 y factor (ref)

Calibration Parameters	Run 1	Run 2	Run 3
Reference Meter Pressure ("H2O), Pr	0.00	0.00	0.00
DGM Pressure ("H2O), Pd	2.25	1.25	0.75
Initial Reference Meter	222.4	233.7	238.8
Final Reference Meter	233.608	238.735	244.617
Initial DGM	0	0	0
Final DGM	11.284	5.124	5.938
Temp. Ref. Meter (°F), Tr	67.0	67.0	68.0
Temperature DGM (°F), Td	78.0	78.0	79.0
Time (min)	53.0	32.0	48.0
Net Volume Ref. Meter, Vr	11.208	5.035	5.817
Net Volume DGM, Vd	11.284	5.124	5.938
Gas Meter y Factor =	0.991	0.982	0.981
Gas Meter y Factor Deviation (from avg.)	0.006	0.002	0.004
Orifice dH@	N/A	N/A	N/A
Orifice dH@ Deviation (from avg.)	N/A	N/A	N/A

where:

1. Deviation = |Average value for all runs - current run value|
- ** 2. $y = [Vr \times (y \text{ factor (ref)}) \times (Pb + (Pr / 13.6)) \times (Td + 460)] / [Vd \times (Pb + (Pd / 13.6)) \times (Tr + 460)]$
- ** 3. $dH@ = 0.0317 \times Pd / (Pb (Td + 460)) \times [(Tr + 460) \times \text{time}] / Vr^2$

* Reference calibration is traceable to NIST through NIST Test # 40674, Kimble ASTM E1272, or NIST traceable laboratory

** Equations come from EPA Method 5

The uncertainty of measurement is 0.14 % This is based on the reference standard having a TAR Test Accuracy Ratio of at least 4:1

OMNI-Test Laboratories, Inc.

DIFFERENTIAL PRESSURE GAUGE CALIBRATION DATA SHEET

Instrument to be calibrated: Pressure Transducer

Maximum Range: 2"WC ID Number: OMI-00335B

Calibration Instrument: Digital Manometer ID Number: OMI-00633

Date: 1/3/17 By: B. Davis


This form is to be used only in conjunction with Standard Procedure C-SPC.

Range of Calibration Point ("WC)	Digital Manometer Input ("WC)	Pressure Gauge Response ("WC)	Difference (Input - Response)	% Error of Full Span
0-20" Max Range 0" 0.4"	0.155	0.16	0.005	0.25
20-40" Max Range 0.4" 0.8"	0.505	0.50	0.005	0.25
40-60" Max Range 0.8" 1.2"	1.001	1.00	0.001	0.05
60-80" Max Range 1.2" 1.6"	1.495	1.48	0.015	0.75
80-100" Max Range 1.6" 2.0"	1.985	1.99	0.005	0.25

Acceptable tolerance is 4%

The uncertainty of measurement is 0.4"WC. This is based on the reference standard having a TAR Test Accuracy Ratio of at least 4:1

Technician signature:  Date: 1/3/17

Reviewed by:  Date: 1/6/2017

OMNI-Test Laboratories, Inc.

Temperature Calibration EPA Method 28R, ASTM 2515							
BOOTH:		TEMPERATURE MONITOR TYPE:				EQUIPMENT NUMBER:	
E1		National Instruments Logger				00335, 00336	
REFERENCE METER EQUIPMENT NUMBER: 00373				Calibration Due Date: 8/02/17			
CALIBRATION PERFORMED BY:			DATE:	AMBIENT TEMPERATURE:		BAROMETRIC PRESSURE:	
B. Davis			1/4/17	66		30.16	
Input Temperature (F)	Ambient	Meter A					FB Interior
			Meter B	Filter A	Filter B	Tunnel	
0	0	0	0	0	0	0	0
100	100	100	100	100	100	100	100
300	300	300	300	300	300	300	300
500	500	501	501	500	500	500	500
700	700	701	701	701	701	700	700
1000	1001	1001	1001	1001	1001	1000	1000

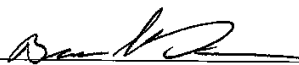
Input (F)	FB Top	FB Bottom	FB Back	FB Left	FB Right	Imp A	Imp B	Cat	Stack
0	0	0	0	0	0	0	0	0	0
100	100	100	100	100	100	100	100	100	100
300	300	300	300	300	300	300	300	300	300
500	500	500	500	500	500	500	501	500	500
700	700	700	700	700	700	701	701	701	700
1000	1000	1000	1000	1000	1000	1001	1001	1001	1000

1500

1501

2000

2001

Technician signature:  Date: 1/4/17
 Reviewed By: _____ Date: _____



1/6/2017

OMNI-Test Laboratories, Inc.

Thermal Metering System Calibration Y Factor

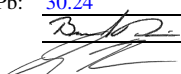
Manufacturer: APEX
 Model: XC-60-EP
 Serial Number: 606002
 OMNI Tracking No.: OMNI-00336
 Calibrated Orifice: Yes

Date	7/7/2016	Acceptable Deviation (5%)	Deviation
y Factor	1.005	0.05025	0.015
Acceptance	Acceptable		

Average Gas Meter y Factor 0.990
--

Orifice Meter dH@ N/A

Acceptable y Deviation	0.020
Maximum y Deviation	0.002
Acceptable dH@ Deviation	N/A
Maximum dH@ Deviation	N/A
Acceptance	Acceptable

Calibration Date: 01/03/17
 Calibrated by: B. Davis
 Calibration Frequency: Six months
 Next Calibration Due: 7/3/2017
 Instrument Range: 1.000 cfm
 Standard Temp.: 68 °F
 Standard Press.: 29.92 "Hg
 Barometric Press., Pb: 30.24 "Hg
 Signature/Date:  1/6/2017

Standard	Model	Standard Test Meter
Calibrator	S/N	OMNI-00001
	Calib. Date	27-Oct-16
	Calib. Value	0.9823 y factor (ref)

Calibration Parameters	Run 1	Run 2	Run 3
Reference Meter Pressure ("H ₂ O), Pr	0.00	0.00	0.00
DGM Pressure ("H ₂ O), Pd	1.90	1.00	0.70
Initial Reference Meter	249.7	257	262.227
Final Reference Meter	256.938	262.17	269.982
Initial DGM	0	0	0
Final DGM	7.263	5.214	7.847
Temp. Ref. Meter (°F), Tr	68.0	68.0	68.0
Temperature DGM (°F), Td	76.0	79.0	79.0
Time (min)	34.0	33.0	59.0
Net Volume Ref. Meter, Vr	7.238	5.170	7.755
Net Volume DGM, Vd	7.263	5.214	7.847
Gas Meter y Factor =	0.989	0.992	0.989
Gas Meter y Factor Deviation (from avg.)	0.001	0.002	0.001
Orifice dH@	N/A	N/A	N/A
Orifice dH@ Deviation (from avg.)	N/A	N/A	N/A

where:

1. Deviation = |Average value for all runs - current run value|
- ** 2. $y = [Vr \times (y \text{ factor (ref)}) \times (Pb + (Pr / 13.6)) \times (Td + 460)] / [Vd \times (Pb + (Pd / 13.6)) \times (Tr + 460)]$
- ** 3. $dH@ = 0.0317 \times Pd / (Pb (Td + 460)) \times [(Tr + 460) \times \text{time}] / Vr^2$

* Reference calibration is traceable to NIST through NIST Test # 40674, Kimble ASTM E1272, or NIST traceable laboratory

** Equations come from EPA Method 5

The uncertainty of measurement is 0.14 % This is based on the reference standard having a TAR Test Accuracy Ratio of at least 4:1

OMNI-Test Laboratories, Inc.

DIFFERENTIAL PRESSURE GAUGE CALIBRATION DATA SHEET

Instrument to be calibrated: Pressure Transducer

Maximum Range: 2"WC ID Number: OMI-00336B

Calibration Instrument: Digital Manometer ID Number: OMI-00633

Date: 1/3/17 By: B. Davis


This form is to be used only in conjunction with Standard Procedure C-SPC.

Range of Calibration Point ("WC)	Digital Manometer Input ("WC)	Pressure Gauge Response ("WC)	Difference (Input - Response)	% Error of Full Span
0-20" Max Range 0" 0.4	0.134	0.140	0.006	0.30
20-40" Max Range 0.4" 0.8	0.514	0.52	0.006	0.30
40-60" Max Range 0.8" 1.2	0.925	0.93	0.005	0.25
60-80" Max Range 1.2" 1.6	1.356	1.35	0.006	0.30
80-100" Max Range 1.6" 2.0	1.917	1.91	0.007	0.35

Acceptable tolerance is 4%

The uncertainty of measurement is 0.4"WC. This is based on the reference standard having a TAR Test Accuracy Ratio of at least 4:1.

Technician signature:  Date: 1/3/17

Reviewed by:  Date: 1/6/2017

OMNI-Test Laboratories, Inc.

Temperature Calibration EPA Method 28R, ASTM 2515							
BOOTH:		TEMPERATURE MONITOR TYPE:				EQUIPMENT NUMBER:	
E1		National Instruments Logger				00335, 00336	
REFERENCE METER EQUIPMENT NUMBER: 00373				Calibration Due Date: 8/02/17			
CALIBRATION PERFORMED BY:			DATE:	AMBIENT TEMPERATURE:		BAROMETRIC PRESSURE:	
B. Davis			1/4/17	66		30.16	
Input Temperature (F)	Ambient	Meter A					FB Interior
			Meter B	Filter A	Filter B	Tunnel	
0	0	0	0	0	0	0	0
100	100	100	100	100	100	100	100
300	300	300	300	300	300	300	300
500	500	501	501	500	500	500	500
700	700	701	701	701	701	700	700
1000	1001	1001	1001	1001	1001	1000	1000

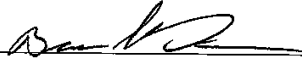
Input (F)	FB Top	FB Bottom	FB Back	FB Left	FB Right	Imp A	Imp B	Cat	Stack
0	0	0	0	0	0	0	0	0	0
100	100	100	100	100	100	100	100	100	100
300	300	300	300	300	300	300	300	300	300
500	500	500	500	500	500	500	501	500	500
700	700	700	700	700	700	701	701	701	700
1000	1000	1000	1000	1000	1000	1001	1001	1001	1000

1500

1501

2000

2001

Technician signature:  Date: 1/4/17
 Reviewed By: _____ Date: _____



1/6/2017

Certificate of Calibration

Certificate Number: **629694**



JJ Calibrations, Inc.
 7007 SE Lake Rd
 Portland, OR 97267-2105
 Phone 503.786.3005
 FAX 503.786.2994

Omni-Test Laboratories
 13327 NE Airport Way
 Portland, OR 97230

PO: **160099**
 Order Date: **08/18/2016**
 Authorized By: **N/A**



Property #: **OMNI-00410**
 User: **N/A**
 Department: **N/A**
 Make: **Dwyer**
 Model: **1430**
 Serial #: **OMNI-00410**
 Description: **Microtector**
 Procedure: **500908**
 Accuracy: **±0.00025" WC**

Calibrated on: **08/29/2016**
 *Recommended Due: **08/29/2017**
 Environment: **19 °C 50 % RH**
 * As Received: **Other - See Remarks**
 * As Returned: **Limited**
 Action Taken: **Calibrated**
 Technician: **34**

Remarks: * Many factors may cause the unit to drift out of calibration before the recommended due date. Any reported error is the absolute value between the reference and the unit. Uncertainties include the effects of the unit.

Calibrated micrometer head only per Bruce Davis.

Limited Calibration - Calibrated micrometer head only.

Standards Used

Std ID	Manufacturer	Model	Nomenclature	Due Date	Trace ID
541A	Select	E8FED2	8 Piece Gage Block Set	11/24/2016	607288

Parameter Measurement Description	Range Unit	Measurement Data				UUT	Uncertainty Accredited = ✓
		Reference	Min	Max	*Error		
Before/After Length	Inch	0.1300	0.129	0.131	0.000	0.130 Inch	1.1E-03 ✓
	Inch	0.3850	0.384	0.386	0.000	0.385 Inch	1.1E-03 ✓
	Inch	0.6150	0.614	0.616	0.000	0.615 Inch	1.1E-03 ✓
	Inch	0.8700	0.869	0.871	0.001	0.871 Inch	1.1E-03 ✓
	Inch	1.0000	0.999	1.001	0.001	1.001 Inch	1.1E-03 ✓

JJ Calibrations, Inc. certifies that this instrument has been calibrated in accordance with the JJ Calibrations Quality Assurance Manual with the stated procedure using standards that are traceable to the National Institute of Standards and Technology (NIST), or other National Measurement Institutes (NMI's), or by using natural physical constants, intrinsic standards or ratio calibration techniques. The quality system and this certificate are in compliance with ANSI/NCCL Z540-1-1994, ISO/IEC 17025-2005, ISO 10012-1, the ISO 9000 family and QS 9000. The expanded uncertainties of measurements for this calibration are based upon 95% (2 sigma) confidence limits. Unless otherwise stated, a test accuracy ratio (TAR) of 4:1, if achievable, is maintained. The results reported herein apply only to the calibration of the item described above. This report may not be reproduced, except in full, without prior written consent of JJ Calibrations, Inc.
 JJ Calibrations, Inc. quality system has been assessed and accredited to ISO/IEC 17025:2005.

Reviewer

3 Issued 08/31/2016

Rev # 15

Inspector

WOOD MOISTURE CONTENT CALIBRATION WORKSHEET

Moisture Content Standard OMNI ID #: 00431

Reference Moisture Content Standard: OMNI # 00430

Date	Temp.	Barometric Pressure	Fixed Moisture %		Observed Moisture %		Initials
			22%	12%	22%	12%	
11/14/16	68° F	30.10 in Hg	22%	12%	22%	12%	BR
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			
			22%	12%			

Notes: _____

Technician signature: *BR* Date: 11/15/16

OMNI Track # OMNI-00559					
Equipment Name/Description: Vaneometer, Air Velometer - Dwyer					
Equipment Size: T36					
Comments: New Vane installed					
Status: Active					
Part # 480					
Reference Standard:		YES	X	<input type="checkbox"/> O	Check <input checked="" type="checkbox"/> for answer
Location of Equipment:		Ca 1			
Calibration vendor:		OMNI in house			
Type of Calibration:		6 month			
Calibration Period (Months):		6			
Date of Last Calibration:		11/15/2016			
Date of Next Calibration:		5/15/2017			

Do the following:

- 1 Complete Calibration documentation
- 2 Complete top half of this form
- 3 Attach appropriate calibration forms and save in following location
 Form - serial Test Equipment Equipment OMNI-XXXXX - Equipment Name
- 4 Repopulate database with updated information
- 5 Print, laminate and adhere calibration tag to equipment

**Six Month
 OMNI-00559
 Vaneometer**
 Last Cal Date: 11/15/2016
 Due Date of Cal: 5/15/2017

**Six Month
 OMNI-00559
 Vaneometer**
 Last Cal Date: 11/15/2016
 Due Date of Cal: 5/15/2017

OMNI Environmental, Inc.
OMNI-Test Laboratories, Inc.

VWR Temperature Hygrometer Calibration Procedure and Data Sheet

Frequency: Every Two Years

Step 1: Locate NIST traceable standard.

Step 2: Place unit to be calibrated, tracking No. OMNI-00592, inside OMNI desiccate box on the same shelf with the NIST traceable standard.

Step 3: After a period of not less than four hours record the temperature and humidity of both units in the spaces provide below.

Step 4: If the unit to be calibrated matches the NIST standard within $\pm 4\%$, it is acceptable. If not, the unit needs to be sent to a repair company or replaced.

Verification Data:

Date: 1/5/17 Technician: B DAVIS

Time in desiccate: 0900 Recording time: 0845 1/6/17

NIST Standard Temperature: 67.5 °F NIST Standard Humidity: 9.5

Test Unit Temperature Reading: 66.9 °F Test Unit Humidity Reading: 6.1

Test unit OMNI- 00592 is or was not within acceptable limits.

Technician Signature: 

Comments: Humidity Results of 00592 are within $\pm 4\%$ of Reference meting
BD

OMNI Track #		OMNI-00594		
Equipment Name/Description	CAI RE-4 Gas Analyzer			
Equipment S#	5F0112			
Comments	CO2, O2, and dual range CO gas analyzer			
Status	Active, Calibrate prior to use			
Part #	RE-4			
Reference Standard:	YES	X	NO	Check X for answer
Location of Equipment:	Portable gas cart			
Calibration vendor	OMNI in house			
Type of Calibration	Calibrate Prior to use			
Calibration Period (Months)	A			
Date of Last Calibration	A			
Date of Next Calibration	A			

Do the following:

- 1 Complete Calibration documentation
- 2 Complete top half of this form
- 3 Attach appropriate calibration forms and save in following location
 omni-ser# Test Equipment/Equipment/OMNI-XXXXX - Equipment Name
- 4 Repopulate database with updated information
- 5 Print, laminate and adhere calibration tag to equipment

Verify before use
 OMNI-00594
 Gas Analyzer

Verify before use
 OMNI-00594
 Gas Analyzer

*Model: Viva L Series
RAIS A/S
Industrivej 20, Vangen
DK-9900 Frederikshavn
Denmark*

Example Calculations

Equations and Sample Calculations – ASTM E2780 & E2515

Manufacturer: RAIS
Model: Viva L
Run: 1
Category: II

Equations used to calculate the parameters listed below are described in this appendix. Sample calculations are provided for each equation. The raw data and printout results from a sample run are also provided for comparison to the sample calculations.

M_{Sdb} – Weight of test fuel spacers, dry basis, kg

M_{Cdb} – Weight of test fuel crib, excluding nails and spacers, dry basis, kg

D_{Cdb} - Density of fuel crib, excluding spacers and nails, dry basis, lbs/ft³

M_{FTAdb} - Total weight of fuel crib excluding nails, dry basis, kg

BR – Dry burn rate, kg/hr

V_s – Average gas velocity in the dilution tunnel, ft/sec

Q_{sd} – Average gas flow rate in dilution tunnel, dscf/hr

$V_{m(std)}$ – Volume of gas sampled, corrected to dry standard conditions, dscf

m_n – Total particulate matter collected, mg

C_s - Concentration of particulate matter in tunnel gas, dry basis, corrected to standard conditions, g/dscf

E_T – Total particulate emissions, g

PR - Proportional rate variation

PM_R – Particulate emissions for test run, g/hr

PM_F – Particulate emission factor for test run, g/dry kg of fuel burned

M_{Sdb} – Weight of test fuel spacers, dry basis, kg

ASTM E2780 equation (1)

$$M_{Sdb} = (M_{Swb}) (100 / (100 + FM_S))$$

Where,

FM_S = average fuel moisture of test fuel spacers, % dry basis

M_{Swb} = weight of test fuel spacers, wet basis, kg

Sample Calculation:

$$FM_S = 20.9 \%$$

$$M_{Swb} = 2.0 \text{ lbs}$$

0.4536 = Conversion factor from lbs to kg

$$M_{Sdb} = [(2.0 \times 0.4536) (100 / (100 + 20.9))]$$

$$M_{Sdb} = 0.8 \text{ kg}$$

M_{Cdb} – Weight of test fuel crib, excluding nails and spacers, dry basis, kg
ASTM E2780 equation (2)

$$M_{Cdb} = \Sigma[(M_{CPnwb})(100/(100 + FM_{CPn}))]$$

Where,

M_{CPnwb} = weight of each test fuel piece n in fuel crib, excluding nails and spacers, wet basis, kg

FM_{CPn} = Average fuel moisture of test fuel n in fuel crib, % dry basis

Sample Calculation (test fuel piece 1):

$$M_{CPnwb} = 1$$

$$FM_{CPn} = 22.9$$

$$= 1.0 (100/(100+ 22.9)$$

$$= 0.8 \text{ lbs}$$

Total crib weight, excluding spacer: 5.22 lbs

$$M_{Cdb} = \mathbf{2.37 \text{ kg}}$$

D_{Cdb} - Density of fuel crib, excluding spacers and nails, dry basis, lbs/ft³
ASTM E2780 equation (3)

$$D_{Cdb} = M_{Cdb}/V_C$$

Where,

$$V_C = \text{Volume of fuel crib, ft}^3$$

Sample calculation:

$$V_C = 307 \text{ in}^3$$

$$1728 = \text{conversion from in}^3 \text{ to ft}^3$$

$$D_{Cdb} = 5.22 / 307 * 1728$$

$$= \mathbf{29.4} \text{ lbs/ft}^3$$

M_{FTAdb} - Total weight of fuel crib excluding nails, dry basis, kg
ASTM E2780 equation (4)

$$M_{FTAdb} = M_{Sdb} + M_{Cdb}$$

Sample calculation:

$$M_{FTAdb} = 0.75 + 2.37$$

$$= \mathbf{3.12 \text{ kg}}$$

BR – dry burn rate, kg/hr

ASTM E2780 equation (5)

$$BR = \frac{60 M_{FTAdb}}{\theta}$$

Where,

θ = Total length of test run, min

Sample Calculation:

$$M_{Bdb} = 3.12 \quad \text{kg}$$

$$\theta = 180 \quad \text{min}$$

$$BR = \frac{60 \times 3.12}{180}$$

$$BR = \mathbf{1.04} \quad \text{kg/hr}$$

V_s – Average gas velocity in the dilution tunnel, ft/sec

ASTM E2515 equations (9)

$$V_s = F_p \times k_p \times C_p \times (\sqrt{\Delta P})_{avg} \times \sqrt{\frac{T_{s(avg)}}{P_s \times M_s}}$$

Where:

- F_p = Adjustment factor for center of tunnel pitot tube placement, $F_p = \frac{V_{strav}}{V_{scent}}$, ASTM E2515 Equation (1)
- V_{scent} = Dilution tunnel velocity calculated after the multi-point pitot traverse at the center, ft/sec
- V_{strav} = Dilution tunnel velocity calculated after the multi-point pitot traverse, ft/sec
- k_p = Pitot tube constant, 85.49
- C_p = Pitot tube coefficient: 0.99, unitless
- ΔP* = Velocity pressure in the dilution tunnel, in H₂O
- T_s = Absolute average gas temperature in the dilution tunnel, °R; (°R = °F + 460)
- P_s = Absolute average gas static pressure in dilution tunnel, = P_{bar} + P_g, in Hg
- P_{bar} = Barometric pressure at test site, in. Hg
- P_g = Static pressure of tunnel, in. H₂O; (in Hg = in H₂O/13.6)
- M_s = **The dilution tunnel wet molecular weight; M_s = 28.78 assuming a dry weight of 29 lb/lb-mole

Sample calculation:

$$F_p = \frac{17.78}{20.18} = 0.881$$

$$V_s = 0.881 \times 85.49 \times 0.99 \times 0.297 \times \left(\frac{85.6 + 460}{\left(\frac{29.75 + \frac{-0.28}{13.6}}{28.78} \right)^{1/2}} \right)$$

$$V_s = \mathbf{17.67 \text{ ft/s}}$$

*The ASTM test standard mistakenly has the square root of the average delta p instead of the average of the square root of delta p. The current EPA Method 2 is also incorrect. This was verified by Mike Toney at EPA.

**The ASTM test standard mistakenly identifies M_s as the dry molecular weight. It should be the wet molecular weight as indicated in EPA Method 2.

Q_{sd} – Average gas flow rate in dilution tunnel, dscf/hr

ASTM E2515 equation (3)

$$Q_{sd} = 3600 \times (1 - B_{ws}) \times v_s \times A \times \frac{T_{std}}{T_{s(avg)}} \times \frac{P_s}{P_{std}}$$

Where:

- 3600 = Conversion from seconds to hours (ASTM method uses 60 to convert in minutes)
- B_{ws} = Water vapor in gas stream, proportion by volume; assume 2%
- A = Cross sectional area of dilution tunnel, ft²
- T_{std} = Standard absolute temperature, 528 °R
- P_s = Absolute average gas static pressure in dilution tunnel, = P_{bar} + P_g, in Hg
- T_{s(avg)} = Absolute average gas temperature in the dilution tunnel, °R; (°R = °F + 460)
- P_{std} = Standard absolute pressure, 29.92 in Hg

Sample calculation:

$$Q_{sd} = 3600 \times (1 - 0.02) \times 17.67 \times 0.196 \times \frac{528}{85.6 + 460} \times \frac{29.8 + \frac{-0.28}{13.6}}{29.92}$$

Q_{sd} = ##### dscf/hr

$V_{m(std)}$ – Volume of Gas Sampled Corrected to Dry Standard Conditions, dscf
 ASTM E2515 equation (6)

$$V_{m(std)} = K_1 V_m Y \frac{P_{bar} + \left(\frac{\Delta H}{13.6}\right)}{T_m}$$

Where:

- K_1 = 17.64 °R/in. Hg
- V_m = Volume of gas sample measured at the dry gas meter, dcf
- Y = Dry gas meter calibration factor, dimensionless
- P_{bar} = Barometric pressure at the testing site, in. Hg
- ΔH = Average pressure differential across the orifice meter, in. H₂O
- T_m = Absolute average dry gas meter temperature, °R

Sample Calculation:

Using equation for Train 1:

$$V_{m(std)} = 17.64 \times 29.793 \times 0.984 \times \frac{\left(29.75 + \frac{1.31}{13.6} \right)}{\left(80.7 + 460 \right)}$$

$$V_{m(std)} = \mathbf{28.550} \text{ dscf}$$

Using equation for Train 2:

$$V_{m(std)} = 17.64 \times 30.524 \times 0.99 \times \frac{\left(29.75 + \frac{1.16}{13.6} \right)}{\left(80.8 + 460 \right)}$$

$$V_{m(std)} = \mathbf{29.409} \text{ dscf}$$

Using equation for ambient train:

$$V_{m(std)} = 17.64 \times 0.00 \times 1 \times \frac{\left(29.75 + \frac{0.00}{13.6} \right)}{\left(70.4 + 460 \right)}$$

$$V_{m(std)} = \mathbf{0} \text{ dscf}$$

m_n – Total Particulate Matter Collected, mg

ASTM E2515 Equation (12)

$$m_n = m_p + m_f + m_g$$

Where:

m_p = mass of particulate matter from probe, mg

m_f = mass of particulate matter from filters, mg

m_g = mass of particulate matter from filter seals, mg

Sample Calculation:

Using equation for Train 1 (first hour):

$$m_n = 0.0 + 37.2 + 0.0$$

$$m_n = 37.2 \text{ mg}$$

Using equation for Train 1 (post-first hour):

$$m_n = 0.8 + 4.9 + 0.6$$

$$m_n = 6.3 \text{ mg}$$

Train 1 aggregate:

$$m_n = 37.2 + 6.3$$

$$m_n = \mathbf{43.5} \text{ mg}$$

Using equation for Train 2:

$$m_n = 0.4 + 43.3 + 0.4$$

$$m_n = \mathbf{44.1} \text{ mg}$$

C_s - Concentration of particulate matter in tunnel gas, dry basis, corrected to standard conditions, g/dsc
ASTM E2515 equation (13)

$$C_s = K_2 \times \frac{m_n}{V_{m(\text{std})}}$$

Where:

K₂ = Constant, 0.001 g/mg

m_n = Total mass of particulate matter collected in the sampling train, mg

V_{m(std)} = Volume of gas sampled corrected to dry standard conditions, dscf

Sample calculation:

For Train 1:

$$C_s = 0.001 \times \frac{43.5}{28.55}$$

$$C_s = \mathbf{0.00152} \text{ g/dscf}$$

For Train 2

$$C_s = 0.001 \times \frac{44.1}{29.41}$$

$$C_s = \mathbf{0.00150} \text{ g/dscf}$$

For Ambient Train

$$C_r = 0.001 \times \frac{0.0}{0}$$

$$C_r = \mathbf{0} \text{ g/dscf}$$

E_T – Total Particulate Emissions, g

ASTM E2515 equation (15)

$$E_T = (C_s - C_r) \times Q_{std} \times \theta$$

Where:

- C_s = Concentration of particulate matter in tunnel gas, g/dscf
- C_r = Concentration particulate matter room air, g/dscf
- Q_{std} = Average dilution tunnel gas flow rate, dscf/hr
- θ = Total time of test run, minutes

Sample calculation:

For Train 1

$$E_T = (\underline{0.001524} - 0) \times \underline{\hspace{1cm}} \times \underline{180} /60$$
$$E_T = \underline{53.79} \text{ g}$$

For Train 2

$$E_T = (\underline{0.001500} - 0) \times \underline{\hspace{1cm}} \times \underline{180} /60$$
$$E_T = \underline{52.94} \text{ g}$$

Average

$$E = \underline{53.37} \text{ g}$$

Total emission values shall not differ by more than 7.5% from the total average emissions

$$7.5\% \text{ of the average} = \underline{4.00}$$

$$\text{Train 1 difference} = \underline{0.43}$$

$$\text{Train 2 difference} = \underline{0.43}$$

PR - Proportional Rate Variation

ASTM E2515 equation (16)

$$PR = \left[\frac{\theta \times V_{mi} \times V_s \times T_m \times T_{si}}{\theta_i \times V_m \times V_{si} \times T_{mi} \times T_s} \right] \times 100$$

Where:

- θ = Total sampling time, min
- θ_i = Length of recording interval, min
- V_{mi} = Volume of gas sample measured by the dry gas meter during the "ith" time interval, dcf
- V_m = Volume of gas sample as measured by dry gas meter, dcf
- V_{si} = Average gas velocity in the dilution tunnel during the "ith" time interval, ft/sec
- V_s = Average gas velocity in the dilution tunnel, ft/sec
- T_{mi} = Absolute average dry gas meter temperature during the "ith" time interval, °R
- T_m = Absolute average dry gas meter temperature, °R
- T_{si} = Absolute average gas temperature in the dilution tunnel during the "ith" time interval, °R
- T_s = Absolute average gas temperature in the dilution tunnel, °R

Sample calculation (for the first 1 minute interval of Train 1):

$$PR = \left(\frac{180 \times 1.666 \times 17.67 \times (85.0 + 460) \times (80.7 + 460)}{10 \times 29.79 \times 17.66 \times (85.6 + 460) \times (74.0 + 460)} \right) \times 100$$

$$PR = \underline{102} \%$$

PM_R – Particulate emissions for test run, g/hr

ASTM E2780 equation (6)

$$PM_R = 60 (E_T/\theta)$$

Where,

E_T = Total particulate emissions, grams

θ = Total length of full integrated test run, min

Sample Calculation:

$$E_T (\text{Dual train average}) = 53.37 \text{ g}$$

$$\theta = 180 \text{ min}$$

$$PM_R = 60 \times (53.37 / 180)$$

$$PM_R = \mathbf{17.79} \text{ g/hr}$$

PM_F – Particulate emission factor for test run, g/dry kg of fuel burned
ASTM E2780 equation (7)

$$PM_F = E_T / M_{FTAdb}$$

Sample Calculation:

$$E_T \text{ (Dual train average)} = 53.37 \text{ g}$$

$$M_{Bdb} = 3.12 \text{ kg}$$

$$PM_F = 53.37 / 3.12$$

$$PM_F = \mathbf{17.10} \text{ g/kg}$$