Non-Confidential Business Information (Non-CBI)

Catalyst Equivalence
Certification Test Report

Kuma Stoves, Inc.

K-250 Series
Models: Ashwood LE, Wood Classic LE, Cambridge LE, Cascade LE

Prepared for:	Kuma Stoves, Inc 50145 N Old Hwy 95 Rathdrum ID 83858
Prepared by:	OMNI-Test Laboratories, Inc. 13327 NE Airport Way Portland, OR 97230 (503) 643-3788
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AUTHORIZED SIGNATORIES

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

Evaluator:

Bruce Davis
Testing Manager

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Sampling Procedures and Test Results

INTRODUCTION

Kuma Stoves retained *OMNI* to perform U.S. Environmental Protection Agency (EPA) catalyst equivalency testing on the K-250 Series wood stove. The K-250 Series wood stove is a Catalytic Hybrid-type room heater that was originally certified in 2018 using an Applied Ceramics model ACI-5M catalyst. Using a procedure outlined in appendix B of this report, an Applied Ceramics model ACI-5M-C1 catalyst was tested in an identically produced K-250 Series stove to determine equivalence to the original catalyst. Emissions results were calculated using the same test method as used in the original certification.

Testing was performed at Myren Consulting. The altitude of the laboratory is 1650 feet above sea level. The unit was received in good condition and logged in on 6/9/2020, then assigned and labeled with *OMNI* ID #2406. *OMNI* representative Bruce Davis conducted the certification testing and completed all testing by 6/9/2020.

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 K-250 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 ASTM E2515, EPA Alt-125, and ASTM E3053. Catalyst equivalence procedure is outlined in EPA Applicability Determination WDS-138 shown in appendix B. Particulate emissions were measured using sampling trains consisting of two Teflon coated 47mm filters (front and back). See Appendix A for details on EPA Alt-125. As indicated by the equivalence procedure, a low burn and high burn test were conducted. Emissions results using the alternate catalyst must be within 0.5 grams per hour of the original high burn results, and within 0.5 grams per hour of the original low burn results.

The model K-250 Series was tested for thermal efficiency and carbon monoxide (CO) emissions in accordance with CSA B415.1-10 using Western Larch cordwood.

SUMMARY OF RESULTS

Emissions results of the high burn and low burn tests were found to be within 0.5 grams per hour of the original high burn/low burn values from previous testing. Based on the conditions stated in WDS-138 (see Appendix B), the results are determined to be equivalent and the K-250 Series wood stove will maintain the original certified emissions value of 1.13 grams per hour. By meeting the equivalence criteria, the Applied Ceramics model ACI-5M-C1 catalyst may be offered with the K-250 series appliance.

The proportionality results for the two test runs were acceptable. Quality check results for each test run are presented in Section 2 of this report.

INDIVIDUAL RUN SUMMARIES

Run 1 - Test procedures were followed to produce a high burn rate with a primary air setting of fully open. Observed burn rate was calculated at 2.68 kg/hr. Emissions results were calculated using particulate sampling from kindling, start-up fuel, and test fuel load combined (cold to hot). Burn rate, and efficiency were calculated using data from the test fuel load only (hot to hot).
No anomalies occurred, this test run was determined to be valid for comparison to the original test results.

Run 2 - Test procedures were followed to produce a low burn rate with a primary air setting of full closed leaving a cross sectional opening of 0.410" (See Drawings). Observed burn rate was calculated at 0.89 kg/hr. Emissions and efficiency results were calculated using a hot to hot burn cycle, a coal bed generated by the high burn conducted in test one was used. No sampling anomalies occurred, this test run was determined to be valid for comparison to the original test results.

Table 1 – Particulate Emissions

Run	**Burn Rate** Calculated from a Hot to Hot burn cycle (kg/hr dry)	**Alternate Catalyst ASTM E3053 Emissions** (g/h)	**Original Catalyst ASTM E3053 Emissions** (g/h)	**Difference Between Alternate and Original Catalyst**
1	2.68	[1.]2.58	[1]2.89	- 0.31
2`	0.89	0.54	0.39	0.15

1. Based on a cold start including kindling and start-up fuel.

Table 2 – Particulate Emissions (First Hour)

Run	**ASTM E2515 Emissions – First Hour** (g/h)
1	2.96
2	1.94

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/min)
1	34,172	74.8	81.1	0.14	1.83	0.084
2	12,132	81.3	88.2	0.45	6.42	0.096

Table 4 – Test Facility Conditions

Run	Room Temperature (°F)		Barometric Pressure (Hg)		Air Velocity (ft/min)	
	Before	**After**	**Before**	**After**	**Before**	**After**
1	59	70	28.50	28.50	<50	<50
2	69	68	28.49	28.45	<50	<50

Table 5 – Kindling and Start-up Fuel Description Summary
Western Larch Cordwood

Run	Kindling Weight Wet Basis (lbs.)	Start-up Fuel Weight Wet Basis (lbs.)	Residual Start-up fuel weight (lbs.)
1	4.9	7.36	3.2

Table 6 – Fuel Measurement and Cordwood Description Summary – TEST
Western Larch Cordwood

Run	Test Fuel Wet Basis (lbs)	Firebox Volume (ft^3)	Fuel Loading Density Wet Basis (lbs/ft^3)	Test Fuel Dry Basis (lbs)	Test Fuel Consumed During Test Dry Basis (lbs)	Piece Length (in)
1	24.53	2.5	9.8	20.1	25.0	5@18
2	29.14	2.5	11.7	23.9	23.9	5@18

Table 7 – Dilution Tunnel Gas Measurements and Sampling Data Summary

Run	Length of Test (min)	Average Dilution Tunnel Gas Measurements		
		Velocity (ft/sec)	Flow Rate (dscf/min)	Temperature (°F)
1	249	17.86	186.0	97
2	730	17.57	189.2	79

Table 8-Sample Train Precision

Run Number	Train Precision ≤7.5%	Train Precision ±0.5 g/kg	Compliant
1	5.96	0.07	Yes
2	2.13	0.02	Yes

Note: Compliance is based on 7.5% **or** 0.5 g/kg

Table 10 – Test Configurations

Run	Startup Procedures	Combustion Air
1	Fuel Loading: Kindling and start-up fuel loaded together, a torch was used for 22 seconds to establish a fire. At 68 minutes placed fuel load into the firebox and closed the loading door. Loading required less than 1 minute to complete. Door: For kindling and start-up fuel, loading door was cracked open 1" for 30 seconds, then closed. Test fuel load; fuel loading door was closed by 70 seconds. Primary Air: Air control fully open for the entire test. Secondary: No user control for secondary air. Fan: Fan was turned off during kindling and start up fuel segment, then turned to high 5 minutes after test fuel was loaded and remained on high for the remainder of the test. Bypass: Open for first 15 minutes during kindling/startup load. Was opened for 75 seconds after fuel load was loaded then closed.	Fully open for entire test.
2	Fuel Loading: Test fuel loaded onto coal bed generated by test number 1 in 2 minute and 22 seconds. Door: Closed by 2 minutes 22 seconds. Primary Air: Fully open, then set to full closed by 16 minutes and 15 seconds. Secondary: No user control for secondary air. Fan: Fan turned to high from off at 30 minutes. Bypass: Open until 142 seconds then closed.	Fully open for first 16 minutes 15 seconds, then set to full closed.

Section 2

Photographs/Appliance Description/Drawings

Kuma Stoves
K-250 Series
Test Date: June 9, 2020

Kuma Stoves
K-250 Series

Run 1 – Start-up fuel

Run 1 – Kindling and start-up fuel

Run 1 – Kindling and start-up fuel

Run 1 – Fuel load

Kuma Stoves
K-250 Series

Run 1 – Test Fuel Load In Stove

Run 1 – Remaining Coal bed

Run 2 – Test Fuel Load

Run 2 – Test Fuel Loaded into Stove

Run 2 – Remaining coal bed

WOOD HEATER DESCRIPTION

Appliance Manufacturer: Kuma Stoves

Wood Stove Model: K-250 Series – See design drawings for model simalarities

Type: Wood Burning Freestanding Catalytic Hybrid

WOOD HEATER INFORMATION

Materials of Construction: The unit is constructed primarily of mild steel. The firebox is lined with fire brick that measures 4.50" x 9.0". The feed door has a 15.01" x 10.23" viewing area and 0.63" diameter fiberglass rope gasket.

Air Introduction System: Air is introduced into two different areas of the fire chamber and is controlled by one sliding control rod. Secondary air is introduced into the rear of the fire box through the bottom, it is then channeled up into the secondary air tubes located under the baffle. Air wash air is introduced through an opening in the bottom of the fire box near the front. It is then channeled up to a manifold across the top of the door, air is directed down across the glass and into the fire chamber.

Combustion Control Mechanisms: Combustion air control mechanism is a sliding rod with flat plates attached that cover and uncover air inlets when the rod is pushed in or pulled out.

Combustor: Original catalyst is a metal alloy composition manufactured by Applied Ceramics, model ACI-5M. The catalyst tested in this test series is an Applied Ceramics metal alloy composition model ACI-5M-C1. Each component has an outside dimension of 13.0 x 2.0 x 2.5. An Interram gasket is wrapped around the outside and then the assembly is inserted into a metal can.

Internal Baffles: A steel baffle is mounted near the top of the fire chamber, a 1" thick 6-pound density ceramic blanket is placed on top. A flue bypass is incorporated into the baffle, when opened it allow products of combustion to bypass the catalyst and flow directly to the flue outlet. When closed products of combustion are directed through the catalyst mounted near the front of the baffle system.

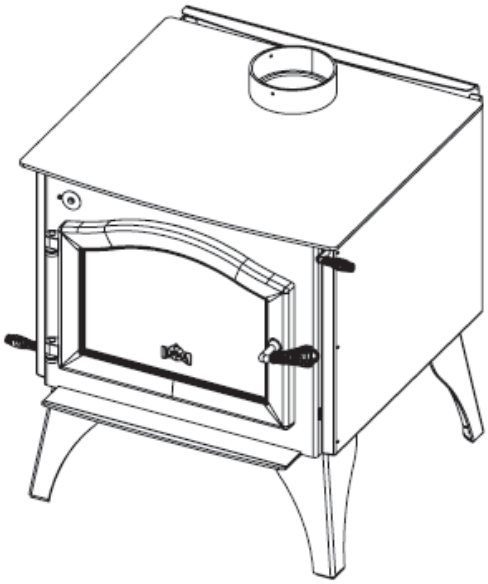
Other Features: Optional room air fan model DC3-C1011-4GS97 manufactured by Revcor is rated at 160 CFM. Freestanding version is offered with either legs or a pedestal and an ashpan. Decorative surround panels are offered for the Insert version of the K-250 Series.

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

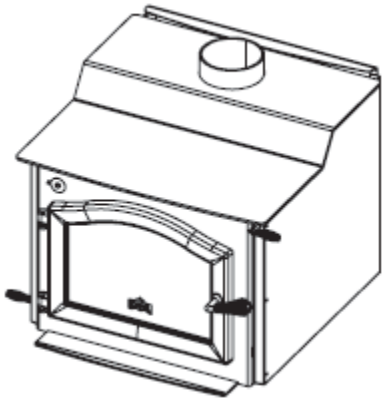
WOOD HEATER OPERATING INSTRUCTIONS

Specific Written Instructions: See Section 4 of this report. All markings and instruction materials were reviewed for content prior to printing.

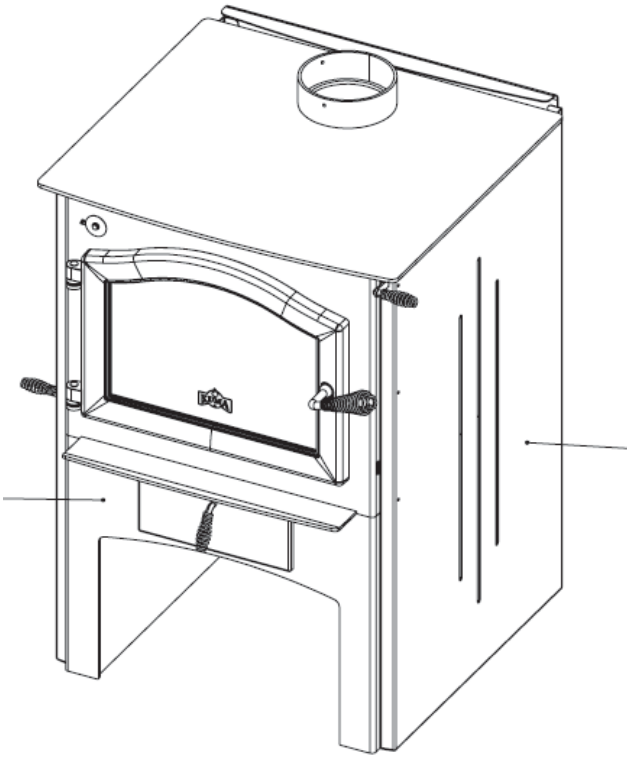
Kuma K-250 Series Model Similarities



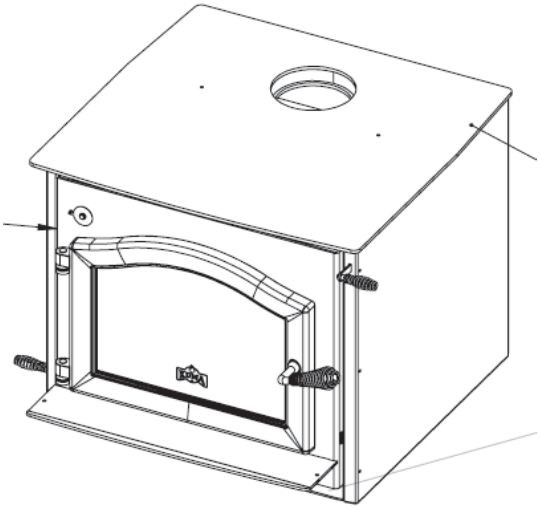
Model ASHWOOD: The tested unit. A pedestal base with an ash drawer can be bolted on in lieu of the legs.



Model WOOD CLASSIC: This unit receives a decorative step at the back of the top plate. The firebox remains flat to match the tested unit and the flue collar is extended through to the top of the step. The position of the flue collar is unchanged from the tested unit.



Model CAMBRIDGE: This unit receives a pre-installed pedestal and extensions to the decorative panels to meet with the base of the pre-installed pedestal. The configuration of the firebox remains unchanged from the pedestal mounting position and up.



Model CASCADE: This unit receives a top and a bottom convection panel for use in a fireplace insert. The side panels remain unchanged. The firebox configuration remains unchanged from the tested unit.

Section 3

Test Data by Run

KUMA STOVES, INC.
50145 N. OLD HWY. 95
RATHDRUM, ID 83858
888 714 5294

22 November 2018

RE: OPERATING INSTRUCTIONS FOR THE
KUMA 2020 WOOD CLASSIC HYBRID WOOD STOVE (V5)

Nominal Fuel Piece Length: 18"

PRIMARY AIR CONTROL:

The Primary air control (PAC) is located on the left side of the stove. Pull the PAC control rod out to increase the amount of air entering the stove. Push the PAC control rod in to reduce the amount of primary air entering the stove.

Kindling Cold Start (KS) Setting: Pull the rod all the way out until the Primary Air Inlet orifice is 3.00" open. The end of the rod should be " from the side of the stove.

High Burn Setting: Pull the rod all the way out until the Primary Air Inlet orifice is 3.00" open. The rod should already be in this position at the end of the KS test segment, i.e., no adjustment is/ should be required.

Medium Burn Setting: At the end of the 90% High Burn test, push the rod in until the end of the primary air control rod is 1.46875" (1 15/32") from the side of the stove. The PAC should be open 7/16".

Low Burn Setting: At the end of the 90% High Burn test, push the rod all the way in until the stop on the primary air control rod touches the side of the stove. The PAC should be open 11/32".

DOOR:

KS Cold Start: Once the fuel pile has been ignited, close the door to a cracked open position of about 1/8 to 1/16" open until it is certain the fuel pile will keep burning. Then close the door. If the fire starts to falter/ die back, immediately reopen the door to the cracked open position for 15-30 seconds to get the fire going again. Close the door once the fire has reestablished itself.

High, Medium and Low Burns: Close the door as soon as the High, Medium or Low Burn fuel load has been loaded. If the fire is slow

to ignite, reopen the door to the cracked open position to get the fire going. Once the fire is going, close the door.

COAL BED:

KS/ High Burn Transition: At the end of KS Cold Start Segment, pull as many of the burning coals forward as possible, leveling the coal bed. Make certain that any E/W pieces that are still "solid" are rotated 90 degrees and nestled between the pieces that are parallel to the sides.

High/ Medium Transition: At the end of the 90% High Burn test, adjust the PAC setting to the Medium Burn setting and leave the coals burn in place, i.e., no adjustments to the coal bed, unless one or more pieces seem to "hang up" and not be burning properly. If that is the case, then, when and as necessary, rake the coal bed and pull the piece(s) in question to in front of the LPAO. At the start of the Medium Burn test, open the door and level the coal bed, pulling as many hot/ orange/ red coals forward to in front of the Lower Primary Air Orifice (LPAO) as possible.

High/ Low Transition: At the end of the 90% High Burn test, adjust the PAC setting to the Low Burn setting and leave the coals burn in place, i.e., no adjustments to the coal bed, unless one or more pieces seem to "hang up" and not be burning properly. If that is the case, then, when and as necessary, rake the coal bed and pull the piece(s) in question to in front of the LPAO. At the start of the Low Burn test, open the door and level the coal bed, pulling as many hot/ orange/ red coals forward to in front of the Lower Primary Air r Orifice (LPAO) as possible.

LOWER PRIMARY AIR ORIFICE (LPAO):

Always clean the coals away from in front of the holes in the LPAO.

FAN:

Kindling Cold Start Segment: Leave Fan off for the entire segment.

High Burn Test: Turn the fan on High @ 5:00 into the test.

Medium and Low Burn Tests: Turn the fan off at the start of the test. Turn the fan on High @ 30 minutes into the test.

BYPASS:

Kindling Cold Start Segment: Leave the bypass open for the first 15 minutes.

High, Medium and Low Burn Tests: Opening the bypass when adjusting the coal bed before and when loading the High, Medium and Low burn fuel loads is optional.

If you have any question, feel free to contact me anytime.

Mark Freeman
KUMA Stoves

K-250 Stove Aging			Technician: Jack Freeman
			Conditioning Dates: 3/5/2020 - 3/11/2020
Elapsed Time (hours)	Flue Gas Temp (°F)	Catalyst Exit Temp (°F)	Notes: (time weight and moisture content for fuel loading):
0	290	561	3/5/2020 9:08 AM - Fuel: 18 lbs. Douglas Fir 18.7% Moisture
1	340	792	
2	274	514	3/5/2020 11:11 AM - Fuel: 25 lbs. Douglas Fir 21.4% Moisture
3	781	1066	
4	540	803	
5	495	611	
6	553	649	3/5/2020 3:15 PM - Fuel: 23 lbs. Douglas Fir 19.7% Moisture
7	727	1122	
8	680	1097	
9	520	997	
10	488	857	
11	468	809	
12	456	795	3/6/2020 7:35 AM - Fuel: 12 lbs. Tamarack 20.9% Moisture
13	633	828	
14	599	1140	3/6/2020 9:40 AM - Fuel: 19.5 lbs. Tamarack 19.5% Moisture
15	265	846	
16	325	649	
17	284	639	3/6/2020 12:00 PM - Fuel: 21 lbs. Douglas Fir 18.7% Moisture
18	315	529	
19	415	894	
20	423	678	
21	483	973	3/9/2020 7:07 AM - Fuel 18 lbs. Tamarack 20.4% Moisture
22	346	830	
23	311	750	
24	229	699	
25	515	1268	3/9/2020 11:29 PM - Fuel: 18 lbs. Tamarack 20.4% Moisture
26	337	769	
27	258	696	
28	265	706	
29	310	629	
30	295	618	
31	321	703	3/10/2020 7:07 AM - Fuel: 24 lbs. Douglas Fir 20.0% Moisture
32	501	1059	
33	453	992	
34	398	826	
35	307	565	
36	517	1164	3/10/2020 12:34 PM - Fuel: 26.5 lbs. Douglas Fir 19.3% Moisture
37	485	1005	
38	324	760	
39	383	699	
40	410	642	
41	440	524	3/11/2020 6:30 AM - Fuel: 18.5 lbs. Tamarack 18.3% Moisture
42	356	685	
43	408	712	3/11/2020 8:46 AM - Fuel: 22.5 lbs. Tamarack 22.3% Moisture
44	451	770	
45	475	788	
46	329	628	
47	249	605	
48	380	651	3/11/2020 1:57 PM - Fuel: 22 lbs. Tamarack 22.9% Moisture
49	368	1075	
50	355	931	
Medium combustion air setting (~7/16" open from minimum-air) was used to achive catalyst exit temperature > 500°F:			

Run 1

High Burn 1-minute data

Emissions Results (Cold to Hot Cycle)

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
0	0.000	0.000			2.70	65	-2.62	2.07	64	-1.9	59	0.080			12.3		58	57	57	57	57	57	58	58	82	59	84	59	59	-0.020	0.07	0
1	0.166	0.165	0.17	0.17	2.30	65	-2.74	1.77	64	-1.9	64	0.080	91	88	12.2	-0.17	59	57	57	57	57	57	67	145	79	59	81	60	59	-0.052	0.51	0.01
2	0.331	0.336	0.17	0.17	2.24	65	-3.08	1.75	64	-1.9	67	0.070	97	97	12.1	-0.09	65	57	58	57	57	59	83	203	78	60	81	60	59	-0.062	2.55	0.04
3	0.495	0.505	0.16	0.17	2.23	65	-2.77	1.73	64	-2	68	0.080	90	90	12.0	-0.05	73	57	59	58	58	61	101	242	78	60	81	61	59	-0.064	3.31	0.06
4	0.660	0.674	0.17	0.17	2.21	65	-2.89	1.70	64	-2.1	72	0.070	97	97	12.0	-0.07	83	57	59	58	59	63	121	270	78	60	81	61	59	-0.073	3.56	0.04
5	0.825	0.841	0.17	0.17	2.23	65	-2.88	1.67	64	-2.1	75	0.070	98	96	11.9	-0.10	92	57	61	59	60	66	141	311	78	60	81	61	59	-0.095	4.37	0.1
6	0.990	1.007	0.17	0.17	2.23	65	-3.21	1.66	65	-1.9	79	0.070	98	95	11.8	-0.08	101	57	62	59	62	68	162	350	79	60	82	61	59	-0.062	4.65	0.14
7	1.155	1.172	0.17	0.17	2.22	65	-3.01	1.64	65	-2	83	0.070	98	95	11.7	-0.10	113	57	64	60	64	72	189	390	80	60	82	61	59	-0.065	5.36	0.14
8	1.321	1.339	0.17	0.17	2.37	65	-3.41	1.81	65	-2.3	88	0.070	99	97	11.5	-0.14	126	57	66	61	66	75	218	427	81	60	82	61	59	-0.070	5.86	0.27
9	1.487	1.517	0.17	0.18	2.36	65	-3.29	1.80	65	-2.3	93	0.070	100	104	11.4	-0.12	144	57	70	63	70	81	266	458	83	60	83	62	59	-0.073	6.74	0.32
10	1.652	1.688	0.17	0.17	2.34	65	-3.24	1.80	65	-2.1	97	0.070	100	100	11.3	-0.13	159	57	74	65	73	86	300	485	84	61	83	62	59	-0.074	7.12	0.32
11	1.821	1.859	0.17	0.17	2.31	65	-3.11	1.77	65	-2.1	102	0.070	103	100	11.1	-0.16	175	57	78	67	77	91	334	516	85	61	83	62	59	-0.077	7.46	0.34
12	1.988	2.030	0.17	0.17	2.30	65	-3.19	1.76	65	-2.1	107	0.070	102	101	10.9	-0.19	190	57	83	69	82	96	366	546	85	61	83	62	59	-0.081	8.22	0.42
13	2.153	2.199	0.17	0.17	2.28	65	-3.38	1.74	65	-2.1	111	0.070	101	100	10.8	-0.17	206	58	89	72	87	102	394	572	85	61	83	62	59	-0.082	8.87	0.45
14	2.319	2.369	0.17	0.17	2.28	66	-3.33	1.73	65	-2.3	111	0.070	101	100	10.6	-0.18	221	58	96	76	92	109	415	556	85	61	83	63	59	-0.081	9.08	0.42
15	2.484	2.539	0.17	0.17	2.28	66	-3.27	1.77	65	-2.2	99	0.070	100	99	10.4	-0.20	237	58	104	80	98	115	441	496	85	61	83	63	59	-0.061	9.2	0.43
16	2.651	2.710	0.17	0.17	2.28	66	-3.36	1.78	65	-2.5	94	0.070	100	100	10.3	-0.09	256	58	112	84	104	123	556	382	84	61	83	63	59	-0.061	9.19	0.16
17	2.816	2.880	0.17	0.17	2.25	66	-3.46	1.79	65	-2.4	91	0.070	99	99	10.2	-0.11	274	58	122	90	111	131	590	349	83	61	82	63	59	-0.060	8.66	0.05
18	2.982	3.051	0.17	0.17	2.26	66	-3.44	1.77	65	-2.3	90	0.070	99	99	10.1	-0.12	290	58	133	97	120	140	615	338	82	61	82	63	60	-0.059	8.46	0.03
19	3.147	3.222	0.17	0.17	2.27	66	-3.17	1.77	65	-2.4	89	0.070	99	99	9.9	-0.15	304	59	143	104	128	148	631	333	82	62	82	63	60	-0.059	8.71	0.03
20	3.313	3.392	0.17	0.17	2.25	66	-3.05	1.76	65	-2.2	88	0.070	99	98	9.8	-0.11	316	59	153	111	137	155	653	334	82	62	82	63	60	-0.059	9.12	0.03
21	3.479	3.563	0.17	0.17	2.26	66	-3.05	1.78	65	-2.2	87	0.070	99	99	9.7	-0.13	325	60	163	118	146	162	645	329	82	62	81	64	59	-0.059	8.65	0.01
22	3.644	3.734	0.17	0.17	2.26	66	-3.25	1.76	65	-2.2	87	0.070	99	99	9.6	-0.10	335	60	173	124	154	169	653	330	82	62	81	64	60	-0.058	8.43	0.01
23	3.809	3.905	0.17	0.17	2.26	66	-3.08	1.77	65	-2.4	88	0.070	99	99	9.5	-0.13	344	61	182	131	162	176	678	333	82	62	81	64	60	-0.060	8.3	0.01
24	3.975	4.075	0.17	0.17	2.26	66	-3.34	1.77	65	-2.2	87	0.070	99	98	9.3	-0.10	355	61	192	137	170	183	695	338	82	62	81	64	59	-0.059	8.83	0.01
25	4.140	4.246	0.17	0.17	2.25	66	-3.35	1.77	65	-2.2	88	0.070	99	99	9.2	-0.13	366	62	201	143	177	190	705	342	82	62	81	64	59	-0.060	9.19	0.01
26	4.304	4.416	0.16	0.17	2.24	66	-3.43	1.76	65	-2.3	88	0.070	98	98	9.1	-0.12	375	63	210	150	184	196	712	345	82	62	82	64	59	-0.061	9.85	0
27	4.469	4.586	0.17	0.17	2.25	66	-3.12	1.75	65	-2.3	88	0.070	99	98	9.0	-0.14	382	64	218	157	192	203	699	343	82	62	83	65	59	-0.061	9.42	0
28	4.634	4.756	0.17	0.17	2.24	66	-3.04	1.74	65	-2.4	88	0.070	99	98	8.8	-0.11	390	64	226	163	199	208	711	346	82	62	83	65	60	-0.062	9.18	0
29	4.799	4.926	0.17	0.17	2.23	66	-3.2	1.74	65	-2.2	90	0.070	99	99	8.7	-0.14	402	66	232	170	205	215	756	357	82	63	84	65	59	-0.063	9.78	0
30	4.964	5.096	0.17	0.17	2.27	66	-3.14	1.83	65	-2.5	90	0.070	99	99	8.6	-0.14	413	66	239	178	212	222	757	361	82	63	84	65	60	-0.063	10.2	0
31	5.130	5.270	0.17	0.17	2.26	66	-3.11	1.82	65	-2.3	91	0.070	100	101	8.4	-0.17	427	68	245	185	219	229	618	373	82	63	85	65	59	-0.065	11.16	0
32	5.296	5.442	0.17	0.17	2.27	66	-3.13	1.82	65	-2.6	91	0.070	100	100	8.2	-0.14	439	69	252	192	226	236	822	376	82	63	85	66	60	-0.065	11.1	0
33	5.461	5.615	0.17	0.17	2.24	66	-3.25	1.81	65	-2.6	92	0.070	99	101	8.1	-0.17	451	70	257	199	233	242	841	378	82	63	85	66	60	-0.066	10.62	0

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
34	5.626	5.788	0.17	0.17	2.26	67	-3.11	1.80	65	-2.6	92	0.070	99	101	7.9	-0.15	464	72	263	205	240	249	864	385	82	63	85	66	60	-0.066	10.87	0
35	5.792	5.962	0.17	0.17	2.27	67	-3.39	1.81	66	-2.6	94	0.070	100	101	7.8	-0.17	477	73	268	212	247	255	874	389	83	63	85	66	60	-0.067	11.12	0.01
36	5.958	6.133	0.17	0.17	2.27	67	-3.36	1.82	66	-2.6	93	0.070	99	99	7.6	-0.14	485	75	272	218	254	261	852	389	83	64	84	66	60	-0.067	10.54	0.01
37	6.124	6.306	0.17	0.17	2.26	67	-3.15	1.81	66	-2.6	95	0.070	100	101	7.5	-0.15	493	77	277	224	261	266	850	391	83	64	84	66	60	-0.067	10.66	0.01
38	6.289	6.479	0.17	0.17	2.25	67	-3.23	1.80	66	-2.3	95	0.070	99	101	7.3	-0.14	501	79	281	230	268	272	867	394	83	64	84	67	60	-0.067	10.71	0.01
39	6.454	6.652	0.17	0.17	2.26	67	-3.35	1.80	66	-2.5	95	0.070	99	101	7.1	-0.17	510	81	285	235	275	277	884	397	83	64	83	67	60	-0.067	11.16	0.01
40	6.619	6.824	0.17	0.17	2.26	67	-3.51	1.81	66	-2.6	96	0.070	99	100	7.0	-0.12	517	83	289	241	282	282	880	398	83	64	83	67	60	-0.068	11.1	0.01
41	6.788	6.997	0.17	0.17	2.26	67	-3.44	1.80	66	-2.5	96	0.070	100	101	6.9	-0.17	523	86	293	246	288	287	883	399	83	64	83	67	60	-0.068	11.02	0.01
42	6.951	7.169	0.16	0.17	2.24	67	-3.38	1.79	66	-2.4	96	0.070	99	100	6.7	-0.15	529	89	297	251	295	292	879	401	83	64	82	67	60	-0.068	11.26	0
43	7.117	7.341	0.17	0.17	2.26	67	-3.25	1.79	66	-2.6	96	0.070	100	100	6.5	-0.15	532	92	302	256	301	297	868	397	83	64	82	68	60	-0.067	10.93	0
44	7.282	7.514	0.17	0.17	2.26	67	-3.5	1.80	66	-2.6	96	0.070	99	101	6.4	-0.14	535	95	306	261	307	301	866	397	83	65	82	68	60	-0.067	10.8	0
45	7.448	7.686	0.17	0.17	2.23	67	-3.5	1.80	66	-2.6	97	0.070	100	100	6.2	-0.16	538	98	311	266	313	305	871	399	83	65	82	68	60	-0.067	10.92	0
46	7.613	7.858	0.17	0.17	2.25	67	-3.28	1.79	66	-2.6	98	0.070	99	100	6.1	-0.16	554	102	315	270	319	312	983	414	84	65	81	68	60	-0.069	13.36	0.24
47	7.777	8.030	0.16	0.17	2.25	67	-3.49	1.79	66	-2.6	98	0.070	99	100	5.9	-0.16	565	105	320	276	325	318	952	417	84	65	81	68	61	-0.070	13.01	0.02
48	7.943	8.203	0.17	0.17	2.25	67	-3.49	1.78	66	-2.4	99	0.070	100	101	5.8	-0.15	570	109	324	282	330	323	927	415	84	65	81	68	61	-0.068	12.35	0.01
49	8.108	8.375	0.17	0.17	2.23	67	-3.47	1.78	66	-2.6	99	0.070	99	100	5.6	-0.14	574	113	328	288	335	328	930	415	84	65	81	68	61	-0.069	11.98	0.01
50	8.273	8.546	0.16	0.17	2.24	67	-3.13	1.80	66	-2.6	99	0.070	99	100	5.5	-0.17	578	117	331	294	340	332	935	416	84	65	82	69	61	-0.069	12.24	0.01
51	8.438	8.718	0.16	0.17	2.24	67	-3.15	1.79	66	-2.4	99	0.070	99	100	5.3	-0.15	581	121	335	300	344	336	927	414	84	65	83	69	61	-0.068	11.88	0.01
52	8.603	8.890	0.16	0.17	2.25	67	-3.14	1.78	66	-2.5	98	0.070	99	100	5.2	-0.17	581	125	340	305	349	340	914	411	84	66	84	69	61	-0.068	11.58	0
53	8.769	9.062	0.17	0.17	2.24	68	-3.17	1.77	66	-2.6	98	0.070	100	100	5.0	-0.12	583	130	344	311	353	344	915	408	84	66	85	69	61	-0.067	11.62	0
54	8.934	9.234	0.16	0.17	2.24	68	-3.24	1.78	66	-2.4	98	0.070	99	100	4.9	-0.12	583	135	348	316	358	348	912	406	84	66	85	69	61	-0.067	10.98	0
55	9.099	9.406	0.16	0.17	2.25	68	-3.32	1.78	66	-2.6	97	0.070	99	100	4.8	-0.12	583	140	352	320	362	351	908	403	84	66	86	69	62	-0.067	10.55	0
56	9.265	9.578	0.17	0.17	2.24	68	-3.35	1.79	66	-2.4	99	0.070	100	100	4.7	-0.11	584	144	356	324	366	355	923	405	84	66	87	70	61	-0.068	10.67	0
57	9.430	9.749	0.16	0.17	2.26	68	-3.33	1.78	66	-2.6	99	0.070	99	100	4.5	-0.17	589	149	360	328	369	359	965	411	84	66	87	70	61	-0.069	11.67	0.01
58	9.595	9.921	0.16	0.17	2.23	68	-3.5	1.78	66	-2.6	99	0.070	99	100	4.4	-0.14	594	154	365	332	373	364	957	413	84	66	86	70	61	-0.068	12.48	0.01
59	9.760	10.093	0.17	0.17	2.25	68	-3.5	1.77	66	-2.4	99	0.070	99	100	4.2	-0.12	594	159	368	336	377	367	931	410	84	66	86	70	61	-0.068	11.85	0.01
60	9.926	10.266	0.17	0.17	2.25	68	-3.11	1.78	67	-2.5	98	0.070	100	101	4.1	-0.15	593	164	372	341	381	370	925	407	84	67	85	70	61	-0.068	11.68	0.01
61	10.095	10.436	0.17	0.17	2.50	68	-2.85	1.79	67	-2.5	98	0.070	102	99	4.0	-0.10	593	169	376	346	385	374	925	405	83	67	84	70	62	-0.068	11.73	0.01
62	10.265	10.608	0.17	0.17	2.18	68	-2.98	1.78	67	-2.5	99	0.070	102	100	3.8	-0.14	595	174	380	351	389	378	929	407	82	67	83	70	62	-0.067	11.88	0.01
63	10.433	10.780	0.17	0.17	2.29	68	-3.24	1.78	67	-2.6	99	0.070	101	100	3.7	-0.12	596	179	384	356	392	381	928	404	82	67	83	71	62	-0.067	11.63	0.01
64	10.600	10.952	0.17	0.17	2.28	68	-3.08	1.77	67	-2.6	99	0.070	100	100	3.6	-0.12	596	184	387	361	396	385	914	403	82	67	82	71	62	-0.067	11.28	0
65	10.767	11.125	0.17	0.17	2.29	68	-2.88	1.78	67	-2.4	100	0.070	101	101	3.5	-0.10	595	190	391	367	400	389	911	399	81	67	81	71	62	-0.066	10.98	0
66	10.934	11.296	0.17	0.17	2.28	68	-2.87	1.79	67	-2.5	99	0.070	100	100	3.4	-0.11	592	196	394	371	403	391	892	396	81	67	81	71	62	-0.065	10.52	0
67	11.100	11.468	0.17	0.17	2.29	68	-3.06	1.78	67	-2.4	99	0.070	100	100	3.3	-0.09	589	201	398	376	406	394	888	392	81	67	81	71	62	-0.065	10.3	0

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
68	11.267	11.641	0.17	0.17	2.26	68	-3.11	1.76	67	-2.6	185	0.070	108	108	3.2	-0.10	587	207	401	380	409	397	868	463	82	68	81	71	62	-0.076	9.93	0
69	11.433	11.812	0.17	0.17	2.29	68	-3.06	1.77	67	-2.6	123	0.070	102	102	27.7	24.51	571	218	405	384	412	398	691	435	85	68	83	72	63	-0.061	5.47	0.11
70	11.600	11.983	0.17	0.17	2.25	68	-3.23	1.74	67	-2.5	112	0.070	102	101	27.4	-0.31	563	224	408	387	414	399	848	407	84	68	83	72	63	-0.070	5.6	0.15
71	11.765	12.153	0.16	0.17	2.27	68	-3.27	1.72	67	-2.6	109	0.070	100	100	27.2	-0.15	567	230	411	389	415	402	917	418	84	68	83	72	63	-0.070	8.21	0.03
72	11.931	12.321	0.17	0.17	2.27	68	-2.9	1.68	67	-2.8	107	0.070	101	99	27.1	-0.18	570	235	412	389	415	404	932	426	84	68	83	72	62	-0.072	8.93	0.03
73	12.097	12.487	0.17	0.17	2.27	69	-2.87	1.64	67	-2.9	105	0.070	100	97	26.9	-0.17	564	240	412	389	415	404	938	429	84	68	83	72	62	-0.073	9.8	0.03
74	12.263	12.651	0.17	0.16	2.25	68	-2.87	1.61	67	-2.7	103	0.070	100	96	26.7	-0.19	549	244	407	389	417	401	933	423	83	68	83	72	63	-0.071	9.72	0.03
75	12.429	12.813	0.17	0.16	2.26	69	-2.89	1.56	67	-2.8	101	0.070	100	95	26.6	-0.15	539	248	400	389	417	399	947	421	83	68	83	72	62	-0.071	9.72	0.03
76	12.595	12.971	0.17	0.16	2.26	69	-3.27	1.49	67	-3.1	101	0.070	100	92	26.4	-0.17	532	251	390	388	416	395	960	422	83	68	83	72	62	-0.072	10.15	0.03
77	12.761	13.124	0.17	0.15	2.27	69	-3.22	1.36	67	-3.2	101	0.070	100	89	26.2	-0.16	526	254	381	387	414	392	955	423	83	69	83	72	62	-0.071	10.1	0.04
78	12.927	13.270	0.17	0.15	2.26	69	-2.88	1.22	67	-3.6	102	0.070	100	85	26.0	-0.18	518	256	372	386	412	389	941	418	83	69	83	72	62	-0.071	10.81	0.03
79	13.093	13.432	0.17	0.16	2.24	69	-2.88	1.58	67	-5.7	100	0.070	100	94	25.9	-0.16	511	258	364	385	409	385	928	415	83	69	83	72	63	-0.069	10.88	0.02
80	13.258	13.600	0.16	0.17	2.29	69	-3.3	1.83	67	-8.3	100	0.070	99	98	25.7	-0.18	505	259	358	384	407	383	924	410	83	69	82	72	63	-0.069	10.96	0.02
81	13.425	13.770	0.17	0.17	2.29	69	-2.97	1.62	67	-10.9	100	0.070	100	99	25.5	-0.16	498	260	352	383	405	380	921	409	83	69	82	72	63	-0.069	10.7	0.02
82	13.592	13.939	0.17	0.17	2.31	69	-3.05	1.79	67	-1.9	100	0.070	100	99	25.4	-0.17	495	260	346	382	403	377	928	408	83	69	81	73	63	-0.070	10.74	0.02
83	13.760	14.111	0.17	0.17	2.28	69	-3.34	1.76	67	-2.1	99	0.070	101	100	25.2	-0.19	492	260	341	382	400	375	932	406	83	69	80	73	63	-0.069	10.79	0.02
84	13.926	14.283	0.17	0.17	2.30	69	-3.17	1.78	67	-2.1	100	0.070	100	100	25.1	-0.14	490	261	336	382	398	373	941	406	83	69	80	73	63	-0.069	10.79	0.02
85	14.093	14.454	0.17	0.17	2.30	69	-3.29	1.77	67	-2	100	0.070	100	100	24.9	-0.17	489	261	331	382	396	372	945	406	83	69	81	73	63	-0.069	10.78	0.02
86	14.260	14.625	0.17	0.17	2.30	69	-3.14	1.76	67	-2.2	100	0.070	100	100	24.7	-0.15	489	260	327	382	394	370	948	408	83	70	81	73	63	-0.069	10.97	0.02
87	14.428	14.797	0.17	0.17	2.29	69	-3.35	1.76	67	-2.1	99	0.070	101	100	24.5	-0.19	490	260	323	382	392	369	955	407	83	70	81	74	64	-0.069	10.86	0.02
88	14.595	14.969	0.17	0.17	2.31	69	-3.09	1.76	67	-2.3	100	0.070	100	100	24.4	-0.16	491	260	320	383	389	369	959	406	83	70	81	74	64	-0.069	10.66	0.02
89	14.763	15.140	0.17	0.17	2.30	69	-3.02	1.76	68	-2	100	0.070	101	100	24.2	-0.14	492	260	316	384	388	368	972	408	83	70	82	74	64	-0.070	10.67	0.02
90	14.930	15.311	0.17	0.17	2.30	69	-3.13	1.77	68	-2	100	0.070	100	100	24.1	-0.16	495	260	313	384	386	368	982	409	83	70	82	74	64	-0.069	10.7	0.03
91	15.098	15.482	0.17	0.17	2.29	69	-3.38	1.76	68	-2.1	100	0.070	101	100	23.9	-0.17	497	259	311	384	384	367	988	409	83	70	82	74	64	-0.069	10.72	0.03
92	15.265	15.653	0.17	0.17	2.30	69	-2.99	1.76	68	-2	100	0.070	100	100	23.8	-0.15	500	259	309	384	382	367	999	410	83	70	82	74	64	-0.070	10.68	0.03
93	15.432	15.824	0.17	0.17	2.30	69	-3.08	1.75	68	-2	100	0.070	100	100	23.6	-0.20	503	258	308	384	381	367	1000	415	83	70	82	74	64	-0.068	10.71	0.04
94	15.599	15.996	0.17	0.17	2.31	69	-3.24	1.76	68	-2	100	0.070	100	100	23.4	-0.13	504	258	309	384	379	367	989	414	83	70	83	74	65	-0.067	10.97	0.04
95	15.768	16.167	0.17	0.17	2.30	69	-3.21	1.76	68	-2.1	100	0.070	102	100	23.3	-0.17	505	258	310	383	378	367	980	413	83	70	83	75	65	-0.069	10.73	0.04
96	15.935	16.338	0.17	0.17	2.30	69	-3.3	1.76	68	-2.3	101	0.070	100	100	23.1	-0.16	503	257	312	382	377	366	964	410	83	71	83	75	64	-0.068	10.5	0.03
97	16.103	16.508	0.17	0.17	2.28	69	-3.3	1.77	68	-2	100	0.070	101	99	22.9	-0.16	500	257	314	382	375	366	953	408	83	71	83	75	65	-0.068	10.54	0.03
98	16.270	16.679	0.17	0.17	2.30	69	-3.01	1.76	68	-2.1	100	0.070	100	100	22.8	-0.17	499	257	316	381	374	365	953	408	83	71	83	75	65	-0.068	10.67	0.03
99	16.438	16.851	0.17	0.17	2.30	69	-2.99	1.76	68	-2.1	100	0.070	101	100	22.6	-0.16	498	257	319	381	372	365	956	408	83	71	83	75	65	-0.069	10.64	0.03
100	16.605	17.022	0.17	0.17	2.30	70	-3.37	1.76	68	-2.2	100	0.070	100	100	22.5	-0.15	496	257	322	380	371	365	945	407	83	71	84	75	65	-0.068	10.47	0.03
101	16.773	17.192	0.17	0.17	2.30	70	-3.32	1.75	68	-2.3	101	0.070	101	99	22.3	-0.15	493	257	325	380	371	365	935	406	83	71	84	75	65	-0.068	10.35	0.02

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
102	16.941	17.364	0.17	0.17	2.29	70	-3.39	1.75	68	-2	100	0.070	101	100	22.1	-0.18	489	257	327	379	370	364	926	404	83	71	84	75	65	-0.068	10.38	0.02
103	17.108	17.534	0.17	0.17	2.28	70	-3.21	1.77	68	-2.3	101	0.070	100	99	22.0	-0.16	486	257	330	378	370	364	927	405	83	71	84	75	65	-0.071	10.54	0.02
104	17.275	17.705	0.17	0.17	2.28	70	-3.36	1.75	68	-2	101	0.070	100	100	21.8	-0.16	484	257	332	378	370	364	922	406	83	71	84	75	65	-0.068	11.17	0.02
105	17.442	17.876	0.17	0.17	2.29	70	-3.03	1.75	68	-2	102	0.070	100	100	21.6	-0.19	485	258	333	378	371	365	947	412	83	71	84	75	65	-0.072	11.91	0.02
106	17.610	18.046	0.17	0.17	2.29	70	-3.04	1.75	68	-2.3	104	0.070	101	99	21.4	-0.22	490	258	333	379	371	366	980	419	83	71	84	75	65	-0.076	12.03	0.05
107	17.776	18.218	0.17	0.17	2.29	70	-3.32	1.80	68	-2.4	100	0.070	100	100	21.2	-0.16	498	259	333	379	371	368	1019	422	83	71	84	75	65	-0.070	12.08	0.08
108	17.944	18.392	0.17	0.17	2.27	70	-3.03	1.80	68	-2.1	106	0.070	101	102	21.1	-0.15	504	259	332	380	371	369	1018	426	83	72	84	76	65	-0.074	12.34	0.05
109	18.111	18.564	0.17	0.17	2.27	70	-3.21	1.81	68	-2.1	100	0.070	100	100	20.9	-0.21	510	260	331	380	371	370	1027	426	83	72	84	76	65	-0.067	12.57	0.05
110	18.278	18.737	0.17	0.17	2.28	70	-2.99	1.79	68	-2.1	101	0.070	100	101	20.7	-0.17	515	260	330	381	371	371	1028	426	83	72	84	76	65	-0.068	12.84	0.07
111	18.445	18.910	0.17	0.17	2.29	70	-3.04	1.79	68	-2.1	105	0.070	101	101	20.6	-0.15	519	261	329	381	371	372	1039	430	83	72	84	76	66	-0.077	13.05	0.09
112	18.612	19.084	0.17	0.17	2.29	70	-3.13	1.80	68	-2.2	106	0.070	101	102	20.4	-0.16	525	261	328	382	371	373	1043	430	83	72	84	76	66	-0.076	12.92	0.07
113	18.779	19.256	0.17	0.17	2.30	70	-3.33	1.80	68	-2.3	101	0.070	100	100	20.2	-0.21	531	261	328	382	372	375	1051	428	83	72	84	76	66	-0.068	12.65	0.08
114	18.947	19.429	0.17	0.17	2.29	70	-3.08	1.80	68	-2.1	103	0.070	101	101	20.0	-0.19	533	261	328	383	372	375	1015	424	83	72	84	76	66	-0.071	12.39	0.05
115	19.114	19.602	0.17	0.17	2.28	70	-3	1.79	68	-2.2	101	0.070	100	101	19.8	-0.16	531	261	328	384	372	375	1011	423	83	72	84	76	66	-0.070	12.56	0.01
116	19.281	19.774	0.17	0.17	2.29	70	-3.18	1.79	68	-2.4	100	0.070	100	100	19.7	-0.17	528	261	328	385	373	375	996	416	84	72	84	76	66	-0.069	12.79	0.01
117	19.448	19.948	0.17	0.17	2.29	70	-3.11	1.80	68	-2.1	104	0.070	101	102	19.5	-0.18	526	261	327	386	373	375	994	415	84	72	84	76	66	-0.072	12.85	0
118	19.615	20.120	0.17	0.17	2.30	70	-3.23	1.79	68	-2.1	104	0.070	101	100	19.3	-0.19	545	262	328	387	374	379	1110	426	84	72	84	76	66	-0.073	12.61	0.06
119	19.783	20.293	0.17	0.17	2.30	70	-3.4	1.79	69	-2.2	102	0.070	101	101	19.1	-0.17	545	262	328	388	375	380	1025	421	84	73	84	77	66	-0.070	12.11	0.02
120	19.951	20.465	0.17	0.17	2.29	70	-3.4	1.79	69	-2.4	104	0.070	101	100	18.9	-0.17	545	262	328	389	375	380	1015	420	84	73	84	77	66	-0.071	12.03	0.02
121	20.117	20.639	0.17	0.17	2.29	70	-3.32	1.79	69	-2.1	102	0.070	100	101	18.8	-0.12	542	262	328	391	375	380	997	417	84	73	84	77	66	-0.070	12.07	0.02
122	20.284	20.811	0.17	0.17	2.28	70	-3.27	1.80	69	-2.2	101	0.070	100	100	18.7	-0.17	542	262	329	393	375	380	991	414	84	73	84	77	66	-0.068	12.13	0.04
123	20.451	20.983	0.17	0.17	2.30	70	-3.13	1.79	69	-2.2	101	0.070	100	100	18.5	-0.17	540	262	330	395	376	381	990	415	84	73	84	77	66	-0.069	12.22	0.05
124	20.619	21.156	0.17	0.17	2.29	71	-3.41	1.79	69	-2.2	101	0.070	101	101	18.3	-0.17	540	262	332	397	376	381	998	414	84	73	84	77	65	-0.068	12.36	0.08
125	20.786	21.329	0.17	0.17	2.30	71	-3.35	1.78	69	-2.1	101	0.070	100	101	18.2	-0.14	539	262	333	400	378	382	989	412	84	73	84	77	66	-0.069	12.37	0.03
126	20.955	21.502	0.17	0.17	2.30	71	-3.28	1.78	69	-2.2	101	0.070	101	101	18.0	-0.22	536	263	334	403	379	383	980	412	84	73	84	77	66	-0.070	12.29	0.03
127	21.122	21.674	0.17	0.17	2.29	71	-3	1.80	69	-2.4	101	0.070	100	100	17.9	-0.10	533	263	336	405	380	383	967	409	84	73	84	77	66	-0.068	12.29	0.02
128	21.289	21.847	0.17	0.17	2.28	71	-3.39	1.78	69	-2.3	101	0.070	100	101	17.6	-0.21	531	263	337	408	382	384	959	409	84	73	84	77	66	-0.070	12.34	0.02
129	21.456	22.020	0.17	0.17	2.29	71	-3.01	1.78	69	-2.3	101	0.070	100	101	17.5	-0.15	526	263	339	411	384	385	941	405	84	73	84	77	66	-0.068	12.26	0.01
130	21.624	22.193	0.17	0.17	2.30	71	-3.39	1.79	69	-2.4	100	0.070	101	101	17.3	-0.16	523	263	341	414	386	385	933	402	84	74	84	78	66	-0.067	12.23	0.01
131	21.792	22.365	0.17	0.17	2.30	71	-3.4	1.80	69	-2.3	101	0.070	101	100	17.2	-0.15	520	264	342	417	388	386	937	401	84	74	84	78	66	-0.066	12.33	0.01
132	21.959	22.538	0.17	0.17	2.31	71	-3.31	1.79	69	-2.3	100	0.070	100	101	17.0	-0.15	518	264	344	419	390	387	931	402	84	74	84	78	66	-0.068	12.39	0.01
133	22.127	22.711	0.17	0.17	2.30	71	-3.25	1.79	69	-2.2	100	0.070	101	101	16.8	-0.19	517	264	346	422	391	388	934	400	84	74	84	78	66	-0.066	12.55	0.01
134	22.295	22.884	0.17	0.17	2.28	71	-3.32	1.78	69	-2.2	101	0.070	101	101	16.7	-0.15	516	264	348	424	393	389	934	401	84	74	84	78	66	-0.066	12.67	0.01
135	22.462	23.057	0.17	0.17	2.29	71	-3.32	1.80	69	-2.4	100	0.070	100	101	16.5	-0.15	516	265	350	427	395	391	934	398	84	74	84	78	67	-0.066	12.87	0.01

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
136	22.629	23.229	0.17	0.17	2.30	71	-3.01	1.79	69	-2.2	100	0.070	100	100	16.4	-0.15	516	265	352	429	398	392	937	400	84	74	84	78	67	-0.065	13.02	0
137	22.797	23.402	0.17	0.17	2.29	71	-3.21	1.79	69	-2.2	101	0.070	101	101	16.2	-0.20	516	265	355	432	400	394	944	399	84	74	84	78	67	-0.067	13.31	0.01
138	22.965	23.574	0.17	0.17	2.31	71	-3.05	1.78	69	-2.4	100	0.070	101	100	16.0	-0.17	518	266	357	434	402	395	948	399	84	74	84	78	67	-0.067	13.43	0
139	23.133	23.748	0.17	0.17	2.31	71	-3.12	1.78	69	-2.3	100	0.070	101	101	15.8	-0.18	521	266	361	436	404	398	966	400	84	74	84	78	67	-0.068	13.74	0.01
140	23.301	23.919	0.17	0.17	2.30	71	-3.01	1.80	69	-2.4	100	0.070	101	99	15.7	-0.14	526	266	365	438	406	400	985	403	84	74	84	78	67	-0.066	14.08	0.03
141	23.468	24.092	0.17	0.17	2.28	71	-3.21	1.79	69	-2.2	100	0.070	100	101	15.5	-0.18	529	267	370	441	408	403	971	401	84	74	84	78	67	-0.065	13.92	0.01
142	23.636	24.265	0.17	0.17	2.30	71	-3	1.79	69	-2.2	100	0.070	101	101	15.4	-0.15	529	267	375	443	411	405	958	399	84	75	84	78	67	-0.066	13.36	0.02
143	23.804	24.437	0.17	0.17	2.30	71	-3.25	1.78	69	-2.3	100	0.070	101	100	15.2	-0.13	529	267	379	445	413	407	947	397	84	75	84	79	67	-0.066	13.05	0.01
144	23.971	24.610	0.17	0.17	2.29	71	-3.37	1.80	69	-2.3	100	0.070	100	101	15.1	-0.17	529	268	382	447	415	408	949	397	84	75	84	79	67	-0.065	12.84	0
145	24.139	24.783	0.17	0.17	2.31	71	-3.27	1.79	69	-2.1	100	0.070	101	101	14.9	-0.15	529	268	384	449	418	410	946	396	84	75	84	79	68	-0.067	12.73	0.01
146	24.308	24.955	0.17	0.17	2.31	71	-2.99	1.78	69	-2.2	99	0.070	101	100	14.8	-0.14	529	268	387	451	420	411	940	394	84	75	84	79	68	-0.066	12.46	0
147	24.476	25.128	0.17	0.17	2.31	71	-2.99	1.78	69	-2.1	99	0.070	100	100	14.6	-0.14	528	269	390	452	422	412	934	392	84	75	84	79	68	-0.065	11.97	0
148	24.644	25.302	0.17	0.17	2.29	71	-2.99	1.79	69	-2.1	99	0.070	100	101	14.5	-0.11	525	269	392	454	423	413	930	391	84	75	84	79	68	-0.064	11.49	0
149	24.812	25.474	0.17	0.17	2.30	72	-3.16	1.80	69	-2.1	99	0.070	100	100	14.4	-0.17	525	270	395	455	425	414	942	392	84	75	84	79	68	-0.064	11.28	0
150	24.980	25.647	0.17	0.17	2.30	72	-3.17	1.78	70	-2.1	100	0.070	100	100	14.3	-0.10	524	270	397	456	426	415	940	392	84	75	84	79	68	-0.065	11.26	0
151	25.149	25.820	0.17	0.17	2.31	72	-3.35	1.80	70	-2.2	100	0.070	101	100	14.1	-0.13	523	271	399	457	426	415	935	391	84	75	85	79	68	-0.066	11.22	0
152	25.317	25.993	0.17	0.17	2.33	72	-3.28	1.79	70	-2.2	99	0.070	100	100	14.0	-0.13	520	271	401	457	426	415	930	390	84	75	84	79	68	-0.066	11.27	0
153	25.486	26.166	0.17	0.17	2.32	72	-3.38	1.81	70	-2.4	99	0.070	101	100	13.9	-0.12	518	272	402	458	426	415	930	389	84	76	85	79	68	-0.065	11.32	0
154	25.654	26.339	0.17	0.17	2.31	72	-3.39	1.80	70	-2.2	98	0.070	100	100	13.7	-0.14	516	273	404	459	426	416	926	388	84	76	85	79	68	-0.064	11.42	0
155	25.823	26.512	0.17	0.17	2.31	72	-3.19	1.80	70	-2.1	99	0.070	101	100	13.6	-0.10	513	274	405	460	426	416	925	387	84	76	85	79	68	-0.064	11.3	0
156	25.992	26.686	0.17	0.17	2.32	72	-3.35	1.80	70	-2.1	99	0.070	101	101	13.5	-0.12	511	275	406	461	426	416	922	385	84	76	85	80	68	-0.065	11.28	0
157	26.160	26.859	0.17	0.17	2.31	72	-3.38	1.80	70	-2.2	98	0.070	100	100	13.4	-0.16	509	276	407	462	426	416	923	385	84	76	85	80	68	-0.063	11.32	0
158	26.329	27.032	0.17	0.17	2.31	72	-3.32	1.80	70	-2.2	99	0.070	101	100	13.2	-0.11	507	277	408	463	426	416	924	385	84	76	85	80	68	-0.063	11.34	0
159	26.497	27.206	0.17	0.17	2.32	72	-3.38	1.81	70	-2.3	99	0.070	100	101	13.1	-0.11	505	278	409	464	426	416	922	383	84	76	85	80	68	-0.063	11.31	0
160	26.666	27.380	0.17	0.17	2.31	72	-3.39	1.80	70	-2.2	98	0.070	101	101	13.0	-0.14	503	279	410	465	427	417	915	383	85	76	85	80	68	-0.063	11.34	0
161	26.834	27.553	0.17	0.17	2.31	72	-3.33	1.81	70	-2.1	98	0.070	100	100	12.9	-0.11	502	280	411	466	427	417	916	381	84	76	85	80	68	-0.064	11.39	0
162	27.003	27.727	0.17	0.17	2.33	72	-3.35	1.80	70	-2.1	99	0.070	101	101	12.8	-0.11	500	282	412	467	427	418	920	382	84	76	85	80	68	-0.065	11.43	0
163	27.172	27.900	0.17	0.17	2.33	72	-3.39	1.80	70	-2.1	98	0.070	101	100	12.6	-0.13	500	283	413	468	428	418	929	381	85	76	85	80	68	-0.063	11.43	0
164	27.341	28.075	0.17	0.18	2.33	72	-3.14	1.80	70	-2.1	99	0.070	101	101	12.5	-0.13	500	285	414	470	428	419	934	380	85	76	85	80	69	-0.063	11.52	0
165	27.510	28.248	0.17	0.17	2.32	72	-3.33	1.82	70	-2.3	98	0.070	101	100	12.4	-0.11	500	286	415	471	429	420	938	379	85	76	85	80	68	-0.063	11.53	0
166	27.678	28.422	0.17	0.17	2.31	72	-3.05	1.80	70	-2.2	99	0.070	100	101	12.3	-0.13	501	287	415	472	428	421	938	379	85	76	85	80	68	-0.062	11.46	0
167	27.847	28.596	0.17	0.17	2.30	72	-3.27	1.81	70	-2.3	98	0.070	101	101	12.2	-0.12	502	288	415	473	428	421	942	378	85	76	85	80	69	-0.063	11.43	0
168	28.015	28.770	0.17	0.17	2.31	72	-3.12	1.83	70	-2.4	97	0.070	100	101	12.0	-0.14	503	289	415	474	428	422	948	379	85	76	85	80	68	-0.063	11.57	0
169	28.184	28.944	0.17	0.17	2.32	72	-3.12	1.81	70	-2.3	97	0.070	101	101	12.0	-0.06	504	290	414	476	428	422	954	378	85	76	85	80	69	-0.063	11.67	0

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
170	28.352	29.118	0.17	0.17	2.32	72	-3.2	1.81	70	-2.1	98	0.070	100	101	11.8	-0.13	506	291	413	477	427	423	959	380	85	76	85	80	69	-0.063	11.78	0
171	28.521	29.293	0.17	0.18	2.32	72	-3.27	1.81	70	-2.1	98	0.070	101	101	11.7	-0.12	508	293	413	478	427	424	964	378	85	76	85	80	69	-0.063	11.91	0
172	28.690	29.467	0.17	0.17	2.33	72	-3.13	1.83	70	-2.1	98	0.070	101	101	11.6	-0.11	510	294	412	480	427	425	967	377	85	76	85	80	68	-0.062	12.04	0
173	28.859	29.641	0.17	0.17	2.33	72	-3.29	1.81	70	-2.3	98	0.070	101	101	11.4	-0.15	513	295	411	481	427	425	972	378	85	76	85	80	69	-0.063	12.13	0
174	29.028	29.816	0.17	0.18	2.30	72	-3.05	1.81	70	-2.1	98	0.070	101	101	11.3	-0.11	515	297	410	483	427	426	976	381	85	77	85	80	69	-0.062	12.21	0
175	29.196	29.990	0.17	0.17	2.31	72	-3.28	1.83	70	-2.2	97	0.070	100	101	11.2	-0.10	517	298	410	484	427	427	979	379	85	77	85	80	69	-0.063	12.31	0
176	29.365	30.165	0.17	0.18	2.30	72	-3.11	1.81	70	-2.4	98	0.070	101	101	11.1	-0.12	520	299	410	486	427	428	982	380	85	77	85	80	69	-0.063	12.34	0
177	29.534	30.339	0.17	0.17	2.31	72	-2.99	1.82	70	-2.4	98	0.070	101	101	11.0	-0.12	522	300	409	487	427	429	986	380	85	77	85	80	69	-0.063	12.39	0
178	29.702	30.514	0.17	0.18	2.31	72	-3.29	1.82	70	-2.3	98	0.070	100	101	10.9	-0.15	525	302	409	488	427	430	990	380	85	77	85	80	69	-0.063	12.51	0
179	29.871	30.688	0.17	0.17	2.33	72	-3.37	1.83	70	-2.4	98	0.070	101	101	10.7	-0.12	527	303	409	490	428	431	994	382	85	77	85	81	69	-0.063	12.55	0
180	30.040	30.863	0.17	0.18	2.33	72	-3.24	1.82	70	-2.4	98	0.070	101	101	10.6	-0.10	530	305	409	491	428	433	996	381	85	77	85	81	69	-0.063	12.64	0
181	30.209	31.039	0.17	0.18	2.32	72	-3.18	1.83	70	-2.4	98	0.070	101	102	10.5	-0.14	532	306	408	492	429	433	998	382	85	77	85	81	69	-0.062	12.76	0
182	30.377	31.213	0.17	0.17	2.32	72	-3.08	1.83	71	-2.3	98	0.070	100	101	10.4	-0.12	534	308	408	493	430	435	1002	383	85	77	85	81	69	-0.062	12.83	0
183	30.547	31.387	0.17	0.17	2.29	72	-3.37	1.83	71	-2.1	98	0.070	101	101	10.3	-0.12	537	309	408	495	430	436	1006	383	85	77	85	81	69	-0.062	12.97	0
184	30.715	31.563	0.17	0.18	2.32	73	-3.32	1.82	71	-2.1	98	0.070	100	102	10.1	-0.13	538	311	408	496	431	437	1001	383	85	77	85	81	69	-0.062	13.18	0
185	30.884	31.737	0.17	0.17	2.31	73	-3.05	1.84	71	-2.2	98	0.070	101	101	10.0	-0.13	540	312	408	497	432	438	1006	383	85	77	85	81	70	-0.062	13.41	0.01
186	31.053	31.912	0.17	0.18	2.31	73	-3.05	1.82	71	-2.1	98	0.070	101	101	9.9	-0.10	542	313	409	498	433	439	1005	383	85	77	85	81	70	-0.062	13.33	0.02
187	31.221	32.087	0.17	0.18	2.32	73	-3.39	1.83	71	-2.1	98	0.070	100	101	9.7	-0.17	541	315	409	500	435	440	985	382	85	77	85	81	70	-0.061	12.73	0
188	31.390	32.262	0.17	0.17	2.32	73	-3.21	1.84	71	-2.3	98	0.070	101	101	9.7	-0.07	538	316	409	501	436	440	974	378	85	77	85	81	71	-0.061	12.41	0
189	31.559	32.438	0.17	0.18	2.32	73	-3.11	1.83	71	-2.2	99	0.070	101	102	9.5	-0.12	536	318	409	501	438	440	968	379	85	77	85	81	71	-0.062	12.27	0
190	31.728	32.613	0.17	0.17	2.32	73	-3.19	1.82	71	-2.1	98	0.070	101	101	9.4	-0.16	533	320	410	502	439	441	959	377	85	77	85	81	71	-0.061	12.21	0
191	31.897	32.788	0.17	0.17	2.33	73	-3	1.85	71	-2.1	98	0.070	101	101	9.3	-0.05	532	321	410	503	441	441	969	376	85	77	85	81	71	-0.060	12.22	0
192	32.066	32.963	0.17	0.18	2.34	73	-3.03	1.83	71	-2.3	97	0.070	101	101	9.2	-0.11	531	322	410	504	442	442	971	374	85	77	85	81	70	-0.060	12.08	0
193	32.235	33.139	0.17	0.18	2.30	73	-2.99	1.83	71	-2.3	98	0.070	101	102	9.1	-0.12	531	324	410	504	443	442	971	376	85	77	85	81	71	-0.059	11.91	0
194	32.404	33.314	0.17	0.17	2.32	73	-3.38	1.84	71	-2.3	98	0.070	101	101	9.0	-0.09	530	326	409	505	445	443	976	376	85	77	85	80	70	-0.061	11.69	0
195	32.573	33.489	0.17	0.17	2.33	73	-3.02	1.84	71	-2.1	98	0.070	101	101	8.9	-0.07	530	327	409	505	446	443	973	373	85	77	86	80	71	-0.060	11.23	0
196	32.742	33.665	0.17	0.18	2.31	73	-3.06	1.84	71	-2.2	98	0.070	101	102	8.8	-0.10	529	329	408	505	447	444	974	373	85	77	86	80	71	-0.060	11.05	0
197	32.911	33.840	0.17	0.18	2.32	73	-3.05	1.85	71	-2.3	98	0.070	101	101	8.8	-0.09	527	330	408	505	448	444	969	374	85	77	86	80	71	-0.060	10.98	0
198	33.080	34.016	0.17	0.18	2.32	73	-3.01	1.83	71	-2.1	97	0.070	101	102	8.7	-0.09	526	332	407	506	448	444	970	372	85	77	86	80	71	-0.060	10.86	0
199	33.249	34.192	0.17	0.18	2.32	73	-3.11	1.84	71	-2.1	98	0.070	101	102	8.6	-0.10	525	333	406	506	449	444	975	373	85	77	86	80	71	-0.061	10.93	0
200	33.418	34.368	0.17	0.18	2.34	73	-2.99	1.84	71	-2.1	98	0.070	101	102	8.5	-0.09	524	334	406	506	450	444	975	373	85	76	86	80	71	-0.060	10.94	0
201	33.587	34.543	0.17	0.17	2.33	73	-3.24	1.84	71	-2.1	98	0.070	101	101	8.4	-0.10	522	336	405	507	450	444	971	372	85	76	86	80	71	-0.060	10.97	0
202	33.756	34.719	0.17	0.18	2.32	73	-3.32	1.84	71	-2.1	98	0.070	101	102	8.3	-0.09	521	337	405	508	451	444	969	371	85	76	86	80	71	-0.060	11.04	0
203	33.925	34.894	0.17	0.17	2.33	73	-3.39	1.85	71	-2.1	98	0.070	101	101	8.2	-0.09	519	339	405	508	451	444	961	370	85	76	86	79	71	-0.060	11.08	0

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
204	34.095	35.070	0.17	0.18	2.33	73	-3.1	1.84	71	-2.4	98	0.070	101	102	8.1	-0.08	516	340	404	509	452	444	955	369	86	76	86	79	71	-0.060	11.08	0
205	34.265	35.246	0.17	0.18	2.30	73	-3	1.84	71	-2.4	98	0.070	101	102	8.0	-0.11	514	342	404	511	452	445	951	369	86	76	86	79	71	-0.060	11.04	0
206	34.434	35.421	0.17	0.17	2.32	73	-3.04	1.84	71	-2.1	98	0.070	101	101	7.9	-0.10	511	343	404	512	453	445	940	368	86	76	86	79	71	-0.059	10.98	0
207	34.603	35.597	0.17	0.18	2.32	73	-3.4	1.84	71	-2.3	97	0.070	101	102	7.8	-0.08	507	345	404	513	453	444	931	366	86	76	86	79	71	-0.059	10.83	0
208	34.772	35.774	0.17	0.18	2.31	73	-3.17	1.85	71	-2.4	98	0.070	101	102	7.8	-0.09	502	346	404	514	454	444	916	364	86	76	86	79	70	-0.058	10.46	0
209	34.940	35.948	0.17	0.17	2.28	73	-3.27	1.83	71	-2.1	97	0.070	100	100	7.7	-0.05	497	348	404	516	454	444	908	361	86	75	86	78	71	-0.058	10	0
210	35.107	36.123	0.17	0.17	2.29	73	-2.94	1.83	71	-2.3	97	0.070	99	101	7.6	-0.09	492	349	404	517	455	443	899	358	86	75	86	78	69	-0.058	9.76	0
211	35.275	36.299	0.17	0.18	2.29	73	-2.91	1.83	71	-2.3	97	0.070	100	102	7.6	-0.06	486	351	403	518	455	443	890	355	86	75	86	78	71	-0.058	9.48	0
212	35.443	36.473	0.17	0.17	2.30	73	-3.21	1.83	71	-2.1	97	0.070	100	100	7.5	-0.08	481	352	403	519	456	442	883	353	85	75	86	78	70	-0.058	9.33	0
213	35.612	36.648	0.17	0.18	2.29	73	-3.1	1.83	72	-2.2	96	0.070	100	101	7.4	-0.07	477	354	402	520	456	442	879	352	85	75	86	77	70	-0.057	9.16	0
214	35.779	36.824	0.17	0.18	2.29	73	-3.24	1.82	72	-2.3	96	0.070	99	101	7.3	-0.09	473	355	401	521	457	441	879	352	85	75	86	77	70	-0.057	9.08	0
215	35.947	36.998	0.17	0.17	2.27	73	-2.97	1.83	72	-2.1	96	0.070	100	100	7.3	-0.06	469	356	400	521	457	441	876	351	85	75	86	77	71	-0.057	8.96	0
216	36.114	37.173	0.17	0.18	2.29	73	-3.19	1.82	72	-2.2	96	0.070	99	101	7.2	-0.03	466	358	398	521	457	440	873	352	85	75	86	77	70	-0.057	8.92	0
217	36.282	37.349	0.17	0.18	2.30	73	-3.11	1.82	72	-2.2	96	0.070	100	101	7.2	-0.08	463	359	396	520	457	439	870	352	85	74	86	77	70	-0.058	8.89	0
218	36.450	37.523	0.17	0.17	2.30	73	-2.98	1.83	72	-2.1	96	0.070	100	100	7.1	-0.06	461	360	394	520	457	438	870	352	85	74	86	76	70	-0.057	8.79	0
219	36.618	37.698	0.17	0.17	2.30	74	-3.11	1.83	72	-2.1	96	0.070	100	101	7.0	-0.10	458	362	392	519	457	438	868	353	85	74	85	76	70	-0.057	8.86	0
220	36.787	37.874	0.17	0.18	2.27	74	-2.93	1.83	72	-2.1	96	0.070	100	101	7.0	-0.03	457	364	390	518	457	437	866	351	85	74	85	76	71	-0.057	8.88	0
221	36.955	38.049	0.17	0.17	2.29	74	-2.97	1.83	72	-2.2	96	0.070	100	101	6.9	-0.06	453	365	388	516	458	436	855	348	85	74	85	76	70	-0.056	8.63	0
222	37.123	38.224	0.17	0.17	2.29	74	-3.25	1.83	72	-2.3	95	0.070	100	101	6.8	-0.08	450	366	386	515	458	435	850	349	85	74	85	75	70	-0.057	8.66	0
223	37.290	38.399	0.17	0.18	2.29	74	-3.27	1.82	72	-2.2	95	0.070	99	101	6.8	-0.03	445	367	384	513	459	434	839	345	85	74	85	75	70	-0.054	8.59	0
224	37.459	38.574	0.17	0.17	2.29	74	-3.28	1.84	72	-2.1	95	0.070	100	101	6.7	-0.07	441	368	382	511	460	432	834	342	85	74	85	75	71	-0.056	8.59	0
225	37.627	38.749	0.17	0.18	2.30	74	-3	1.82	72	-2.1	95	0.070	100	101	6.7	-0.07	438	369	380	509	461	431	830	340	85	73	85	75	70	-0.056	8.69	0
226	37.795	38.925	0.17	0.18	2.30	74	-3.05	1.83	72	-2.2	94	0.070	99	101	6.6	-0.06	433	370	377	508	463	430	812	339	85	73	85	75	70	-0.055	8.71	0
227	37.963	39.099	0.17	0.17	2.30	74	-3.3	1.83	72	-2.1	95	0.070	100	100	6.5	-0.05	429	371	375	506	465	429	807	338	85	73	85	75	70	-0.055	8.77	0
228	38.132	39.275	0.17	0.18	2.28	74	-2.92	1.83	72	-2.3	94	0.070	100	101	6.4	-0.10	428	371	373	504	467	428	810	335	85	73	85	74	70	-0.054	8.98	0
229	38.299	39.450	0.17	0.18	2.30	74	-2.99	1.82	72	-2.3	94	0.070	99	101	6.4	-0.03	424	372	371	502	469	428	817	335	85	73	85	74	70	-0.055	9.16	0
230	38.467	39.625	0.17	0.17	2.29	74	-3.31	1.84	72	-2.3	94	0.070	99	101	6.3	-0.06	423	372	369	501	471	427	818	335	84	73	85	74	71	-0.055	9.27	0
231	38.635	39.801	0.17	0.18	2.29	74	-2.91	1.82	72	-2.3	94	0.070	99	101	6.3	-0.07	422	373	367	499	474	427	823	335	84	72	84	74	70	-0.055	9.38	0
232	38.804	39.976	0.17	0.17	2.29	74	-3.27	1.82	72	-2.2	94	0.070	100	101	6.2	-0.05	422	373	366	498	476	427	820	333	84	72	84	74	70	-0.055	9.19	0
233	38.972	40.151	0.17	0.18	2.30	74	-3.2	1.84	72	-2.3	94	0.070	99	101	6.1	-0.07	420	373	364	496	479	426	813	332	84	72	84	74	70	-0.055	8.94	0
234	39.140	40.326	0.17	0.17	2.30	74	-2.89	1.82	72	-2.3	94	0.070	99	101	6.1	-0.07	418	373	362	495	481	426	802	330	84	72	84	73	70	-0.055	8.36	0
235	39.308	40.502	0.17	0.18	2.30	74	-3.01	1.83	72	-2.3	94	0.070	99	101	6.1	0.01	415	373	361	493	484	425	797	329	84	72	84	73	70	-0.054	7.93	0
236	39.477	40.677	0.17	0.17	2.28	74	-3.2	1.84	72	-2.3	93	0.070	100	100	6.0	-0.06	412	373	359	492	485	424	793	326	84	72	84	73	70	-0.054	7.57	0
237	39.645	40.852	0.17	0.17	2.28	74	-2.97	1.83	72	-2.2	93	0.070	99	100	6.0	-0.03	410	372	357	490	486	423	786	327	84	72	84	73	70	-0.055	7.4	0

Wood Heater Test Data
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 249 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.86 ft/sec.
Initial Tunnel Flow: 197.2 scfm
Average Tunnel Flow: 186.0 scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 20.40 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	0.065	0.070	0.072	0.070	0.062	0.067	0.073	0.070	0.074	"H2O
Temp:	59	59	59	59	59	59	59	59	59	°F

V_{stav} 17.71 ft/sec V_{scent} 18.32 ft/sec F_p 0.967

	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
238	39.813	41.027	0.17	0.18	2.28	74	-3.26	1.83	72	-2.3	93	0.070	99	100	6.0	-0.04	407	372	355	489	486	422	781	328	84	72	84	73	70	-0.053	7.4	0
239	39.981	41.203	0.17	0.18	2.29	74	-2.94	1.84	72	-2.1	93	0.070	99	101	5.9	-0.05	405	372	353	487	486	421	781	326	84	71	84	72	70	-0.054	7.35	0
240	40.150	41.378	0.17	0.17	2.29	74	-3.07	1.82	72	-2.2	92	0.070	100	100	5.9	-0.05	403	371	352	486	486	420	781	326	84	71	84	72	70	-0.054	7.25	0
241	40.318	41.553	0.17	0.17	2.30	74	-3.28	1.83	72	-2.3	93	0.070	99	100	5.8	-0.02	401	371	350	484	485	418	780	326	84	71	84	72	70	-0.054	7.29	0
242	40.486	41.729	0.17	0.18	2.31	74	-3.29	1.84	72	-2.3	93	0.070	99	101	5.8	-0.03	398	371	348	483	484	417	777	325	84	71	84	72	70	-0.054	7.25	0
243	40.654	41.904	0.17	0.18	2.30	74	-3.3	1.83	72	-2.3	93	0.070	99	100	5.8	-0.03	396	370	346	481	483	415	774	324	84	71	84	72	70	-0.054	7.24	0
244	40.823	42.079	0.17	0.17	2.30	74	-3.24	1.82	72	-2.1	93	0.070	100	100	5.7	-0.05	393	370	345	480	481	414	768	323	84	71	83	72	70	-0.054	7.24	0
245	40.991	42.254	0.17	0.17	2.29	74	-3.3	1.85	72	-2.1	92	0.070	99	100	5.7	-0.02	390	370	343	478	480	412	761	321	84	71	83	72	70	-0.053	7.16	0
246	41.160	42.430	0.17	0.18	2.29	74	-2.89	1.82	72	-2	93	0.070	100	101	5.6	-0.07	387	370	342	477	479	411	756	321	84	71	83	72	70	-0.053	7.07	0
247	41.328	42.605	0.17	0.17	2.28	74	-3.23	1.83	72	-2.2	92	0.070	99	100	5.6	-0.03	385	370	341	476	477	410	754	319	84	71	83	71	70	-0.053	7.06	0
248	41.496	42.781	0.17	0.18	2.30	74	-3.29	1.84	72	-2.3	92	0.070	99	101	5.6	-0.03	382	369	340	474	476	408	752	317	84	70	83	71	70	-0.053	7.08	0
249	41.664	42.956	0.17	0.18	2.30	74	-3.19	1.83	72	-2	92	0.070	99	100	5.6	0.03	380	370	339	473	474	407	751	317	84	70	83	71	70	-0.053	7.09	0
Avg/Tot	41.664	42.956	0.17	0.17	2.29	70		1.79	69		97	0.070	100	100								350.0				71	84	74	66	-0.064		

Wood Heater Lab Data

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Run #: 1
Date: 6/9/20

Equipment Numbers:

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	T244S	102.5	100.0	2.5
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: 2.5

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	T253AP	203.5	198.3	5.2
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe	OES4	114149.1	114148.2	0.9
E. Filter seals catch*	Seals	R982	3371.9	3371.8	0.1

Sub-Total Total Particulate, mg: 6.2

Train 1 Aggregate Total Particulate, mg: **8.7**

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	T253BP	201.8	197.9	3.9
B. Rear filter catch	Filter	T249S	101.6	99.0	2.6
C. Probe catch*	Probe	OES5	113572.3	113570.8	1.5
D. Filter seals catch*	Seals	R983	4114.0	4112.3	1.7

Total Particulate, mg: **9.7**

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter	D1025	118.5	118.6	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: 

Wood Heater Test Results

Manufacturer: Kuma Stoves
Model: K250 Series
Project No.: 0123WN012E
Tracking No.: 2406
Run: 1
Test Date: 06/09/20

Burn Rate	**2.73 kg/hr dry**
Average Tunnel Temperature	97 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.86 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11162.5 dscf/hour
Average Delta p	0.070 inches H20
Total Time of Test	249 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	43.544 cubic feet	41.664 cubic feet	42.956 cubic feet	9.926 cubic feet
Average Gas Meter Temperature	66 degrees Fahrenheit	70 degrees Fahrenheit	69 degrees Fahrenheit	66 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	42.320 dscf	39.263 dscf	40.429 dscf	9.422 dscf
Total Particulates - m_n	0 mg	8.7 mg	9.7 mg	2.5 mg
Particulate Concentration (dry-standard) - C_r/C_s	0.000000 grams/dscf	0.00022 grams/dscf	0.00024 grams/dscf	0.00027 grams/dscf
Total Particulate Emissions - E_T	0.00 grams	10.26 grams	11.11 grams	2.96 grams
Particulate Emission Rate	0.00 grams/hour	2.47 grams/hour	2.68 grams/hour	2.96 grams/hour
Emissions Factor		0.91 g/kg	0.98 g/kg	0.95 g/kg
Difference from Average Total Particulate Emissions		0.42 grams	0.42 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS

Complete Test Run	
Total Particulate Emissions - E_T	10.69 grams
Particulate Emission Rate	**2.58 grams/hour**
Emissions Factor	0.94 grams/kg
First Hour Emissions	
Total Particulate Emissions - E_T	2.96 grams
Particulate Emission Rate	2.96 grams/hour
Emissions Factor	0.95 grams/kg
7.5% of Average Total Particulate Emissions	0.80 grams

QUALITY CHECKS

Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	NOT ACCEPTABLE
Leakage Rate	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	OK
Gram per Kilogram <0.50	0.07
Train Precision ≤ 7.5%	5.96

Technician Signature:_____

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 1
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: A Davis
OMNI Equipment ID numbers:

Wood Heater Supplemental Data

Start Time: 1108
Stop Time: 1517

Booth #: N/A

Stack Gas Leak Check:
Initial: good Final: good

Sample Train Leak Check:
A: 0.0 @ 11 "Hg
B: 0.0 @ 12 "Hg

Calibrations: Span Gas CO_2: 12.4 CO: 2.48

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	1035	1035	1546	1545
CO_2	0.00	12.48	0.06	12.33
CO	0.00	2.49	0.026	2.47

Air Velocity (ft/min): Initial: 450 Final: 450
Scale Audit (lbs): Initial: 10.0 Final: 10.0
Pitot Tube Leak Test: Initial: good Final: good
Stack Diameter (in): 6
Induced Draft: 0.0
% Smoke Capture: 100%
Flue Pipe Cleaned Prior to First Test in Series:
Date: 6/6/20 Initials: AD

	Initial	Middle	Ending
P_b (in/Hg)	28.50		28.50
RH (%)			
Ambient (°F)	59		70

Tunnel Traverse

Microtector Reading	dP (in H_2O)	T(°F)
	.065	59
	.070	59
	.072	59
	.070	59
	.062	59
	.067	59
	.073	59
	.070	59
Center:		
	.074 .0744	59

Tunnel Static Pressure (in H_2O):	
Beginning of Test	End of Test
-.044	-.044

Background Filter Volume: 43.544

Technician Signature:

Date: 6/17/2020

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 1
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: BQ Jones
OMNI Equipment ID numbers:

Wood Heater Run Notes

Air Control Settings

Primary: Fully open

Secondary: ~~N/A~~ fixed

Tertiary/Pilot: N/A

Fan: On High

Preburn Notes

Time	Notes
Ø	Torch used for 22 seconds, bypass closed at 15 min. door closed at 30 seconds. Fan off Top down burn

Test Notes

Sketch test fuel configuration: See photo

Start up procedures & Timeline:

Bypass: closed @ 75 seconds
Fuel loaded by: 70 seconds
Door closed at: 70 seconds
Primary air: Fully open entire test
Notes: FAN on High 73 minutes into test

Time	Notes
60	Changed front filter in target A
83	Changed front filter in target B

Technician Signature: BQ Date: 6/17/2020

Run 1

High Burn 1-minute data

Efficiency and Heat Output Results
Kindling and start-up fuel removed from calculations

Wood Heater Test Data
High Burn Efficiency Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 180 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: #DIV/0! ft/sec.
Initial Tunnel Flow: #DIV/0! scfm
Average Tunnel Flow: #DIV/0! scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 22.01 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										"H2O
Temp:										°F

V_{stav} ft/sec V_{scent} ft/sec F_p

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
0															22.1		571	218	405	384	412	398	691	435	85	68	83	72	63	-0.061	5.47	0.11
1															21.8		563	224	408	387	414	399	848	407	84	68	83	72	63	-0.070	5.6	0.15
2															21.6		567	230	411	389	415	402	917	418	84	68	83	72	63	-0.070	8.21	0.03
3															21.5		570	235	412	389	415	404	932	426	84	68	83	72	62	-0.072	8.93	0.03
4															21.3		564	240	412	389	415	404	938	429	84	68	83	72	62	-0.073	9.8	0.03
5															21.1		549	244	407	389	417	401	933	423	83	68	83	72	63	-0.071	9.72	0.03
6															21.0		539	248	400	389	417	399	947	421	83	68	83	72	62	-0.071	9.72	0.03
7															20.8		532	251	390	388	416	395	960	422	83	68	83	72	62	-0.072	10.15	0.03
8															20.6		526	254	381	387	414	392	955	423	83	69	83	72	62	-0.071	10.1	0.04
9															20.4		518	256	372	386	412	389	941	418	83	69	83	72	62	-0.071	10.81	0.03
10															20.3		511	258	364	385	409	385	928	415	83	69	83	72	63	-0.069	10.88	0.02
11															20.1		505	259	358	384	407	383	924	410	83	69	82	72	63	-0.069	10.96	0.02
12															19.9		498	260	352	383	405	380	921	409	83	69	82	72	63	-0.069	10.7	0.02
13															19.8		495	260	346	382	403	377	928	408	83	69	81	73	63	-0.070	10.74	0.02
14															19.6		492	260	341	382	400	375	932	406	83	69	80	73	63	-0.069	10.79	0.02
15															19.5		490	261	336	382	398	373	941	406	83	69	80	73	63	-0.069	10.79	0.02
16															19.3		489	261	331	382	396	372	945	406	83	69	81	73	63	-0.069	10.78	0.02
17															19.1		489	260	327	382	394	370	948	408	83	70	81	73	63	-0.069	10.97	0.02
18															18.9		490	260	323	382	392	369	955	407	83	70	81	74	64	-0.069	10.86	0.02
19															18.8		491	260	320	383	389	369	959	406	83	70	81	74	64	-0.069	10.66	0.02
20															18.6		492	260	316	384	388	368	972	408	83	70	82	74	64	-0.070	10.67	0.02
21															18.5		495	260	313	384	386	368	982	409	83	70	82	74	64	-0.069	10.7	0.03
22															18.3		497	259	311	384	384	367	988	409	83	70	82	74	64	-0.069	10.72	0.03
23															18.2		500	259	309	384	382	367	999	410	83	70	82	74	64	-0.070	10.68	0.03
24															18.0		503	258	308	384	381	367	1000	415	83	70	82	74	64	-0.068	10.71	0.04
25															17.8		504	258	309	384	379	367	989	414	83	70	83	74	65	-0.067	10.97	0.04
26															17.7		505	258	310	383	378	367	980	413	83	70	83	75	65	-0.069	10.73	0.04
27															17.5		503	257	312	382	377	366	964	410	83	71	83	75	64	-0.068	10.5	0.03
28															17.3		500	257	314	382	375	366	953	408	83	71	83	75	65	-0.068	10.54	0.03
29															17.2		499	257	316	381	374	365	953	408	83	71	83	75	65	-0.068	10.67	0.03
30															17.0		498	257	319	381	372	365	956	408	83	71	83	75	65	-0.069	10.64	0.03
31															16.9		496	257	322	380	371	365	945	407	83	71	84	75	65	-0.068	10.47	0.03
32															16.7		493	257	325	380	371	365	935	406	83	71	84	75	65	-0.068	10.35	0.02
33															16.5		489	257	327	379	370	364	926	404	83	71	84	75	65	-0.068	10.38	0.02

Wood Heater Test Data
High Burn Efficiency Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 180 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: #DIV/0! ft/sec.
Initial Tunnel Flow: #DIV/0! scfm
Average Tunnel Flow: #DIV/0! scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 22.01 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										"H2O
Temp:										°F

V_{stav} ft/sec V_{scent} ft/sec F_p

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
34															16.4		486	257	330	378	370	364	927	405	83	71	84	75	65	-0.071	10.54	0.02
35															16.2		484	257	332	378	370	364	922	406	83	71	84	75	65	-0.068	11.17	0.02
36															16.0		485	258	333	378	371	365	947	412	83	71	84	75	65	-0.072	11.91	0.02
37															15.8		490	258	333	379	371	366	980	419	83	71	84	75	65	-0.076	12.03	0.05
38															15.6		498	259	333	379	371	368	1019	422	83	71	84	75	65	-0.070	12.08	0.08
39															15.5		504	259	332	380	371	369	1018	426	83	72	84	76	65	-0.074	12.34	0.05
40															15.3		510	260	331	380	371	370	1027	426	83	72	84	76	65	-0.067	12.57	0.05
41															15.1		515	260	330	381	371	371	1028	426	83	72	84	76	65	-0.068	12.84	0.07
42															15.0		519	261	329	381	371	372	1039	430	83	72	84	76	66	-0.077	13.05	0.09
43															14.8		525	261	328	382	371	373	1043	430	83	72	84	76	66	-0.076	12.92	0.07
44															14.6		531	261	328	382	372	375	1051	428	83	72	84	76	66	-0.068	12.65	0.08
45															14.4		533	261	328	383	372	375	1015	424	83	72	84	76	66	-0.071	12.39	0.05
46															14.2		531	261	328	384	372	375	1011	423	83	72	84	76	66	-0.070	12.56	0.01
47															14.1		528	261	328	385	373	375	996	416	84	72	84	76	66	-0.069	12.79	0.01
48															13.9		526	261	327	386	373	375	994	415	84	72	84	76	66	-0.072	12.85	0
49															13.7		545	262	328	387	374	379	1110	426	84	72	84	76	66	-0.073	12.61	0.06
50															13.5		545	262	328	388	375	380	1025	421	84	73	84	77	66	-0.070	12.11	0.02
51															13.3		545	262	328	389	375	380	1015	420	84	73	84	77	66	-0.071	12.03	0.02
52															13.2		542	262	328	391	375	380	997	417	84	73	84	77	66	-0.070	12.07	0.02
53															13.1		542	262	329	393	375	380	991	414	84	73	84	77	66	-0.068	12.13	0.04
54															12.9		540	262	330	395	376	381	990	415	84	73	84	77	66	-0.069	12.22	0.05
55															12.7		540	262	332	397	376	381	998	414	84	73	84	77	65	-0.068	12.36	0.08
56															12.6		539	262	333	400	378	382	989	412	84	73	84	77	66	-0.069	12.37	0.03
57															12.4		536	263	334	403	379	383	980	412	84	73	84	77	66	-0.070	12.29	0.03
58															12.3		533	263	336	405	380	383	967	409	84	73	84	77	66	-0.068	12.29	0.02
59															12.0		531	263	337	408	382	384	959	409	84	73	84	77	66	-0.070	12.34	0.02
60															11.9		526	263	339	411	384	385	941	405	84	73	84	77	66	-0.068	12.26	0.01
61															11.7		523	263	341	414	386	385	933	402	84	74	84	78	66	-0.067	12.23	0.01
62															11.6		520	264	342	417	388	386	937	401	84	74	84	78	66	-0.066	12.33	0.01
63															11.4		518	264	344	419	390	387	931	402	84	74	84	78	66	-0.068	12.39	0.01
64															11.2		517	264	346	422	391	388	934	400	84	74	84	78	66	-0.066	12.55	0.01
65															11.1		516	264	348	424	393	389	934	401	84	74	84	78	66	-0.066	12.67	0.01
66															10.9		516	265	350	427	395	391	934	398	84	74	84	78	67	-0.066	12.87	0.01
67															10.8		516	265	352	429	398	392	937	400	84	74	84	78	67	-0.065	13.02	0

Wood Heater Test Data
High Burn Efficiency Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 180 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: #DIV/0! ft/sec.
Initial Tunnel Flow: #DIV/0! scfm
Average Tunnel Flow: #DIV/0! scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 22.01 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										"H2O
Temp:										°F

V_{stav} ft/sec V_{scent} ft/sec F_p

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
68															10.6		516	265	355	432	400	394	944	399	84	74	84	78	67	-0.067	13.31	0.01
69															10.4		518	266	357	434	402	395	948	399	84	74	84	78	67	-0.067	13.43	0
70															10.2		521	266	361	436	404	398	966	400	84	74	84	78	67	-0.068	13.74	0.01
71															10.1		526	266	365	438	406	400	985	403	84	74	84	78	67	-0.066	14.08	0.03
72															9.9		529	267	370	441	408	403	971	401	84	74	84	78	67	-0.065	13.92	0.01
73															9.8		529	267	375	443	411	405	958	399	84	75	84	78	67	-0.066	13.36	0.02
74															9.6		529	267	379	445	413	407	947	397	84	75	84	79	67	-0.066	13.05	0.01
75															9.5		529	268	382	447	415	408	949	397	84	75	84	79	67	-0.065	12.84	0
76															9.3		529	268	384	449	418	410	946	396	84	75	84	79	68	-0.067	12.73	0.01
77															9.2		529	268	387	451	420	411	940	394	84	75	84	79	68	-0.066	12.46	0
78															9.0		528	269	390	452	422	412	934	392	84	75	84	79	68	-0.065	11.97	0
79															8.9		525	269	392	454	423	413	930	391	84	75	84	79	68	-0.064	11.49	0
80															8.8		525	270	395	455	425	414	942	392	84	75	84	79	68	-0.064	11.28	0
81															8.7		524	270	397	456	426	415	940	392	84	75	84	79	68	-0.065	11.26	0
82															8.5		523	271	399	457	426	415	935	391	84	75	85	79	68	-0.066	11.22	0
83															8.4		520	271	401	457	426	415	930	390	84	75	84	79	68	-0.066	11.27	0
84															8.3		518	272	402	458	426	415	930	389	84	76	85	79	68	-0.065	11.32	0
85															8.1		516	273	404	459	426	416	926	388	84	76	85	79	68	-0.064	11.42	0
86															8.0		513	274	405	460	426	416	925	387	84	76	85	79	68	-0.064	11.3	0
87															7.9		511	275	406	461	426	416	922	385	84	76	85	80	68	-0.065	11.28	0
88															7.8		509	276	407	462	426	416	923	385	84	76	85	80	68	-0.063	11.32	0
89															7.6		507	277	408	463	426	416	924	385	84	76	85	80	68	-0.063	11.34	0
90															7.5		505	278	409	464	426	416	922	383	84	76	85	80	68	-0.063	11.31	0
91															7.4		503	279	410	465	427	417	915	383	85	76	85	80	68	-0.063	11.34	0
92															7.3		502	280	411	466	427	417	916	381	84	76	85	80	68	-0.064	11.39	0
93															7.2		500	282	412	467	427	418	920	382	84	76	85	80	68	-0.065	11.43	0
94															7.0		500	283	413	468	428	418	929	381	85	76	85	80	68	-0.063	11.43	0
95															6.9		500	285	414	470	428	419	934	380	85	76	85	80	69	-0.063	11.52	0
96															6.8		500	286	415	471	429	420	938	379	85	76	85	80	68	-0.063	11.53	0
97															6.7		501	287	415	472	428	421	938	379	85	76	85	80	68	-0.062	11.46	0
98															6.6		502	288	415	473	428	421	942	378	85	76	85	80	69	-0.063	11.43	0
99															6.4		503	289	415	474	428	422	948	379	85	76	85	80	68	-0.063	11.57	0
100															6.4		504	290	414	476	428	422	954	378	85	76	85	80	69	-0.063	11.67	0
101															6.2		506	291	413	477	427	423	959	380	85	76	85	80	69	-0.063	11.78	0

Wood Heater Test Data
High Burn Efficiency Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 180 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: #DIV/0! ft/sec.
Initial Tunnel Flow: #DIV/0! scfm
Average Tunnel Flow: #DIV/0! scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 22.01 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										"H2O
Temp:										°F

V_{stav} ft/sec V_{scent} ft/sec F_p

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
102															6.1		508	293	413	478	427	424	964	378	85	76	85	80	69	-0.063	11.91	0
103															6.0		510	294	412	480	427	425	967	377	85	76	85	80	68	-0.062	12.04	0
104															5.8		513	295	411	481	427	425	972	378	85	76	85	80	69	-0.063	12.13	0
105															5.7		515	297	410	483	427	426	976	381	85	77	85	80	69	-0.062	12.21	0
106															5.6		517	298	410	484	427	427	979	379	85	77	85	80	69	-0.063	12.31	0
107															5.5		520	299	410	486	427	428	982	380	85	77	85	80	69	-0.063	12.34	0
108															5.4		522	300	409	487	427	429	986	380	85	77	85	80	69	-0.063	12.39	0
109															5.3		525	302	409	488	427	430	990	380	85	77	85	80	69	-0.063	12.51	0
110															5.1		527	303	409	490	428	431	994	382	85	77	85	81	69	-0.063	12.55	0
111															5.0		530	305	409	491	428	433	996	381	85	77	85	81	69	-0.063	12.64	0
112															4.9		532	306	408	492	429	433	998	382	85	77	85	81	69	-0.062	12.76	0
113															4.8		534	308	408	493	430	435	1002	383	85	77	85	81	69	-0.062	12.83	0
114															4.7		537	309	408	495	430	436	1006	383	85	77	85	81	69	-0.062	12.97	0
115															4.5		538	311	408	496	431	437	1001	383	85	77	85	81	69	-0.062	13.18	0
116															4.4		540	312	408	497	432	438	1006	383	85	77	85	81	70	-0.062	13.41	0.01
117															4.3		542	313	409	498	433	439	1005	383	85	77	85	81	70	-0.062	13.33	0.02
118															4.1		541	315	409	500	435	440	985	382	85	77	85	81	70	-0.061	12.73	0
119															4.1		538	316	409	501	436	440	974	378	85	77	85	81	71	-0.061	12.41	0
120															3.9		536	318	409	501	438	440	968	379	85	77	85	81	71	-0.062	12.27	0
121															3.8		533	320	410	502	439	441	959	377	85	77	85	81	71	-0.061	12.21	0
122															3.7		532	321	410	503	441	441	969	376	85	77	85	81	71	-0.060	12.22	0
123															3.6		531	322	410	504	442	442	971	374	85	77	85	81	70	-0.060	12.08	0
124															3.5		531	324	410	504	443	442	971	376	85	77	85	81	71	-0.059	11.91	0
125															3.4		530	326	409	505	445	443	976	376	85	77	85	80	70	-0.061	11.69	0
126															3.3		530	327	409	505	446	443	973	373	85	77	86	80	71	-0.060	11.23	0
127															3.2		529	329	408	505	447	444	974	373	85	77	86	80	71	-0.060	11.05	0
128															3.2		527	330	408	505	448	444	969	374	85	77	86	80	71	-0.060	10.98	0
129															3.1		526	332	407	506	448	444	970	372	85	77	86	80	71	-0.060	10.86	0
130															3.0		525	333	406	506	449	444	975	373	85	77	86	80	71	-0.061	10.93	0
131															2.9		524	334	406	506	450	444	975	373	85	76	86	80	71	-0.060	10.94	0
132															2.8		522	336	405	507	450	444	971	372	85	76	86	80	71	-0.060	10.97	0
133															2.7		521	337	405	508	451	444	969	371	85	76	86	80	71	-0.060	11.04	0
134															2.6		519	339	405	508	451	444	961	370	85	76	86	79	71	-0.060	11.08	0
135															2.5		516	340	404	509	452	444	955	369	86	76	86	79	71	-0.060	11.08	0

Wood Heater Test Data
High Burn Efficiency Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 180 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.50 Middle End 28.5 Average 28.50

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: #DIV/0! ft/sec.
Initial Tunnel Flow: #DIV/0! scfm
Average Tunnel Flow: #DIV/0! scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 22.01 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										"H2O
Temp:										°F

V_{stav} ft/sec V_{scent} ft/sec F_p

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
136															2.4		514	342	404	511	452	445	951	369	86	76	86	79	71	-0.060	11.04	0
137															2.3		511	343	404	512	453	445	940	368	86	76	86	79	71	-0.059	10.98	0
138															2.2		507	345	404	513	453	444	931	366	86	76	86	79	71	-0.059	10.83	0
139															2.2		502	346	404	514	454	444	916	364	86	76	86	79	70	-0.058	10.46	0
140															2.1		497	348	404	516	454	444	908	361	86	75	86	78	71	-0.058	10	0
141															2.0		492	349	404	517	455	443	899	358	86	75	86	78	69	-0.058	9.76	0
142															2.0		486	351	403	518	455	443	890	355	86	75	86	78	71	-0.058	9.48	0
143															1.9		481	352	403	519	456	442	883	353	85	75	86	78	70	-0.058	9.33	0
144															1.8		477	354	402	520	456	442	879	352	85	75	86	77	70	-0.057	9.16	0
145															1.7		473	355	401	521	457	441	879	352	85	75	86	77	70	-0.057	9.08	0
146															1.7		469	356	400	521	457	441	876	351	85	75	86	77	71	-0.057	8.96	0
147															1.6		466	358	398	521	457	440	873	352	85	75	86	77	70	-0.057	8.92	0
148															1.6		463	359	396	520	457	439	870	352	85	74	86	77	70	-0.058	8.89	0
149															1.5		461	360	394	520	457	438	870	352	85	74	86	76	70	-0.057	8.79	0
150															1.4		458	362	392	519	457	438	868	353	85	74	85	76	70	-0.057	8.86	0
151															1.4		457	364	390	518	457	437	866	351	85	74	85	76	71	-0.057	8.88	0
152															1.3		453	365	388	516	458	436	855	348	85	74	85	76	70	-0.056	8.63	0
153															1.2		450	366	386	515	458	435	850	349	85	74	85	75	70	-0.057	8.66	0
154															1.2		445	367	384	513	459	434	839	345	85	74	85	75	70	-0.054	8.59	0
155															1.1		441	368	382	511	460	432	834	342	85	74	85	75	71	-0.056	8.59	0
156															1.1		438	369	380	509	461	431	830	340	85	73	85	75	70	-0.056	8.69	0
157															1.0		433	370	377	508	463	430	812	339	85	73	85	75	70	-0.055	8.71	0
158															0.9		429	371	375	506	465	429	807	336	85	73	85	75	70	-0.055	8.77	0
159															0.8		426	371	373	504	467	428	810	335	85	73	85	74	70	-0.054	8.98	0
160															0.8		424	372	371	502	469	428	817	335	85	73	85	74	70	-0.055	9.16	0
161															0.7		423	372	369	501	471	427	818	335	84	73	85	74	71	-0.055	9.27	0
162															0.7		422	373	367	499	474	427	823	335	84	72	84	74	70	-0.055	9.38	0
163															0.6		422	373	366	498	476	427	820	333	84	72	84	74	70	-0.055	9.19	0
164															0.5		420	373	364	496	479	426	813	332	84	72	84	74	70	-0.055	8.94	0
165															0.5		418	373	362	495	481	426	802	330	84	72	84	73	70	-0.055	8.36	0
166															0.5		415	373	361	493	484	425	797	329	84	72	84	73	70	-0.054	7.93	0
167															0.4		412	373	359	492	485	424	793	326	84	72	84	73	70	-0.054	7.57	0
168															0.4		410	372	357	490	486	423	786	327	84	72	84	73	70	-0.055	7.4	0
169															0.4		407	372	355	489	486	422	781	328	84	72	84	73	70	-0.053	7.4	0

Wood Heater Test Data
High Burn Efficiency Data

Run: 1

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E
Test Date: 09-Jun-20
Beginning Clock Time: 11:08

Total Sampling Time: 180 min
Recording Interval: 1 min
Background Sample Volume: 43.544 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure:	Begin	Middle	End	Average
	28.50		28.5	28.50 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: #DIV/0! ft/sec.
Initial Tunnel Flow: #DIV/0! scfm
Average Tunnel Flow: #DIV/0! scfm
Post-Test Leak Check (1): 0.000 cfm @ 11 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 12 in. Hg
Average Test Piece Fuel Moisture: 22.01 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										"H2O
Temp:										°F

V_{stav} ft/sec V_{scent} ft/sec F_p

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
170															0.3		405	372	353	487	486	421	781	326	84	71	84	72	70	-0.054	7.35	0
171															0.3		403	371	352	486	486	420	781	326	84	71	84	72	70	-0.054	7.25	0
172															0.2		401	371	350	484	485	418	780	326	84	71	84	72	70	-0.054	7.29	0
173															0.2		398	371	348	483	484	417	777	325	84	71	84	72	70	-0.054	7.25	0
174															0.2		396	370	346	481	483	415	774	324	84	71	84	72	70	-0.054	7.24	0
175															0.1		393	370	345	480	481	414	768	323	84	71	83	72	70	-0.054	7.24	0
176															0.1		390	370	343	478	480	412	761	321	84	71	83	72	70	-0.053	7.16	0
177															0.0		387	370	342	477	479	411	756	321	84	71	83	72	70	-0.053	7.07	0
178															0.0		385	370	341	476	477	410	754	319	84	71	83	71	70	-0.053	7.06	0
179															0.0		382	369	340	474	476	408	752	317	84	70	83	71	70	-0.053	7.08	0
180															0.0		380	370	339	473	474	407	751	317	84	70	83	71	70	-0.053	7.09	0
Avg/Tot	0.000	0.000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!								9.2				73	84	77	68	-0.064		

Wood Heater Test Results

Manufacturer: Kuma Stoves
Model: K250 Series
Project No.: 0123WN012E
Tracking No.: 2406
Run: 1
Test Date: 06/09/20

Burn Rate	**2.68 kg/hr dry**
Average Delta p	
Total Time of Test	180 minutes

	FINAL AVERAGE RESULTS
Complete Test Run	
Total Particulate Emissions - E_T	
Particulate Emission Rate	
Emissions Factor	
First Hour Emissions	
Total Particulate Emissions - E_T	
Particulate Emission Rate	
Emissions Factor	
7.5% of Average Total Particulate Emissions	

	QUALITY CHECKS
Filter Temps < 90 °F	OK
Filter Face Velocity (47 mm)	OK
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK

Technician Signature: _____

Wood Heater Efficiency Results - CSA B415.1

Manufacturer: Kuma Stoves
Model: K250 Series
Date: 06/09/20
Run: 1
Control #: 0123WN012E
Test Duration: 180
Output Category: IV

Technician Signature: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	74.8%	81.1%
Combustion Efficiency	99.5%	99.5%
Heat Transfer Efficiency	75%	81.5%

Output Rate (kJ/h)	36,023	34,172	**(Btu/h)**
Burn Rate (kg/h)	2.74	6.04	**(lb/h)**
Input (kJ/h)	48,161	45,686	**(Btu/h)**

Test Load Weight (dry kg)	8.22	18.11	**dry lb**
MC wet (%)	18.03726572		
MC dry (%)	22.01		
Particulate (g)	#DIV/0!		
CO (g)	15		
Test Duration (h)	3.00		

Emissions	Particulate	CO
g/MJ Output	#DIV/0!	0.14
g/kg Dry Fuel	#DIV/0!	1.83
g/h	#DIV/0!	5.02
lb/MM Btu Output	#DIV/0!	0.32

Air/Fuel Ratio (A/F)	10.37

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

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 1
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: A Davis
OMNI Equipment ID numbers:

Wood Heater Supplemental Data

Start Time: 1108
Stop Time: 1517

Booth #: N/A

Stack Gas Leak Check:
Initial: good Final: good

Sample Train Leak Check:
A: 0.0 @ 11 "Hg
B: 0.0 @ 12 "Hg

Calibrations: Span Gas CO_2: 12.4 CO: 2.48

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	1035	1035	1546	1545
CO_2	0.00	12.48	0.06	12.33
CO	0.00	2.49	0.026	2.47

Air Velocity (ft/min): Initial: 450 Final: 450
Scale Audit (lbs): Initial: 10.0 Final: 10.0
Pitot Tube Leak Test: Initial: good Final: good
Stack Diameter (in): 6
Induced Draft: 0.0
% Smoke Capture: 100%
Flue Pipe Cleaned Prior to First Test in Series:
Date: 6/6/20 Initials: AD

	Initial	Middle	Ending
P_b (in/Hg)	28.50		28.50
RH (%)			
Ambient (°F)	59		70

Tunnel Traverse

Microtector Reading	dP (in H_2O)	T(°F)
	.065	59
	.070	59
	.072	59
	.070	59
	.062	59
	.067	59
	.073	59
	.070	59
Center:		
	.074 .0744	59

Tunnel Static Pressure (in H_2O):	
Beginning of Test	End of Test
-.044	-.044

Background Filter Volume: 43.544

Technician Signature:

Date: 6/17/2020

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 1
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: BJ Adams
OMNI Equipment ID numbers:

Wood Heater Run Notes

Air Control Settings

Primary: Fully open

Secondary: ~~N/A~~ fixed

Tertiary/Pilot: N/A

Fan: On High

Preburn Notes

Time	Notes
Ø	Torch used for 22 seconds, bypass closed at 15 min. door closed at 30 seconds. Fan off Top down burn

Test Notes

Sketch test fuel configuration:

See photo

Start up procedures & Timeline:

Bypass: closed @ 75 seconds
Fuel loaded by: 70 seconds
Door closed at: 70 seconds
Primary air: Fully open entire test
Notes: FAN on High 73 minutes into test

Time	Notes
60	Changed front filter in target A
83	Changed front filter in target B

Technician Signature: BJ Adams Date: 6/17/2020

Adjunct to ASTM E XXXX Wood Heater Cordwood Test Method - May 10, 2017 Version

Cordwood Fuel Load Calculators - 10 lb/ft^3 Nominal Load Density

Core 45-65% of Total Load Weight, Remainder 35-55% of Total Load Weight

Values to be input manually

For All Usable Firebox Volumes - High Fire Test Only

Nominal Required Load Density (wet basis)	10	lb/ft^3			
Usable Firebox Volume	2.50	ft^3			
Total Nom. Load Wt. Target	25.00	lb			
Total Load Wt. Allowable Range	23.80	to 26.30	lb		
Core Target Wt. Allowable Range	11.30	to 16.30	lb		
Remainder Load Wt. Allowable Range	8.80	to 13.80	lb		
					Mid-Point
Core Load Pc. Wt. Allowable Range	3.80	to 6.30	lb		5.05
Remainder Load Pc. Wt. Allowable Range	2.50	to 13.80	lb		8.15
	Pc. #				
Core Load Piece Wt. Actual	1	4.09	lb	In Range	
	2	4.01	lb	In Range	
	3	6.14	lb	In Range	
Core Load Total. Wt. Actual		14.23	lb	In Range	
	Pc. #				
Remainder Load Piece Wt.	1	3.29	lb	In Range	
(1 to 3 Pcs.)	2	7.01	lb	In Range	
	3		lb	NA	
Remainder Load Tot. Wt. Act		10.29	lb	In Range	
Total Load Wt. Actual		24.53	lb	In Range	
Core % of Total Wt.		58%		In Range	45-65%
Remainder % of Total Wt.		42%		In Range	35-55%
Actual Load % of Nominal Target		98%		In Range	95-105%
Actual Fuel Load Density		9.8	lb/ft^3		
Kindling and Start-up Fuel					
Maximim Kindling Wt. (20% of Tot. Load Wt.)		4.91	lb		
Actual Kindling Wt.		4.90	lb	In Range	20.0%
Maximum Start-up Fuel Wt. (30% of Tot. Load Wt.)		7.36	lb		
Actual Start-up Fuel Wt.		7.36	lb	In Range	30.0%
Allowable Residual Start-up Fuel Wt. Range	2.5	to 4.9	lb		Mid-Point
Actual Residual Start-up Fuel Wt.		3.2	lb	In Range	3.7
Total Wt. All Fuel Added (wet basis)		36.79	lb		
High Fire Test Run End Point Range	Low		High		Mid-Point
Based on Fuel Load Wt. (w/tares)	2.2	to	2.7	lb	2.5
Actual Fuel Load Ending Wt.		2.4	lb	In Range	

Fuel Piece Moisture Reading (%-dry basis)

1	2	3	Ave.		Pc. Wt. Dry Basis		
21.8	21.6	21.8	21.7	In Range	3.36	lb	1.52 kg
20.2	20.8	22.3	21.1	In Range	3.31	lb	1.50 kg
25.8	24.1	25.5	25.1	In Range	4.90	lb	2.22 kg
21.7	22.2	21.7	21.9	In Range	2.70	lb	1.22 kg
19.7	21.5	19.4	20.2	In Range	5.83	lb	2.64 kg
			NA	NA	NA	lb	NA kg
Total Load Ave. MC (%-dry basis)			22.0	In Range			
Total Load Ave. MC % (wet basis)			18.1				
Total Test Load Weight (dry basis) →					20.10	lb	9.12 kg
Kindling Moisture (%-dry basis)							
11.7	11.7	11.7	11.7	In Range	4.39	lb	1.99 kg
Start-up Fuel Moisture Readings (%-dry basis)							
21.1	21.1	21.1	21.1	In Range	6.08	lb	2.76 kg
Total Wt. All Fuel Added (dry basis) →					30.57	lb	13.86 kg
Total Wt. All Fuel Burned (dry basis) →					25.0	lb	11.3 kg

Run 2

Low Burn

Wood Heater Test Data
High Burn Emissions Data

Run: 2

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E.FREV 001
Test Date: 09-Jun-20
Beginning Clock Time: 15:52

Total Sampling Time: 730 min
Recording Interval: 10 min
Background Sample Volume: 128.196 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.49 Middle End 28.45 Average 28.47 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.57 ft/sec.
Initial Tunnel Flow: 192.9 scfm
Average Tunnel Flow: 189.2 scfm
Post-Test Leak Check (1): 0.000 cfm @ 6 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 6 in. Hg
Average Test Piece Fuel Moisture: 21.75 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	0.065	0.070	0.072	0.070	0.070	0.072	0.066	0.064	0.074	"H2O
Temp:	82	82	82	82	82	82	82	82	82	°F

V_{stray} 18.10 ft/sec V_{scent} 18.72 ft/sec F_p 0.967

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)															Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
0	0.000	0.000			2.52	73	-2.93	1.93	72	-2.2	79	0.070			29.1		313	371	278	419	407	358	678	181	85	64	82	65	69	-0.031	8.52	0.03
10	1.674	1.736	0.17	0.17	2.25	74	-2.66	1.80	72	-2.2	94	0.070	101	102	28.2	-0.93	389	343	300	396	387	363	828	339	81	66	85	65	68	-0.059	7.41	0.01
20	3.340	3.467	0.17	0.17	2.25	74	-3.11	1.79	72	-1.9	88	0.070	100	102	27.4	-0.81	440	336	296	368	357	359	722	256	84	66	85	66	68	-0.048	5.55	0
30	5.009	5.194	0.17	0.17	2.28	74	-3.02	1.78	73	-2.2	84	0.070	100	101	27.0	-0.42	393	329	284	342	330	336	668	225	86	66	83	67	68	-0.044	5.66	0
40	6.678	6.921	0.17	0.17	2.25	74	-2.85	1.78	73	-2.1	80	0.070	100	100	26.5	-0.45	310	318	222	321	304	295	652	203	86	67	81	68	69	-0.038	5.78	0.01
50	8.348	8.648	0.17	0.17	2.26	74	-3.14	1.77	73	-1.9	79	0.070	100	100	26.1	-0.40	270	309	199	297	277	270	610	186	84	67	85	69	69	-0.034	5.48	0.01
60	10.021	10.375	0.17	0.17	2.25	74	-2.93	1.77	73	-2	78	0.080	93	94	25.8	-0.36	252	300	187	278	257	255	615	179	83	68	87	69	68	-0.032	5.58	0.01
70	11.693	12.101	0.17	0.17	2.27	74	-2.88	1.79	73	-2	77	0.070	100	100	25.4	-0.37	241	291	179	264	244	244	601	174	80	68	84	69	68	-0.032	5.56	0.02
80	13.365	13.829	0.17	0.17	2.26	74	-2.94	1.78	73	-2	76	0.070	100	100	25.1	-0.34	235	282	173	254	235	236	614	172	80	68	83	69	68	-0.031	5.9	0.02
90	15.033	15.559	0.17	0.17	2.24	74	-2.96	1.78	73	-2.1	77	0.070	99	100	24.5	-0.52	276	273	167	250	232	240	779	195	81	68	82	69	69	-0.037	8.72	0.03
100	16.697	17.287	0.17	0.17	2.22	75	-2.95	1.77	73	-2.2	79	0.070	99	100	23.9	-0.69	326	265	164	250	235	248	840	212	81	68	83	69	69	-0.041	9.27	0.03
110	18.362	19.014	0.17	0.17	2.25	75	-2.87	1.78	73	-2.2	79	0.070	99	100	23.1	-0.74	362	259	167	251	240	256	885	225	82	68	82	69	69	-0.043	9.86	0.03
120	20.028	20.741	0.17	0.17	2.25	75	-2.76	1.76	73	-1.9	80	0.070	99	100	22.3	-0.77	390	256	171	254	247	264	925	232	82	69	81	70	69	-0.043	10.32	0.03
130	21.694	22.464	0.17	0.17	2.25	75	-2.94	1.77	73	-2.2	81	0.070	99	100	21.6	-0.78	409	255	178	257	254	271	928	237	83	69	87	70	69	-0.044	10.32	0.03
140	23.360	24.189	0.17	0.17	2.23	75	-2.82	1.77	74	-2	82	0.070	100	100	20.8	-0.74	400	255	185	261	261	272	886	233	83	69	88	70	69	-0.044	9.51	0.03
150	25.026	25.913	0.17	0.17	2.28	75	-2.82	1.77	74	-2.1	82	0.070	100	100	20.1	-0.68	387	256	189	264	266	272	865	228	83	69	87	70	69	-0.043	9.3	0.03
160	26.705	27.637	0.17	0.17	2.27	75	-2.83	1.77	74	-1.9	81	0.070	100	100	19.5	-0.62	370	258	193	268	270	272	828	222	83	69	88	70	69	-0.042	8.96	0.03
170	28.383	29.362	0.17	0.17	2.28	75	-3	1.79	74	-2.2	81	0.070	100	100	18.9	-0.64	360	259	195	271	273	272	824	219	84	69	88	70	69	-0.040	9.11	0.03
180	30.083	31.087	0.17	0.17	2.27	75	-3.12	1.77	74	-1.9	81	0.070	100	100	18.3	-0.61	365	261	197	275	276	275	842	220	84	70	87	70	70	-0.041	9.32	0.03
190	31.742	32.813	0.17	0.17	2.27	75	-3.13	1.77	74	-2.2	81	0.070	100	100	17.6	-0.66	374	262	201	283	278	280	856	222	84	70	86	70	70	-0.042	9.6	0.03
200	33.421	34.539	0.17	0.17	2.29	75	-3.07	1.77	74	-2	81	0.070	100	100	16.9	-0.65	379	264	206	293	280	284	856	222	84	70	86	70	70	-0.042	9.72	0.03
210	35.100	36.264	0.17	0.17	2.27	75	-2.8	1.77	74	-2	81	0.070	100	100	16.3	-0.66	384	266	211	303	284	290	863	223	84	70	86	70	70	-0.042	9.79	0.03
220	36.779	37.990	0.17	0.17	2.27	76	-3.13	1.78	74	-2.1	81	0.070	100	100	15.7	-0.61	384	269	215	311	285	293	850	221	84	69	86	70	70	-0.040	9.54	0.02
230	38.458	39.716	0.17	0.17	2.29	76	-2.89	1.78	74	-2.1	81	0.070	100	100	15.1	-0.61	381	272	219	318	288	296	850	220	84	69	86	70	70	-0.040	9.67	0.02
240	40.140	41.442	0.17	0.17	2.30	76	-3.22	1.78	74	-2	82	0.070	100	100	14.4	-0.67	398	275	227	325	288	303	895	226	84	70	86	70	70	-0.041	10.32	0.02
250	41.821	43.167	0.17	0.17	2.28	76	-2.96	1.77	74	-1.9	82	0.070	100	100	13.7	-0.68	416	278	239	332	287	310	908	229	84	70	86	70	70	-0.042	10.37	0.02
260	43.502	44.892	0.17	0.17	2.29	76	-3.21	1.77	74	-2	82	0.070	100	100	13.1	-0.57	395	281	250	339	285	310	841	218	84	70	86	69	70	-0.038	9.63	0.01
270	45.185	46.619	0.17	0.17	2.29	76	-3.21	1.77	75	-2.2	81	0.070	100	100	12.6	-0.55	377	283	259	343	284	309	815	214	84	70	87	69	70	-0.036	9.39	0.01
280	46.868	48.344	0.17	0.17	2.28	76	-3.14	1.78	75	-2.1	81	0.070	100	100	12.1	-0.51	366	286	268	343	282	309	797	210	83	69	87	69	70	-0.036	9.08	0.02
290	48.550	50.071	0.17	0.17	2.29	76	-2.83	1.78	75	-2	80	0.070	100	100	11.5	-0.54	368	288	274	341	281	310	813	210	83	69	87	69	70	-0.035	9.19	0.02
300	50.233	51.797	0.17	0.17	2.29	76	-3.09	1.78	75	-2.2	80	0.070	100	100	11.0	-0.51	370	289	275	339	280	311	821	209	83	69	86	69	70	-0.036	9.34	0.02
310	51.917	53.523	0.17	0.17	2.30	76	-2.94	1.77	75	-1.9	80	0.070	100	100	10.5	-0.51	379	289	274	339	280	312	852	211	83	69	86	69	70	-0.036	9.64	0.02
320	53.601	55.249	0.17	0.17	2.29	76	-3.18	1.76	75	-2.2	80	0.070	100	100	10.0	-0.51	393	289	276	338	279	315	877	214	83	69	86	69	70	-0.036	9.65	0.02
330	55.284	56.973	0.17	0.17	2.29	76	-3.14	1.79	75	-2.1	81	0.070	100	100	9.4	-0.64	441	289	276	339	279	325	1052	230	83	69	86	69	70	-0.041	11.95	0.04
340	56.966	58.698	0.17	0.17	2.29	76	-2.89	1.78	75	-2	83	0.070	100	100	8.6	-0.82	558	288	275	342	279	348	1173	254	83	69	86	69	71	-0.044	13.73	0.06

Wood Heater Test Data
High Burn Emissions Data

Run: 2

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E,FREV 001
Test Date: 09-Jun-20
Beginning Clock Time: 15:52

Total Sampling Time: 730 min
Recording Interval: 10 min
Background Sample Volume: 128.196 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.49 Middle End 28.45 Average 28.47 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.57 ft/sec.
Initial Tunnel Flow: 192.9 scfm
Average Tunnel Flow: 189.2 scfm
Post-Test Leak Check (1): 0.000 cfm @ 6 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 6 in. Hg
Average Test Piece Fuel Moisture: 21.75 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	0.065	0.070	0.072	0.070	0.070	0.072	0.066	0.064	0.074	"H2O
Temp:	82	82	82	82	82	82	82	82	82	°F

V_{stray} 18.10 ft/sec V_{scent} 18.72 ft/sec F_p 0.967

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
350	58.646	60.421	0.17	0.17	2.29	76	-3.03	1.77	75	-2	85	0.070	100	100	7.6	-0.94	636	288	276	346	282	366	1250	268	83	69	87	69	71	-0.049	15.39	1.12
360	60.326	62.143	0.17	0.17	2.28	76	-3.14	1.77	75	-2	84	0.070	100	100	6.7	-0.96	649	287	278	355	290	372	1221	263	84	70	87	69	71	-0.047	14.6	0.69
370	62.006	63.867	0.17	0.17	2.28	76	-2.93	1.77	75	-2.2	83	0.070	100	100	6.2	-0.46	505	286	280	368	298	347	864	229	85	70	88	69	72	-0.038	9.54	0.01
380	63.689	65.592	0.17	0.17	2.29	76	-2.98	1.77	75	-2.1	81	0.070	100	100	5.9	-0.32	398	288	280	382	303	330	764	204	84	70	87	69	72	-0.033	9.28	0.01
390	65.372	67.318	0.17	0.17	2.28	76	-2.96	1.78	75	-1.9	80	0.070	100	100	5.6	-0.30	356	291	280	384	303	323	730	193	84	70	88	69	72	-0.032	9.22	0.01
400	67.056	69.045	0.17	0.17	2.29	76	-3.17	1.78	75	-2.2	79	0.070	100	100	5.3	-0.30	335	294	278	383	304	319	713	187	84	70	87	69	72	-0.030	9.3	0.01
410	68.742	70.771	0.17	0.17	2.28	76	-2.87	1.78	75	-2.2	78	0.070	100	100	5.0	-0.33	331	295	276	379	305	317	727	184	83	69	87	69	72	-0.030	9.35	0.01
420	70.427	72.498	0.17	0.17	2.28	76	-3.05	1.78	75	-2.2	78	0.070	100	100	4.7	-0.25	327	297	274	374	306	316	715	181	83	69	87	69	72	-0.029	9.19	0.01
430	72.113	74.227	0.17	0.17	2.29	76	-2.94	1.78	75	-2.2	78	0.070	100	100	4.4	-0.29	321	298	276	370	306	314	707	178	83	69	86	69	71	-0.027	9.51	0.01
440	73.800	75.955	0.17	0.17	2.30	76	-3.17	1.79	75	-2	78	0.070	100	100	4.2	-0.26	312	300	277	368	308	313	660	172	82	69	86	69	71	-0.025	8.96	0
450	75.487	77.684	0.17	0.17	2.29	76	-2.79	1.78	75	-1.9	77	0.070	100	100	4.0	-0.17	296	303	279	368	308	311	628	165	82	69	86	69	71	-0.022	8.98	0
460	77.175	79.413	0.17	0.17	2.30	76	-2.8	1.78	75	-2.1	77	0.070	100	100	3.8	-0.19	290	307	281	366	308	310	629	161	82	69	86	68	71	-0.021	9.03	0
470	78.862	81.141	0.17	0.17	2.30	76	-3.18	1.79	75	-2	76	0.070	100	100	3.7	-0.15	287	310	281	364	308	310	637	159	81	69	86	68	71	-0.021	8.98	0.01
480	80.550	82.869	0.17	0.17	2.31	76	-2.82	1.78	75	-1.9	76	0.070	100	100	3.5	-0.17	285	313	279	361	308	309	643	158	81	69	85	68	71	-0.020	8.84	0.01
490	82.238	84.598	0.17	0.17	2.30	76	-3.11	1.77	75	-2.1	76	0.070	100	100	3.3	-0.15	281	313	276	357	308	307	638	156	81	69	85	68	71	-0.020	8.67	0.01
500	83.926	86.326	0.17	0.17	2.30	76	-2.79	1.78	75	-2.2	76	0.070	100	100	3.2	-0.15	277	312	273	352	307	304	636	155	81	69	85	68	70	-0.019	8.71	0.01
510	85.615	88.054	0.17	0.17	2.30	76	-2.79	1.78	75	-2.1	76	0.070	100	100	3.1	-0.13	275	311	269	348	308	302	635	154	81	69	87	68	70	-0.020	8.59	0.02
520	87.304	89.782	0.17	0.17	2.30	76	-3.12	1.77	75	-2.2	76	0.070	100	100	2.9	-0.17	274	310	264	344	308	300	632	153	81	69	89	68	70	-0.021	8.43	0.02
530	88.995	91.509	0.17	0.17	2.30	76	-2.78	1.77	75	-1.9	76	0.070	100	100	2.7	-0.16	272	308	260	340	309	298	632	153	80	69	92	68	70	-0.019	8.45	0.02
540	90.686	93.236	0.17	0.17	2.31	76	-2.86	1.78	75	-1.9	76	0.070	100	100	2.5	-0.17	271	306	254	336	313	296	630	154	79	69	94	68	70	-0.020	8.42	0.02
550	92.378	94.963	0.17	0.17	2.29	76	-3.16	1.78	75	-2	76	0.070	100	100	2.4	-0.14	272	304	248	331	316	294	638	154	80	69	93	68	70	-0.019	8.48	0.02
560	94.066	96.689	0.17	0.17	2.29	76	-3.2	1.78	75	-1.9	75	0.070	100	100	2.2	-0.18	270	304	245	327	317	293	630	152	81	69	96	68	70	-0.020	8.23	0.02
570	95.756	98.418	0.17	0.17	2.28	76	-3.09	1.78	75	-2	75	0.070	100	100	2.1	-0.10	267	304	242	322	316	290	623	151	81	69	83	68	70	-0.020	8.17	0.02
580	97.441	100.149	0.17	0.17	2.29	76	-3.16	1.79	75	-2	75	0.070	100	100	2.0	-0.16	264	304	240	319	316	289	615	150	84	69	82	69	70	-0.020	8.13	0.02
590	99.130	101.880	0.17	0.17	2.29	76	-3.17	1.78	75	-1.9	75	0.070	100	100	1.8	-0.12	261	304	238	315	317	287	611	149	81	69	82	69	70	-0.020	7.95	0.02
600	100.822	103.611	0.17	0.17	2.30	76	-2.77	1.79	75	-2	75	0.070	100	100	1.7	-0.17	259	304	236	313	317	286	607	148	81	69	83	69	69	-0.019	7.85	0.01
610	102.511	105.342	0.17	0.17	2.30	76	-2.9	1.78	75	-2	75	0.070	100	100	1.6	-0.10	258	303	235	309	318	285	609	147	82	69	83	69	69	-0.019	7.99	0.01
620	104.199	107.073	0.17	0.17	2.30	76	-3.18	1.78	75	-2.2	75	0.070	100	100	1.4	-0.15	256	301	234	307	319	283	603	147	82	69	83	69	69	-0.019	7.79	0.01
630	105.887	108.804	0.17	0.17	2.29	76	-3.17	1.78	75	-2.2	75	0.070	100	100	1.3	-0.10	255	300	232	304	320	282	605	147	82	69	83	69	69	-0.019	7.86	0.01
640	107.575	110.536	0.17	0.17	2.29	76	-2.81	1.78	75	-2	74	0.070	100	100	1.2	-0.13	254	299	230	301	321	281	607	146	82	69	82	69	69	-0.019	7.86	0.02
650	109.263	112.267	0.17	0.17	2.28	76	-2.84	1.79	75	-2.1	75	0.070	100	100	1.0	-0.14	251	298	227	299	322	279	601	145	82	69	82	69	69	-0.019	7.69	0.02
660	110.951	113.997	0.17	0.17	2.28	76	-2.88	1.78	75	-2.2	74	0.070	100	100	0.9	-0.11	248	296	223	296	321	277	595	144	82	69	83	69	69	-0.019	7.77	0.01
670	112.638	115.728	0.17	0.17	2.29	76	-3.17	1.78	75	-1.9	74	0.070	100	100	0.8	-0.16	248	296	221	295	321	276	596	144	83	69	83	69	69	-0.019	7.87	0.02
680	114.326	117.459	0.17	0.17	2.28	76	-2.95	1.79	75	-2.1	74	0.070	100	100	0.6	-0.13	247	297	219	295	321	276	590	144	82	69	83	69	69	-0.019	7.62	0.01
690	116.014	119.191	0.17	0.17	2.28	76	-3.19	1.78	75	-2	74	0.070	100	100	0.5	-0.14	244	297	217	292	319	274	579	143	82	69	82	69	69	-0.018	7.36	0.01

OMNI-Test Laboratories, Inc.

Wood Heater Test Data
Hign Burn Emissions Data

Run: 2

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E.FREV 001
Test Date: 09-Jun-20
Beginning Clock Time: 15:52

Total Sampling Time: 730 min
Recording Interval: 10 min
Background Sample Volume: 128.196 cubic feet

Meter Box Y Factor: 0.988 (1) 0.985 (2) 1.016 (Amb)

Barometric Pressure: Begin 28.49 Middle End 28.45 Average 28.47 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372
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: -0.114 "H2O
Tunnel Area: 0.19635 ft2
Pitot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.57 ft/sec.
Initial Tunnel Flow: 192.9 scfm
Average Tunnel Flow: 189.2 scfm
Post-Test Leak Check (1): 0.000 cfm @ 6 in. Hg
Post-Test Leak Check (2): 0.000 cfm @ 6 in. Hg
Average Test Piece Fuel Moisture: 21.75 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	0.065	0.070	0.072	0.070	0.070	0.072	0.066	0.064	0.074	"H2O
Temp:	82	82	82	82	82	82	82	82	82	°F

V_{stav} 18.10 ft/sec V_{scent} 18.72 ft/sec F_p 0.967

	Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)														Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft^3)	Gas Meter 2 (ft^3)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 ("H_2O)	Meter 1 Temp (°F)	Meter 1 Vacuum ("Hg)	Orifice dH 2 ("H_2O)	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	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft ("H_2O)	CO_2 (%)	CO (%)
700	117.701	120.923	0.17	0.17	2.29	76	-2.9	1.80	75	-1.9	74	0.070	100	100	0.4	-0.10	240	298	216	289	315	272	571	141	82	69	82	69	69	-0.018	7.28	0.01
710	119.390	122.655	0.17	0.17	2.29	76	-2.76	1.78	75	-2.2	74	0.070	100	100	0.3	-0.15	237	299	214	285	311	269	567	141	82	69	82	69	69	-0.018	7.33	0.01
720	121.078	124.388	0.17	0.17	2.29	76	-2.79	1.79	75	-2	74	0.070	100	100	0.1	-0.13	235	299	213	282	309	268	563	139	82	69	82	69	69	-0.017	7.14	0.01
728	122.768	126.121	0.17	0.17	2.29	76	-3.13	1.79	75	-2.1	74	0.070	100	100	0.0	-0.09	232	299	212	278	306	265	559	139	82	69	82	69	68	-0.017	7.01	0.01
Avg/Tot	122.768	126.121	0.17	0.17	2.28	76		1.78	74		79	0.070	100	100								92.2				69	85	69	70	-0.031		

Wood Heater Lab Data

Manufacturer: Kuma Stoves
Model: K250 Series
Tracking No.: 2406
Project No.: 0123WN012E.FREV 001
Run #: 2
Date: 6/9/20

Equipment Numbers:

TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	T250S	100.3	98.7	1.6
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: 1.6

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	T254AP	203.1	199.6	3.5
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe	12	114286.4	114286.1	0.3
E. Filter seals catch*	Seals	R984	3257.2	3257.0	0.2

Sub-Total Total Particulate, mg: 4.0

Train 1 Aggregate Total Particulate, mg: **5.6**

TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	T254BP	203.4	198.3	5.1
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe	13	114322.9	114323.1	0.0
D. Filter seals catch*	Seals	R985	3403.1	3402.3	0.8

Total Particulate, mg: **5.9**

AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter	D1026	119.9	119.7	0.2

Total Particulate, mg: **0.2**

*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:

Wood Heater Test Results

Manufacturer: Kuma Stoves
Model: K250 Series
Project No.: 0123WN012E.FREV 001
Tracking No.: 2406
Run: 2
Test Date: 06/09/20

Burn Rate	**0.89 kg/hr dry**
Average Tunnel Temperature	79 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.57 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11351.8 dscf/hour
Average Delta p	0.070 inches H20
Total Time of Test	730 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	128.196 cubic feet	122.768 cubic feet	126.121 cubic feet	10.021 cubic feet
Average Gas Meter Temperature	70 degrees Fahrenheit	76 degrees Fahrenheit	74 degrees Fahrenheit	75 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	123.471 dscf	114.414 dscf	117.282 dscf	9.341 dscf
Total Particulates - m_n	0.2 mg	5.6 mg	5.9 mg	1.6 mg
Particulate Concentration (dry-standard) - C_f/C_s	0.000002 grams/dscf	0.00005 grams/dscf	0.00005 grams/dscf	0.00017 grams/dscf
Total Particulate Emissions - E_T	0.22 grams	6.54 grams	6.72 grams	1.94 grams
Particulate Emission Rate	0.02 grams/hour	0.54 grams/hour	0.55 grams/hour	1.94 grams/hour
Emissions Factor		0.60 g/kg	0.62 g/kg	1.55 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	6.63 grams
Particulate Emission Rate	**0.54 grams/hour**
Emissions Factor	0.61 grams/kg
First Hour Emissions	
Total Particulate Emissions - E_T	1.94 grams
Particulate Emission Rate	1.94 grams/hour
Emissions Factor	1.55 grams/kg
7.5% of Average Total Particulate Emissions	0.50 grams

QUALITY CHECKS

Filter Temps < 90 °F	NOT ACCEPTABLE
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
Gram per Kilogram <0.50	0.02
Train Precision ≤ 7.5%	2.13

Technician Signature:_____

Wood Heater Efficiency Results - CSA B415.1

Manufacturer: Kuma Stoves
Model: K250 Series
Date: 06/09/20
Run: 2
Control #: WN012E.FREV 001
Test Duration: 728
Output Category: II

Technician Signature: 

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	81.3%	88.2%
Combustion Efficiency	99.5%	99.5%
Heat Transfer Efficiency	82%	88.6%

Output Rate (kJ/h)	12,790	12,132	**(Btu/h)**
Burn Rate (kg/h)	0.90	1.97	**(lb/h)**
Input (kJ/h)	15,735	14,926	**(Btu/h)**

Test Load Weight (dry kg)	10.86	23.93	**dry lb**
MC wet (%)	17.86222758		
MC dry (%)	21.75		
Particulate (g)	0.54		
CO (g)	70		
Test Duration (h)	12.13		

Emissions	**Particulate**	**CO**
g/MJ Output	0.00	0.45
g/kg Dry Fuel	0.05	6.42
g/h	0.04	5.75
lb/MM Btu Output	0.01	1.04

Air/Fuel Ratio (A/F)	12.58

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

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 2
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: B Davis
OMNI Equipment ID numbers:

Wood Heater Supplemental Data

Start Time: 1552
Stop Time: 0410 12:18 hrs

Booth #:

Stack Gas Leak Check:
Initial: good Final: good

Sample Train Leak Check:
A: 0.0 @ 6 "Hg
B: 00 @ 6 "Hg

Calibrations: Span Gas CO_2: 12.4 CO: 2.48

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	1545	1545	0418	0418
CO_2	0.00 ~~00.03~~	12.33	0.06	12.32
CO	0.00 2	247	-0.008	2.45

Air Velocity (ft/min): Initial: 250 Final: 250
Scale Audit (lbs): Initial: 10.0 Final: 10.0
Pitot Tube Leak Test: Initial: good Final: good
Stack Diameter (in): 6"
Induced Draft: 0.0
% Smoke Capture: 100%
Flue Pipe Cleaned Prior to First Test in Series:
Date: 6/6/20 Initials: DK

	Initial	Middle	Ending
P_b (in/Hg)	28.49		28.45
RH (%)			
Ambient (°F)	69		68

Tunnel Traverse

Microtector Reading	dP (in H_2O)	T(°F)
	.065	82
	.070	82
	.072	82
	.070	82
	.070	82
	.072	82
	.066	82
	.064	82
Center:		
	.074	82

Tunnel Static Pressure (in H_2O):	
Beginning of Test	End of Test
-.114	-.114

Background Filter Volume: 128.196

Technician Signature: B Davis Date: 6/12/2020

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 2
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: B Davis
OMNI Equipment ID numbers:

Wood Heater Run Notes

Air Control Settings

Primary:

full closed

Secondary: fixed

Tertiary/Pilot: N/A

Fan: On High

Preburn Notes

Time	Notes

Test Notes

Sketch test fuel configuration:

See photo

Start up procedures & Timeline:

Bypass: fully open until 2:22 minutes then closed
Fuel loaded by: 2:22 min
Door closed at: 2:22 min
Primary air: fully open until 16:15 minutes then set to full closed

Notes: Fan off for first 30 min then set to high

Time	Notes
60	Changed front filter on train A.

Technician Signature: [signature] Date: 6/19/2020

Adjunct to ASTM E XXXX Wood Heater Cordwood Test Method - May 10, 2017 Version

Cordwood Fuel Load Calculators - 12 lb/ft^3 Nominal Load Density

Core 45-65% of Total Load Weight, Remainder 35-55% of Total Load Weight

Values to be input manually

For Usable Firebox Volumes up to 3.0 ft^3 - Low and Medium Fire

Nominal Required Load Density (wet basis)	12	lb/ft^3				
Usable Firebox Volume	2.50	ft^3				
Total Nom. Load Wt. Target	30	lb				
Total Load Wt. Allowable Range	28.50	to	31.50	lb		
Core Target Wt. Allowable Range	13.5	to	19.50	lb		
Remainder Load Wt. Allowable Range	10.50	to	16.50	lb		
						Mid-Point
Core Load Fuel Pc. Wt. Allowable Range	4.50	to	7.50	lb		6.00
Remainder Load Pc. Wt. Allowable Range	3.00	to	9.00	lb		6.00
	Pc. #					
Core Load Piece Wt. Actual	1	5.49	lb	In Range		
	2	6.69	lb	In Range		
	3	5.04	lb	In Range		
Core Load Total. Wt. Actual		17.22	lb	In Range		
	Pc. #					
Remainder Load Piece Wt.	1	4.14	lb	In Range		
(2 or 3 Pcs.)	2	7.79	lb	In Range		
	3		lb	NA		
Remainder Load Piece Weight Ratio - Small/Large		53%		In Range		≤ 67%
Remainder Load Tot. Wt. Act		11.92	lb	In Range		
Total Load Wt. Actual		29.14	lb	In Range		
Core % of Total Wt.		59%		In Range		45-65%
Remainder % of Total Wt.		41%		In Range		35-55%
Actual Load % of Nominal Target		97%		In Range		95-105%
Actual Fuel Load Density		11.7	lb/ft^3			
Allowable Charcoal Bed Wt. Range (lb)	3.0	to	5.8			Mid-Point
Actual Charcoal Bed Wt.		4.7	lb	In Range		4.4
Actual Fuel Load Ending Wt.		0.0	lb	Valid Test		≥ 90%
Total Wt. of Fuel Burned During Test Run lb.		29.1	lb			

Fuel Piece Moisture Reading (%-dry basis)

1	2	3	Ave.		Pc. Wt. Dry Basis			
22	21.4	21.4	21.6	In Range	4.51	lb	2.05	kg
22	21.7	21.3	21.7	In Range	5.50	lb	2.49	kg
21.2	23.6	21.5	22.1	In Range	4.13	lb	1.87	kg
21.1	21.1	20.5	20.9	In Range	3.42	lb	1.55	kg
22.2	22.8	22.4	22.5	In Range	6.36	lb	2.88	kg
			NA	NA	NA	lb	NA	kg
Total Load Ave. MC % (dry basis)			21.8	In Range				
Total Load Ave. MC % (wet basis)			17.9					
Total Test Load Weight (dry basis) →					23.92	lb	10.85	kg
Total Fuel Weight Burned During Test Run (dry basis)					23.9	lb	10.85	kg

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 to produce the K-250 Series at Kuma Stoves 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.

Sample Analysis

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

Tare Sheet: (check one) Probes_____ 47mm Filters_✓_ 100mm Filters_____ O-Ring Pair_____

Prepared By: Tony Tong Balance ID #: 00637 Thermohygrometer ID #: 00592 Audit Weight ID #/Mass: 00283A 1200 mg

Placed in Dessicator: Date: 04/28/2020 Time: 8:15 / ID #	Date: 04/29/2020 Time: 8:15 RH %: 19.6 T (°F): 72.5 Audit: 199.8	Date: 04/30/2020 Time: 9:00 RH %: 18.6 T (°F): 71.9 Audit: 200.1	Date: Time: RH %: T (°F): Audit:	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
T253AP	198.3	198.3 ✓			06/09/2020	0123WM012E	1
T253BP	198.0	197.9 ✓			↓	↓	↓
T254AP	199.4	199.6 ✓			06/09/2020	0123WM012E	2
T254BP	198.3	198.3 ✓			↓	↓	↓
T255AP	189.4	189.3 ✓					
T255BP	179.7	179.7 ✓					
T256AP	182.7	182.6 ✓					
T256BP	181.7	181.6 ✓					
T257AP	181.5	181.4 ✓					
T257BP	181.9	181.8 ✓					
T258AP	181.0	181.1 ✓					
T258BP	180.9	180.8 ✓					
T259AP	180.5	180.5 ✓					
T259BP	181.7	181.6 ✓					
T260AP	192.3	192.2 ✓					
T260BP	192.0	191.8 ✓					
T261AP	195.0	195.1 ✓					
T261BP	196.0	196.1 ✓					
T262AP	196.0	196.1 ✓					
T262BP	193.9	194.0 ✓					
	Initials: TT	Initials: TT	Initials:	Initials:			

Final Technician Signature: Tony Tong Date: 05/04/2020 Evaluator signature:_____

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

Tare Sheet: (check one) Probes_____ 47mm Filters_✓_ 100mm Filters_____ O-Ring Pair_____

Prepared By: Tony Tong Balance ID #: 00637 Thermohygrometer ID #: 00592 Audit Weight ID #/Mass: 00283A / 200mg

Placed in Dessicator: Date: 03/12/2020 Time: 13:40 ID #	Date: 03/16/2020 Time: 09:10 RH %: 12.3 T (°F): 73.7 Audit: 200.0	Date: 03/17/2020 Time: 09:00 RH %: 11.5 T (°F): 73.5 Audit: 200.1	Date: Time: RH %: T (°F): Audit:	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
T233S	99.2	99.3 ✓					
T234S	100.3	100.1 ✓					
T235S	98.8	98.9 ✓					
T236S	98.1	98.3 ✓					
T237S	98.6	98.6 ✓					
T238S	98.5	98.4 ✓					
T239S	100.3	100.3 ✓					
T240S	98.6	98.5 ✓					
T241S	99.0	99.2 ✓					
T242S	99.4	99.4 ✓					
T243S	97.9	97.9 ✓					
T244S	100.1	100.0 ✓			06/09/2020	0123WM012E	1
T245S	98.9	99.0 ✓					
T246S	99.3	99.1 ✓					
T247S	99.4	99.4 ✓					
T248S	100.7	100.6 ✓					
T249S	98.9	99.0 ✓			06/09/2020	0123WM012E	1
T250S	98.7	98.7 ✓			06/09/2020	0123WM012E	2
T251S	100.3	100.3 ✓					
T252S	97.8	97.7 ✓					
	Initials: TT	Initials: TT	Initials:	Initials:			

Final Technician Signature: Tony Tong Date: 03/17/2020 Evaluator signature: [signature] 4/21/20

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

Tare Sheet: (check one) Probes_____ 47mm Filters_____ 100mm Filters_____ O-Ring Pair ✓

Prepared By: Tony Tong Balance ID #: OMNI – 00637 Thermohygrometer ID #: OMNI – 00592 Audit Weight ID #/Mass: OMNI – 00283A/5g

Placed in Dessicator: Date: 05/26/2020 Time: 9:00	Date: 05/27/2020 Time: 12:00 RH %: 9.8 T (°F): 73.2	Date: 05/28/2020 Time: 13:00 RH %: 10.3 T (°F): 74.8	Date: 06/01/2020 Time: 8:00 RH %: 6.2 T (°F): 70.7	Date: 06/02/2020 Time: 9:30 RH %: 7.0 T (°F): 72.3	Date Used	Project Number	Run No.
ID #	Audit: 5000.0	Audit: 5000.2	Audit: 5000.0	Audit: 4999.9			
R964	3289.9	3289.9 ✓					
R972	3348.3	3347.9	3347.4	3347.9			
R973	3499.1	3499.1 ✓					
R980	3420.5	3420.1	3419.6	3419.7 ✓			
R981	4168.2	4167.8	4167.5	4167.7 ✓			
R982	3372.0	3371.8 ✓			06/09/2020	0123WM012E	1
R983	4112.5	4112.3 ✓			↓	↓	↓
R984	3257.2	3257.0 ✓			06/09/2020	0123WM012E	2
R985	3403.0	3403.0	3402.1	3402.3 ✓	↓	↓	↓
R986	3386.3	3386.1 ✓					
R987	4120.4	4120.3 ✓					
R988	4150.0	4149.9 ✓					
R989	3289.7	3289.4	3288.6	3288.9			
R990	4151.4	4151.1	4150.7	4150.9 ✓			
R991	3351.0	~~3350.0~~	3350.3	3350.4 ✓	Not Used		
R992	3311.5	3311.2	3310.8	3310.9 ✓	Not Used		
	Initials: TT	Initials: TT	Initials: TT	Initials: TT			

Final Technician Signature: Tony Tong Date: 06/02/2020 Evaluator signature:

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

Tare Sheet: (check one) Probes ✓ 47mm Filters_____ 100mm Filters_____ O-Ring Pair_____

Prepared By: Tony Tong Balance ID #: OMNI-00637 Thermohygrometer ID #: OMNI-00582 Audit Weight ID #/Mass: OMNI-00283A/100g

Placed in Dessicator: Date: 05/21/2020 Time: 14:00 ID #	Date: 05/26/2020 Time: 10:00 RH %: 7.6 T (°F): 73.2 Audit: 99998.1	Date: 05/27/2020 Time: 11:30 RH %: 12.3 T (°F): 74.1 Audit: 99998.0	Date: 05/28/2020 Time: 13:30 RH %: 8.0 T (°F): 75.2 Audit: 99998.0	Date: Time: RH %: T (°F): Audit:	Date Used	Project Number	Run No.
2	115016.8	115016.3	115016.5 ✓				
3	116012.9	116012.6	116012.7 ✓				
OES3	114769.8	114769.5	114769.7 ✓				
4	114858.7	114858.8	114858.7 ✓				
OES4	114148.3	114148.2	114148.2 ✓		06/09/2020	0123 WM012E	1
OES5	113571.0	113570.8 ✓			↓	↓	↓
12	114286.3	114286.0	114286.1 ✓		06/09/2020	0123 WM012E	2
13	114323.2	114323.1 ✓			↓	↓	↓
14	114548.9	114548.7 ✓					
15	114341.7	114341.5 ✓					
18	114402.4	114402.3 ✓					
20	114254.1	114254.1 ✓					
21	114392.6	114392.5 ✓					
22	114342.8	114342.7 ✓					
35	114327.0	114326.8 ✓					
36	114883.8	114883.8 ✓					
37	114466.2	114465.9	114465.9 ✓				
67	117759.1	117759.0 ✓					
	Initials: TT	Initials: TT	Initials: TT	Initials:			

Final Technician Signature: Tony Tong Date: 06/04/2020 Evaluator signature:

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

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 1
Model: K-250 Tracking Number: 2406 Date: 6/9/20
Test Crew: BOAKS
OMNI Equipment ID numbers:

ASTM E2515 Lab Sheet

Assembled By:

_____

Date/Time in Dessicator:

_____

	Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time:	06/15/2020 8:10	6/16/2020 0805	6/17/2020 8:30		
R/H %:	16.4	17.2	14.6		
Temp:	72.3	71.4	77.1		
200 mg Audit:	200.0	200.1	200.1		
2 g Audit:	2000.3	2000.3	2000.2		
100 g Audit:	99997.9	99997.9	99998.2		
Initials:	TT	DR	TT		

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	T2445	100.0	102.6	102.5	✓		
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	T254AP	198.3	203.4	203.5	✓		
	Rear Filter							
	Probe	OES4	114148.2	114149.2	114149.1	✓		
	O-Ring Set	R982	3371.8	3372.5	3372.1	3371.9 ✓		
B	Front Filter	T253DP	197.9	201.8	201.8	✓		
	Rear Filter	T249S	99.0	101.7	101.6	✓		
	Probe	OES5	113570.8	113572.4	113572.3	✓		
	O-Ring Set	R983	4112.3	4115.0	4114.2	4114.0 ✓		
BG	Filter	P1025	118.6	118.5	118.5	✓		

Technician Signature: _____ Date: 6/17/20

OMNI-Test Laboratories, Inc.

Wood Heater Run Sheets

Client: Kuma Stoves Project Number: 0123WM012E.REV001 Run Number: 2

Model: K-250 Tracking Number: 2406 Date: 6/9/20

Test Crew: BDA

OMNI Equipment ID numbers:

ASTM E2515 Lab Sheet

Assembled By:

Date/Time in Dessicator:

	Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time:	06/15/2020 8:10	6/16/2020 0805	06/17/2020 8:30		
R/H %:	16.4	17.2	14.6		
Temp:	72.3	71.4	77.1		
200 mg Audit:	200.0	200.1	200.1		
2 g Audit:	2000.3	2000.3	2000.2		
100 g Audit:	99997.9	99997.9	99998.2		
Initials:	TT	BA	TT		

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	T250S	98.7	100.5	100.3	✓		
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	T254AP	199.6 ~~199.8~~	203.1	203.1	✓		
	Rear Filter							
	Probe	12	114286.1	114286.4	114286.4	✓		
	O-Ring Set	R984	3257.0	3257.3	3257.2	✓		
B	Front Filter	T254BP	198.3 ~~189.3~~ BA	203.5	203.4	✓		
	Rear Filter							
	Probe	13	114323.1	114323.5	114323.0	114322.9		
	O-Ring Set	R985	3402.3	3403.6	3403.2	3403.1		
BG	Filter	D1026	119.7	119.7	119.9	✓		

Technician Signature: Date: 6/17/20

Calibrations

ASTM E2515, ASTM E3053

ID #	Lab Name/Purpose	Log Name	Attachment Type
132	10 lb Weight	Weight Standard, 10 lb.	Calibration Certificate
South Scale	Platform Scale	Weight Indicator, Panther 1000 pound by 0.1 resolution	Calibration Certificate
Fuel Scale	Ohaus Ranger fuel scale	24 pound capacity by 0.002 pound resolution.	Calibration Certificate
650	Barometer	Barometer – Digital	Calibration Certificate
283A	Audit Weights	Troemner 21pc Msas Set	Calibration Certificate
371	Sample Box / Dry Gas Meter	Apex Automated Emissions Sampling Box	Calibration Log
372	Sample Box / Dry Gas Meter	Apex Automated Emissions Sampling Box	Calibration Log
410	Microtector	Dwyer Microtector	Calibration Certificate
559	Vaneometer	Dwyer Vaneometer	Equipment Record
592	Thermohygrometer	Omega Digital Thermohygrometer	Calibration Log
420	Combustion Gas Analyzer	CAI Gas Analyzer	See Run Sheet
637	Milligram Balance	Analytical Balance - Mettler - Toledo	Calibration Certificate

SCALE WEIGHT CALIBRATION DATA SHEET

Weight to be calibrated: 10 pounds

ID Number: OMNI-00132

Standard Calibration Weight: 10 pounds

ID Number: OMNI-00255

Scale Used: MTW-150K

ID Number: OMNI-00353

Date: 2/23/2018 By: B. Davis

Standard Weight (A) (Lb.)	Weight Verified (B) (Lb.)	Difference (A - B)	% Error
10.0	10.0	0.0	0

*Acceptable tolerance is 1%.

This calibration is traceable to NIST using calibrated standard weights.

Technician signature: _____ Date: 2/23/18

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

SCALE CALIBRATION RECORD

Customer: MYREIN | Date: 9/1/17

Work Order Number: 49320 | PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. PANTHER	4466459	1000 x .1	Ø		
	Pass...Fail		50		
			100		
			300		
			500		
			Ø		

Notes: DOA
will be new Scale deck

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. PANTHER	00155656CH	5K x 1	Ø		
	Pass...Fail		50		
			100		
			300		
			500		
			Ø		

Notes: DNF
SPARE Readout

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3. PANTHER	00025736AJ	1000 x .1	Ø	Ø	Ø
	Pass...Fail		50	50	50
			100	99.9	100
			300	299.6	300
			500	498.8	500
			Ø	Ø	Ø

Notes: SCALE CALIBRATED w/CERT. WEIGHTS.
SOUTH Scale ✓

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
4. PANTHER	00926516KL	1000 x .1	Ø	Ø	
	Pass...Fail		50	50	
			100	100	
			300	300	
			500	500	
			Ø	Ø	

Notes: SCALE CHECKS GOOD
Center Scale

Additional Comments:

Last Checked: 11/16 | Next Check Due: —

Weights Certified: 10/16 | Technician: BB

Calibration checked JAW NIST handbook 44

Certificate of Calibration

Certificate Number: **725761**

JJ Calibrations, Inc.
7724 SE Aspen Summit Drive
Portland, OR 97266-9217
Phone 503.786.3005
FAX 503.786.2994

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

0723.01
Calibration

PO: **200299**
Order Date: 05/28/2020
Authorized By: **N/A**

Property #: **OMNI-00650**
User: **N/A**
Department: **N/A**
Make: **Control Company**
Model: **6530**
Serial #: **181062211**
Description: **Thermohygrometer / Barometer**
Procedure: **403406**
Accuracy: **±3%RH, ±.4°C(0.8°F), ±4mbar(0.12inHg)**

Calibrated on: 06/01/2020
*Recommended Due: 06/01/2021
Environment: **23** °C **41** % RH
* As Received: **Within Tolerance**
* As Returned: **Within Tolerance**
Action Taken: **Calibrated**
Technician: **146**

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
644A	Thunder Scientific	1200	Two Pressure Humidity Generator	10/14/2020	710583

Measurement Data

Parameter / Measurement Description	Range Unit	Reference	Min	Max	tError	UUT	Uncertainty
Before/After							Accredited = ✓
Humidity							
	%	25.0	22	28	1	26 %	8.1E-01 ✓
	%	50.0	47	53	3	47 %	8.1E-01 ✓
	%	75.0	72	78	3	72 %	8.1E-01 ✓
Temperature							
	°F	68.00	67.2	68.8	0.2	68.2 °F	1.2E-01 ✓
	°F	86.00	85.2	86.8	0.2	85.8 °F	1.2E-01 ✓
	°F	104.00	103.2	104.8	0.3	104.3 °F	1.2E-01 ✓

This instrument has been calibrated in accordance with the JJ Calibrations Quality Assurance Manual and is traceable to either the SI or to National Institute of Standards and Technology (NIST). The quality system and this certificate are in compliance with ANSI/NCSL Z540-1-1994, ISO/IEC 17025-2017, 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 stated in the comments, certificates reflect the "Simple Acceptance Rule" as specified by JCGM 106:2012. 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 written approval of JJ Calibrations.

Reviewer

3 Issued 06/04/2020 Rev # 15

Inspector

Certificate of Calibration

Certificate Number: **685888**

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

A2LA ACCREDITED 0723.01 Calibration

PO: **180188**
Order Date: 10/09/2018
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, 21pc
Procedure: DCN 500901
Accuracy: Class F

Calibrated on: 10/26/2018
*Recommended Due: 10/26/2023
Environment: 20 °C 57 % RH
* As Received: Within Tolerance
* As Returned: Within Tolerance
Action Taken: Calibrated
Technician: **139**

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.

This set meets Class F specifications.
Received and returned eight (8) masses in a black case secured by a rubber band.

Standards Used

Std ID	Manufacturer	Model	Nomenclature	Due Date	Trace ID
723A	Rice Lake	1mg-200g (Class 0)	Mass Set,	03/23/2019	668240
800A	Sartorius	MSA225W100DI	Analytical Balance	12/11/2018	663857

Measurement Data

Parameter / Measurement Description	Range Unit	Reference	Min	Max	ᵏError	UUT	Uncertainty
Before/After							Accredited = ✓
Mass							
Dot	200 mg	200.00030	199.4603	200.5403	0.0500	200.0503 mg	6.2E-01 ✓
	1 g	1.00000880	0.9991088	1.0009088	0.0000000	1.0000088 g	1E-03 ✓
	2 g	2.00001470	1.9989147	2.0011147	0.0003250	2.0003397 g	1.3E-03 ✓
	5 g	5.00000840	4.9985084	5.0015084	0.0000400	4.9999684 g	1.7E-03 ✓
	10 g	10.0000100	9.998010	10.002010	0.000245	9.999765 g	2.3E-03 ✓
Dot	20 g	20.0000140	19.996014	20.004014	0.000990	20.001004 g	4.6E-03 ✓
	50 g	49.9999660	49.989966	50.009966	0.000595	49.999371 g	1.1E-02 ✓
	100 g	100.000000	99.98000	100.02000	0.00194	99.99806 g	2.3E-02 ✓

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 10/29/2018 Rev # 15

Inspector

Thermal Metering System Calibration
Y Factor

Manufacturer:	Apex
Model:	XC-60-EP
Serial Number:	0702003
OMNI Tracking No.:	OMNI-00371
Calibrated Orifice:	☐ Yes

Previous Calibration Comparision

		Acceptable Deviation (5%)	Deviation
Date	7/2/2019		
y Factor	0.992	0.0496	0.004
Acceptance	Acceptable		

Current Calibration

Acceptable y Deviation	0.020
Maximum y Deviation	0.008
Acceptable dH@ Deviation	N/A
Maximum dH@ Deviation	N/A
Acceptance	Acceptable

Average Gas Meter y Factor	Orifice Meter dH@
0.988	N/A

Calibration Date:	01/03/20	
Calibrated by:	B. Davis	
Calibration Frequency:	6 months	
Next Calibration Due:	7/3/2020	
Instrument Range:	1.000	cfm
Standard Temp.:	68	oF
Standard Press.:	29.92	"Hg
Barometric Press., Pb:	30.2	"Hg
Signature/Date:		1/16/2020
		1/17/20

Reference Standard *			
Standard Calibrator	Model	Standard Test Meter	
	S/N	OMNI-00001	
	Calib. Date	25-Nov-19	
	Calib. Value	0.9981	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	3.00	1.70	0.90
Initial Reference Meter	644.9	636.8	631.5
Final Reference Meter	650.008	644.805	636.604
Initial DGM	0	0	0
Final DGM	5.112	8.045	5.184
Temp. Ref. Meter (°F), Tr	76.0	79.0	75.0
Temperature DGM (°F), Td	79.0	75.0	78.0
Time (min)	26.3	49.3	50.3
Net Volume Ref. Meter, Vr	5.108	8.005	5.104
Net Volume DGM, Vd	5.112	8.045	5.184
Gas Meter y Factor =	**0.996**	**0.982**	**0.986**
Gas Meter y Factor Deviation (from avg.)	0.008	0.006	0.002
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 x (y factor (ref)) x (Pb + (Pr/ 13.6)) x (Td + 460)]/ [Vd x (Pb + (Pd / 13.6)) x (Tr + 460)]

** 3. dH@ = 0.0317 x Pd / (Pb (Td + 460)) x [(Tr + 460) x 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 ft^3/min. This is based on the reference standard having a TAR (Test Accuracy Ratio) of at least 4:1.

DIFFERENTIAL PRESSURE GAUGE CALIBRATION DATA SHEET

Instrument to be calibrated: Pressure Transducer

Maximum Range: 0-2" WC ID Number: OMNI-00371

Calibration Instrument: Digital Manometer ID Number: OMNI-00633

Date: 1/13/20 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	0.068	0.073	0.005	0.25
20-40% Max. Range 0.4 - 0.8	0.555	0.561	0.006	0.30
40-60% Max. Range 0.8 – 1.2	0.946	0.950	0.004	0.20
60-80% Max. Range 1.2 – 1.6	1.223	1.230	0.007	0.35
80-100% Max. Range 1.6 – 2.0	1.734	1.735	0.001	0.05

*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: 1/13/2020

Reviewed by: _____ Date: 1/17/20

Temperature Calibration
EPA Method 28R, ASTM 2515

Booth:	Temperature Monitor Type:	Equipment Number:
Mobile	National Instruments Logger	00371, 00372

Reference Meter Equipment Number: 00373	Calibration Due Date: 9/11/20

Calibration Performed By:	Date:	Ambient Temperature:	Barometric Pressure:
B. Davis	1/13/20	70	29.95

Input Temperature (F)	Ambient	Meter A	Meter B	Filter A	Filter B	Tunnel	FB Interior
0	-1	0	0	-1	-1	0	0
100	99	100	100	99	99	100	99
300	299	300	300	299	299	300	299
500	499	500	500	499	499	500	499
700	699	700	700	699	699	700	699
1000	999	1000	1000	999	999	1000	999

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	-1	-1	0
100	100	100	100	100	100	100	99	99	100
300	300	300	300	300	300	300	299	299	300
500	500	500	500	500	500	500	499	499	500
700	700	700	700	700	700	700	699	699	700
1000	1000	1000	1000	1000	1010	1000	999	999	1000
1500								1499	
2000								1999	

Technician signature: _____ Date: 1/13/20

Reviewed By: _____ Date: 1/23/2020

Thermal Metering System Calibration
Y Factor

Manufacturer:	Apex
Model:	XC-60-EP
Serial Number:	702003
OMNI Tracking No.:	OMNI-00371
Calibrated Orifice:	☐ Yes

Previous Calibration Comparision

Date	1/3/2020	Acceptable Deviation (5%)	Deviation
y Factor	0.988	0.0494	0.006
Acceptance	Acceptable		

Current Calibration

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

Average Gas Meter y Factor	**Orifice Meter dH@**
0.994	**N/A**

Calibration Date:	06/15/20	
Calibrated by:	Tony Tong	
Calibration Frequency:	Six Month	
Next Calibration Due:	12/15/2020	
Instrument Range:	1.000	cfm
Standard Temp.:	68	oF
Standard Press.:	29.92	"Hg
Barometric Press., Pb:	29.99	"Hg
Signature/Date:		6/29/2020

Reference Standard *			
Standard Calibrator	Model	Standard Test Meter	
	S/N	OMNI-00001	
	Calib. Date	25-Nov-19	
	Calib. Value	0.9981	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	3.00	1.70	0.90
Initial Reference Meter	145.242	151.1	157.68
Final Reference Meter	150.859	156.2	163.08
Initial DGM	0	0	0
Final DGM	5.578	5.107	5.448
Temp. Ref. Meter (°F), Tr	70.7	71.0	68.0
Temperature DGM (°F), Td	72.0	71.0	69.0
Time (min)	30.0	36.0	54.0
Net Volume Ref. Meter, Vr	5.617	5.100	5.400
Net Volume DGM, Vd	5.578	5.107	5.448
Gas Meter y Factor =	**1.000**	**0.993**	**0.989**
Gas Meter y Factor Deviation (from avg.)	0.006	0.001	0.005
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 x (y factor (ref)) x (Pb + (Pr/ 13.6)) x (Td + 460)]/ [Vd x (Pb + (Pd / 13.6)) x (Tr + 460)]
** 3. dH@ = 0.0317 x Pd / (Pb (Td + 460)) x [(Tr + 460) x 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 ft^3/min. This is based on the reference standard having a TAR (Test Accuracy Ratio) of at least 4:1.

DIFFERENTIAL PRESSURE GAUGE CALIBRATION DATA SHEET

Instrument to be calibrated: Pressure Transducer

Maximum Range: 0 – 2" H_2O ID Number: OMNI-00371

Calibration Instrument: Digital Manometer ID Number: OMNI-00395

Date: 06/16/2020 By: Tony Tong

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 – 0.4	0.37	0.34	0.03	1.5
20-40% Max. Range 0.4 – 0.8	0.46	0.44	0.02	1.0
40-60% Max. Range 0.8 – 1.2	0.84	0.82	0.02	1.0
60-80% Max. Range 1.2 – 1.6	1.25	1.23	0.02	1.0
80-100% Max. Range 1.6 – 2.0	1.87	1.85	0.02	1.0

*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: Tony Tong Date: 06/16/2020

Reviewed by: [signature] Date: 6/29/2020

Temperature Calibration
EPA Method 28R, ASTM 2515

BOOTH:	TEMPERATURE MONITOR TYPE:	EQUIPMENT NUMBER:
Mobile	National Instruments Logger	00371, 00372

REFERENCE METER EQUIPMENT NUMBER: 00373	Calibration Due Date: 09/11/2020

CALIBRATION PERFORMED BY:	DATE:	AMBIENT TEMPERATURE:	BAROMETRIC PRESSURE:
Tony Tong	06/16/2020	71	29.95

Input Temperature (F)	Ambient	Meter A	Meter B	Filter A	Filter B	Tunnel	FB Interior
0	-1	-1	-1	-1	-1	0	0
100	99	99	99	99	99	100	100
300	299	299	299	299	299	300	300
500	499	499	499	499	499	500	500
700	699	699	699	699	699	700	700
1000	999	999	1000	999	999	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	-1	-1	-1	-1
100	100	100	100	100	100	100	99	99	99
300	300	300	300	300	300	299	299	299	299
500	500	500	500	500	500	499	499	499	499
700	700	700	700	700	700	699	699	699	699
1000	1000	1000	1000	1000	1000	999	999	999	1000
1500								1499	
2000								1999	

Technician signature: Tony Tong Date: 06/16/2020

Reviewed By: Date: 6/29/2020

Thermal Metering System Calibration
Y Factor

Manufacturer:	Apex
Model:	XC-60-EP
Serial Number:	0702004
OMNI Tracking No.:	OMNI-00372
Calibrated Orifice:	☐ Yes

Previous Calibration Comparision

		Acceptable Deviation (5%)	Deviation
Date	7/2/2019		
y Factor	0.989	0.04945	0.004
Acceptance	Acceptable		

Current Calibration

Acceptable y Deviation	0.020
Maximum y Deviation	0.014
Acceptable dH@ Deviation	N/A
Maximum dH@ Deviation	N/A
Acceptance	Acceptable

Average Gas Meter y Factor	**Orifice Meter dH@**
0.985	**N/A**

Calibration Date:	01/06/20	
Calibrated by:	B. Davis	
Calibration Frequency:	6 months	
Next Calibration Due:	7/6/2020	
Instrument Range:	1.000	cfm
Standard Temp.:	68	oF
Standard Press.:	29.92	"Hg
Barometric Press., Pb:	30.33	"Hg
Signature/Date:		1/16/2020
		1/17/20

Reference Standard *			
Standard Calibrator	Model	Standard Test Meter	
	S/N	OMNI-00001	
	Calib. Date	25-Nov-19	
	Calib. Value	0.9981	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	2.00	1.00	0.80
Initial Reference Meter	663.4	672.9	682.6
Final Reference Meter	672.8	682.505	688.3
Initial DGM	0	0	0
Final DGM	9.416	9.712	5.872
Temp. Ref. Meter (°F), Tr	74.0	74.0	75.0
Temperature DGM (°F), Td	76.0	76.0	77.0
Time (min)	53.8	30.3	51.8
Net Volume Ref. Meter, Vr	9.400	9.605	5.700
Net Volume DGM, Vd	9.416	9.712	5.872
Gas Meter y Factor =	**0.995**	**0.988**	**0.971**
Gas Meter y Factor Deviation (from avg.)	0.011	0.004	0.014
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 x (y factor (ref)) x (Pb + (Pr/ 13.6)) x (Td + 460)]/ [Vd x (Pb + (Pd / 13.6)) x (Tr + 460)]

** 3. dH@ = 0.0317 x Pd / (Pb (Td + 460)) x [(Tr + 460) x 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 ft^3/min. This is based on the reference standard having a TAR (Test Accuracy Ratio) of at least 4:1.

DIFFERENTIAL PRESSURE GAUGE CALIBRATION DATA SHEET

Instrument to be calibrated: Pressure Transducer

Maximum Range: 0-2" WC ID Number: OMNI-00372

Calibration Instrument: Digital Manometer ID Number: OMNI-00633

Date: 1/13/20 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	0.018	0.017	0.001	0.05
20-40% Max. Range 0.4 - 0.8	0.733	0.732	0.001	0.05
40-60% Max. Range 0.8 – 1.2	1.002	1.001	0.001	0.05
60-80% Max. Range 1.2 – 1.6	1.370	1.368	0.002	0.10
80-100% Max. Range 1.6 – 2.0	1.850	1.851	0.001	0.05

*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: 1/13/2020

Reviewed by: _____ Date: 1/17/20

Temperature Calibration
EPA Method 28R, ASTM 2515

Booth:	Temperature Monitor Type:	Equipment Number:
Mobile	National Instruments Logger	00371, 00372

Reference Meter Equipment Number: 00373	Calibration Due Date: 9/11/20

Calibration Performed By:	Date:	Ambient Temperature:	Barometric Pressure:
B. Davis	1/13/20	70	29.95

Input Temperature (F)	Ambient	Meter A	Meter B	Filter A	Filter B	Tunnel	FB Interior
0	-1	0	0	-1	-1	0	0
100	99	100	100	99	99	100	99
300	299	300	300	299	299	300	299
500	499	500	500	499	499	500	499
700	699	700	700	699	699	700	699
1000	999	1000	1000	999	999	1000	999

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	-1	-1	0
100	100	100	100	100	100	100	99	99	100
300	300	300	300	300	300	300	299	299	300
500	500	500	500	500	500	500	499	499	500
700	700	700	700	700	700	700	699	699	700
1000	1000	1000	1000	1000	1000	1000	999	999	1000
1500								1499	
2000								1999	

Technician signature: _____ Date: 1/13/20

Reviewed By: _____ Date: 1/23/2020

Thermal Metering System Calibration
Y Factor

Manufacturer:	Apex
Model:	XC-60-EP
Serial Number:	702004
OMNI Tracking No.:	OMNI-00372
Calibrated Orifice:	☐ Yes

Previous Calibration Comparision

Date	1/6/2020	Acceptable Deviation (5%)	Deviation
y Factor	0.985	0.04925	0.013
Acceptance	Acceptable		

Current Calibration

Acceptable y Deviation	0.020
Maximum y Deviation	0.005
Acceptable dH@ Deviation	N/A
Maximum dH@ Deviation	N/A
Acceptance	Acceptable

Average Gas Meter y Factor	Orifice Meter dH@
0.998	N/A

Calibration Date:	06/16/20	
Calibrated by:	Tony Tong	
Calibration Frequency:	Six Months	
Next Calibration Due:	12/16/2020	
Instrument Range:	1.000	cfm
Standard Temp.:	68	oF
Standard Press.:	29.92	"Hg
Barometric Press., Pb:	29.94	"Hg
Signature/Date:		6/29/2020

Reference Standard *			
Standard Calibrator	Model	Standard Test Meter	
	S/N	OMNI-00001	
	Calib. Date	25-Nov-19	
	Calib. Value	0.9981	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	2.00	1.00	0.80
Initial Reference Meter	163.775	170.2	176.412
Final Reference Meter	169.978	175.987	183.35
Initial DGM	0	0	0
Final DGM	6.155	5.782	6.977
Temp. Ref. Meter (°F), Tr	68.0	68.0	69.0
Temperature DGM (°F), Td	69.0	69.0	70.0
Time (min)	34.9	47.2	62.2
Net Volume Ref. Meter, Vr	6.203	5.787	6.938
Net Volume DGM, Vd	6.155	5.782	6.977
Gas Meter y Factor =	**1.003**	**0.998**	**0.992**
Gas Meter y Factor Deviation (from avg.)	0.005	0.000	0.005
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 x (y factor (ref)) x (Pb + (Pr/ 13.6)) x (Td + 460)]/ [Vd x (Pb + (Pd / 13.6)) x (Tr + 460)]

** 3. dH@ = 0.0317 x Pd / (Pb (Td + 460)) x [(Tr + 460) x 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 ft^3/min. This is based on the reference standard having a TAR (Test Accuracy Ratio) of at least 4:1.

DIFFERENTIAL PRESSURE GAUGE CALIBRATION DATA SHEET

Instrument to be calibrated: Pressure Transducer

Maximum Range: 0 – 2" H_2O ID Number: OMNI-00372

Calibration Instrument: Digital Manometer ID Number: OMNI-00395

Date: 06/16/2020 By: Tony Tong

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 – 0.4	0.25	0.22	0.03	1.5
20-40% Max. Range 0.4 – 0.8	0.48	0.47	0.01	0.5
40-60% Max. Range 0.8 – 1.2	1.01	0.98	0.03	1.5
60-80% Max. Range 1.2 – 1.6	1.44	1.43	0.01	0.5
80-100% Max. Range 1.6 – 2.0	1.78	1.77	0.01	0.5

*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: Tony Tong Date: 06/16/2020

Reviewed by: [signature] Date: 6/29/2020

Temperature Calibration
EPA Method 28R, ASTM 2515

BOOTH:	TEMPERATURE MONITOR TYPE:	EQUIPMENT NUMBER:
Mobile	National Instruments Logger	00371, 00372

REFERENCE METER EQUIPMENT NUMBER: 00373	Calibration Due Date: 09/11/2020

CALIBRATION PERFORMED BY:	DATE:	AMBIENT TEMPERATURE:	BAROMETRIC PRESSURE:
Tony Tong	06/16/2020	71	29.95

Input Temperature (F)	Ambient	Meter A	Meter B	Filter A	Filter B	Tunnel	FB Interior
0	-1	-1	-1	-1	-1	0	0
100	99	99	99	99	99	100	100
300	299	299	299	299	299	300	300
500	499	499	499	499	499	500	500
700	699	699	699	699	699	700	700
1000	999	999	1000	999	999	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	-1	-1	-1	-1
100	100	100	100	100	100	100	99	99	99
300	300	300	300	300	300	299	299	299	299
500	500	500	500	500	500	499	499	499	499
700	700	700	700	700	700	699	699	699	699
1000	1000	1000	1000	1000	1000	999	999	999	1000
1500								1499	
2000								1999	

Technician signature: Tony Tong Date: 06/16/2020

Reviewed By: [signature] Date: 6/29/2020

Certificate of Calibration

Certificate Number: **712014**

JJ Calibrations, Inc.
7724 SE Aspen Summit Drive
Portland, OR 97266-9217
Phone 503.786.3005
FAX 503.786.2994

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

ACCREDITED
0723.01
Calibration

PO: **190268**
Order Date: **10/29/2019**
Authorized By: **N/A**

Property #: **OMNI-00410**
User: **N/A**
Department: **N/A**
Make: **Dwyer**
Model: **1430**
Serial #: **OMNI-00410**
Description: **Microtector**
Procedure: **500364**
Accuracy: **±0.00025" WC**

Calibrated on: **11/07/2019**
*Recommended Due: **11/07/2020**
Environment: **19** °C **38** % RH
* As Received: **Limited**
* As Returned: **Limited**
Action Taken: **Calibrated**
Technician: **53**

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.

Previous limitation continued: Calibrated micrometer head only.

Standards Used

Std ID	Manufacturer	Model	Nomenclature	Due Date	Trace ID
541A	Select	E8FED2	Gage Block Set, 8pc	12/30/2019	689507

Measurement Data

Parameter / Measurement Description	Range	Unit	Reference	Min	Max	[k]Error	UUT	Uncertainty
Before/After								Accredited = ✓
Length								
		Inch	0.1300	0.129	0.131	0.000	0.130 Inch	8.1E-03 ✓
		Inch	0.3850	0.384	0.386	0.000	0.385 Inch	8.1E-03 ✓
		Inch	0.6150	0.614	0.616	0.000	0.615 Inch	8.1E-03 ✓
		Inch	0.8700	0.869	0.871	0.000	0.870 Inch	8.1E-03 ✓
		Inch	1.0000	0.999	1.001	0.000	1.000 Inch	8.1E-03 ✓

This instrument has been calibrated in accordance with the JJ Calibrations Quality Assurance Manual and is traceable to either the SI or to National Institute of Standards and Technology (NIST). The quality system and this certificate are in compliance with ANSI/NCSL Z540-1-1994, ISO/IEC 17025-2017, 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 stated in the comments, certificates reflect the "Simple Acceptance Rule" as specified by JCGM 106:2012. Unless otherwise stated, a test accuracy ration (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 written approval of JJ Calibrations.

Reviewer

3 Issued 11/08/2019 Rev # 15

Inspector

Calibration Record

Vaneometer Air Velocity Meter OMNI-00559

Calibration Service Record			
Date	**By**	**Results**	**Date of next Calibration**
11/17/17	BD	Installed New Vane From Manufacturer	5/17/18
7/12/18	BR	Installed New Vane from Manufacturer	1/12/19
6/13/19	BR	Installed New Vane From Manufacture	6/15/19
6/13/19	BD	Installed New Vane From Manufacture	12/13/19
05/21/2020	TT	Installed new vane from manufacturer	11/21/2020

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 ± 4%, it is acceptable. If not, the unit needs to be sent to a repair company or replaced.

Verification Data:

Date: ~~1/29/19~~ 1/29/19 pa Technician: BDAVIS

Time in desiccate: 0840 Recording time: 1415

NIST Standard Temperature: 70.2 °F NIST Standard Humidity: 14.6

Test Unit Temperature Reading: 69.9 °F Test Unit Humidity Reading: 12.1

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

Technician Signature: [signature]

Comments: A difference of 2.5% was found, with a full scale of 90% on the Instrument this gives a 2.77% deviation.

Certificate of Calibration

Certificate Number: **716748**

JJ Calibrations, Inc.
7724 SE Aspen Summit Drive
Portland, OR 97266-9217
Phone 503.786.3005
FAX 503.786.2994

OnSite

0723.01
Calibration

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

PO: **190269**
Order Date: **01/20/2020**
Authorized By: **N/A**

Property #: **OMNI-00637**
User: **N/A**
Department: **N/A**
Make: **Mettler Toledo**
Model: **MS104TS/00**
Serial #: **B729400181**
Description: **Analytical Scale, 120g**
Procedure: **DCN 500887**
Accuracy: **±0.0005g**

Calibrated on: **01/20/2020**
*Recommended Due: **07/20/2020**
Environment: **20** °C **40** % RH
* As Received: **Within Tolerance**
* As Returned: **Within Tolerance**
Action Taken: **Calibrated**
Technician: **135**

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,	05/22/2020	694890

Measurement Data

Parameter / Measurement Description	Range	Unit	Reference	Min	Max	*Error	UUT	Uncertainty
Before/After								Accredited = ✓
Force								
		g	10.00000	9.9995	10.0005	0.0001	10.0001 g	9.7E-05 ✓
		g	30.00000	29.9995	30.0005	0.0003	30.0003 g	1.2E-04 ✓
		g	60.00000	59.9995	60.0005	0.0002	60.0002 g	1.8E-04 ✓
		g	90.00000	89.9995	90.0005	0.0001	90.0001 g	2.4E-04 ✓
		g	120.00000	119.9995	120.0005	0.0000	120.0000 g	3E-04 ✓

This instrument has been calibrated in accordance with the JJ Calibrations Quality Assurance Manual and is traceable to either the SI or to National Institute of Standards and Technology (NIST). The quality system and this certificate are in compliance with ANSI/NCSL Z540-1-1994, ISO/IEC 17025-2017, 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 stated in the comments, certificates reflect the "Simple Acceptance Rule" as specified by JCGM 106:2012. 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

Reviewer

3 Issued 01/22/2020 Rev # 15

Inspector

Example Calculations

Equations and Sample Calculations

Manufacturer:	Kuma Stoves
Model:	K250 Series
Run:	2
Category:	

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.

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

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} = 10.85 kg

θ = 730 min

$$BR = \frac{60 \times 10.9}{730}$$

BR = **0.89** 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, $Fp = \frac{V_{strav}}{V_{scent}}$, 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 H_2O

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. H_20; (in Hg = in H_20/13.6)

M_s = **The dilution tunnel wet molecular weight; M_s = 28.78 assuming a dry weight of 29 lb/lb-mole

Sample calculation:

$$Fp = \frac{18.10}{18.72} = 0.967$$

$$V_s = 0.967 \times 85.49 \times 0.99 \times 0.265 \times \left(\frac{78.6 + 460}{\left(28.47 + \frac{-0.11}{13.6}\right) \times 28.78} \right)^{1/2}$$

V_s = **17.57** 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 Ms 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, ft^2
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:

$$Q_{sd} = 3600 \times (1 - 0.02) \times 17.57 \times 0.196 \times \frac{528}{78.6 + 460} \times \frac{28.5 + \frac{-0.11}{13.6}}{29.92}$$

Q_{sd} = **11351.8** 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. H_2O
T_m	=	Absolute average dry gas meter temperature, °R

Sample Calculation:

Using equation for Train 1:

$$V_{m(std)} = 17.64 \times 122.768 \times 0.988 \times \frac{\left(28.47 + \frac{2.28}{13.6}\right)}{(75.6 + 460)}$$

$V_{m(std)}$ = **114.414** dscf

Using equation for Train 2:

$$V_{m(std)} = 17.64 \times 126.121 \times 0.985 \times \frac{\left(28.47 + \frac{1.78}{13.6}\right)}{(74.4 + 460)}$$

$V_{m(std)}$ = **117.282** dscf

Using equation for ambient train:

$$V_{m(std)} = 17.64 \times 128.20 \times 1.016 \times \frac{\left(\underline{28.47} + \frac{0.00}{13.6}\right)}{(69.8 + 460)}$$

$V_{m(std)}$ = **123.471** 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 + 1.6 + 0.0

m_n = 1.6 mg

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

m_n = 0.3 + 3.5 + 0.2

m_n = 4.0 mg

Train 1 aggregate:

m_n = 1.6 + 4.0

m_n = **5.6** mg

Using equation for Train 2:

m_n = 0 + 5.1 + 0.8

m_n = **5.9** mg

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

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

Where:

K_2	=	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:

$$C_s = 0.001 \times \frac{5.6}{114.41}$$

C_s = **0.00005** g/dscf

For Train 2

$$C_s = 0.001 \times \frac{5.9}{117.28}$$

C_s = **0.00005** g/dscf

For Ambient Train

$$C_r = 0.001 \times \frac{0.2}{123.47}$$

C_r = **0.000002** 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 = (0.000049 - 0.000002) x 11351.8 x 730 /60

E_T = 6.54 g

For Train 2

E_T = (0.000050 - 0.000002) x 11351.8 x 730 /60

E_T = 6.72 g

Average

E = 6.63 g

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

7.5% of the average =	0.50
Train 1 difference =	0.09
Train 2 difference =	0.09

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, ^oR

T_m = Absolute average dry gas meter temperature, ^oR

T_{si} = Absolute average gas temperature in the dilution tunnel during the "ith" time interval, ^oR

T_s = Absolute average gas temperature in the dilution tunnel, ^oR

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

$$PR = \left(\frac{730 \times 1.674 \times 17.57 \times (94.0 + 460) \times (75.6 + 460)}{10 \times 122.8 \times 17.81 \times (78.6 + 460) \times (74.0 + 460)} \right) \times 100$$

PR = 101 %

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 (Dual train average) = 6.63 g

θ = 730 min

$PM_R = 60$ x (6.63 / 730)

PM_R = **0.54** 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 (Dual train average) = 6.63 g

M_{Bdb} = 10.85 kg

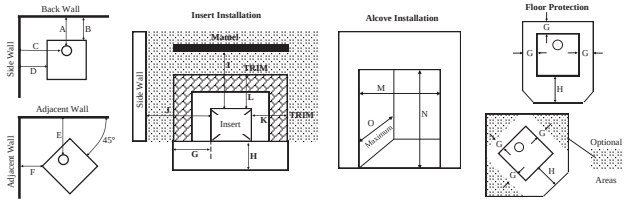
PM_F = 6.63 / 10.85

PM_F = **0.61** g/kg

Section 5

Labeling & Owner's Manual

Installation	Clearance	Connector	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Residential	Standard	Single Wall															
Residential or Mobile home	Reduced	Double Wall															
Insert	Standard	UL 1777 Liner															
Alcove	Reduced	Double Wall															MAX.



INSTALL AND USE ONLY IN ACCORDANCE WITH KUMA STOVES' INSTALLATION AND OPERATION INSTRUCTIONS. CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTION IN YOUR AREA. REFER TO INSTALLATION INSTRUCTIONS FOR PRECAUTIONS REQUIRED FOR PASSING A CHIMNEY THROUGH A COMBUSTIBLE WALL OR CEILING.

ROOM HEATER, SOLID FUEL TYPE, ALSO FOR USE IN MOBILE HOMES. FOR USE WITH SOLID FUEL ONLY. USE ONLY SEASONED CORDWOOD. DO NOT CONNECT THIS UNIT TO A FLUE SERVICING ANOTHER APPLIANCE. DO NOT USE GRATE OR ELEVATE FIRE - BUILD WOOD FIRE DIRECTLY ON FIREBRICK. REPLACE GLASS ONLY WITH 5mm CERAMIC. ATTACH LEGS OR PEDESTAL USING INSTALLTION INSTRUCTIONS. BLOWER ELECTRICAL RATING: 115 VOLT, 18 WATT, 60 HERTZ. DO NOT ROUTE POWER CORD BENEATH HEATER.

USE ONLY LISTED CHIMNEY SYSTEMS THAT ARE 6" DIAMETER U.L. 103 TYPE HT, ALL FUEL, OR SOLID FUEL. MASONRY CHIMNEY SHOULD BE LISTED TO UL 1777. ONLY INSTALL INSERT INTO MASONRY OR UL127 FACTORY BUILT FIREPLACE. INSERT INSTALLATION MUST USE LISTED STAINLESS STEEL LINER. USE ONLY 24 MSG BLACK OR 25 MSG BLLIED STEEL SINGLE WALL CONNECTOR FOR STANDARD CLEARANCE. USE ONLY LISTED DOUBLE WALL CONNECTOR FOR REDUCED CLEARANCE AND MOBILE HOMES. SEE DIAGRAMS FOR STANDARD AND REDUCED CLEARANCE DIMENSIONS. USE ONLY U.L. 1618 TYPE 1 (EMBER PROTECTION) OR TYPE 2 (R-VALUE 1.0) HEARTH PAD OR EQUIVALENT. SEE DIAGRAM FOR HEARTH DIMENSIONS.

This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instruction in the owner's manual

OMNI-Test Laboratories Inc. Portland OR, USA

MANUFACTURED BY:
KUMA STOVES INC
50145 N OLD HWY 95
RATHDRUM ID 83858

MODEL NAME: K-250

Serial Number

Emissions Test Report #: 0123WM012E Safety Test Report # 0123WS012S

CAUTION: HOT WHILE IN OPERATION - DO NOT TOUCH - KEEP CHILDREN AND CLOTHING AWAY - CONTACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS. KEEP FURNISHINGS AND OTHER COMBUSTIBLE MATERIALS A CONSIDERABLE DISTANCE FROM THE APPLIANCE. DO NOT OVERFIRE - IF HEATER OR CHIMNEY CONNECTOR GLOWS, YOU ARE OVERFIRING. INSPECT AND CLEAN CHIMNEY FREQUENTLY - UNDER CERTAIN CONDITIONS OF USE, CREOSOTE BUILDUP MAY OCCUR RAPIDLY. DO NOT PASS CONNECTOR PIPE THROUGH COMBUSTIBLE WALLS OR CEILINGS. DO NOT OBSTRUCT BENEATH THE HEATER.

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

U.S. ENVIRONMENTAL PROTECTION AGENCY: Certified to comply with 2020 particulate emission standards using cord wood. 1.13 Grams per hour. Tested to ASTM 3053-2017.

Model # K-250:

Wood Classic LE, Ashwood LE, Cascade LE, Cambridge LE

Tested and listed by OMNI-Test Laboratories Inc.
Portland OR, USA

Emissions tested to: ASTM 3053-2017
Report# 0123WM012E

Safety tested to UL 1482
Report # 0123WS012S

INSTALLATION AND OPERATING INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual describes the installation and operation of the Kuma Model K-250 Catalytic equipped wood heater. This heater meets the 2020 U.S. Environmental Protection Agency's cord wood emission limits for wood heaters sold after May 15, 2020. Under specific test conditions (ASTM 3053-2017) this heater has been shown to deliver heat at rates ranging from 11,196 to 30,308 Btu/hr. and an efficiency of 79.4% (High Heating Value). Please visit https://www.kumastoves.com/content/page/EPA for a detailed explanation of stove efficiencies. Particulate emissions are 1.13 grams per hour and average CO emissions are 0.1813 grams per minute.

Please read the safety precautions and the entire installation and operation instructions carefully. Failure to properly install and maintain your wood stove can result in an unsafe condition.

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SECTION 1 - SAFETY PRECAUTIONS

WARNING

- If this stove is not properly installed, a house fire can occur. For your protection, follow the installation instructions provided. We recommend contacting local building or fire officials regarding restrictions and installation inspection requirements in your area. **We also recommend that your Kuma stove be installed by a properly trained and licensed installer, preferably an NFI (National Fireplace Institute) expert.**
- **DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVICING ANOTHER APPLIANCE.**
- **Do not burn garbage or flammable fluids such as gasoline, naptha or engine oil**. Do not use charcoal lighter fluid or similar liquids to start or "freshen up" a fire in this heater. Keep all such fluids well away from the heater while in use. Storing these fluids near a stove could cause a fire.
- **DO NOT CONNECT TO ANY AIR DISTRIBUTION OR DUCT SYSTEM.**
- **DO NOT OVERFIRE.** If any part of the stove or chimney glows, the stove is in an over fire condition. If this happens, shut the air control off immediately. Over firing can cause damage.
- **WARNING: DO NOT INSTALL IN A SLEEPING ROOM.**
- **An improperly drafting stove can cause smoke and carbon monoxide to enter the home. Smoke detectors and carbon monoxide monitors are recommended to be installed in the same room as this heater.**
- **CAUTION: THE STRUCTURAL INTEGRITY OF THE FLOOR, WALLS, ROOF/CEILING, AND VAPOR BARRIERS MUST BE MAINTAINED.**
- **DO NOT USE SINGLE WALL PIPE OR CONNECTOR PIPE FOR ANY CHIMNEY APPLICATION, EXTERIOR OR THROUGH THE WALL OR CEILING.** Single wall pipe may only be used as a connection between the stove and an approved masonry or stainless steel chimney. **Single wall pipe may not be used as a connector in mobile homes.**
- When installing into an existing masonry or metal chimney, examine the chimney system carefully. If you have any questions, seek professional advice. We recommend having existing chimneys cleaned and inspected by a qualified professional prior to the installation of your new stove.
- **NOTE ALL MINIMUM CLEARANCE REQUIREMENTS TO COMBUSTIBLES.** Installation must comply with minimum clearances as listed in this manual. (see section 2) **Clearances may only be reduced by means approved by the regulatory authority.**
- Do not operate this stove with the door in an open position, except for cracking open during start-up. Continued operation with the door open can cause overheating of the unit, and expose embers to nearby combustibles.
- **Do not operate with broken glass. Do not abuse glass such as striking or slamming the door.**
- This stove must be connected to a minimum 6" diameter listed chimney that complies with U.L. type 103HT factory built chimney or a code approved masonry chimney. If the masonry chimney does not meet code, a U.L. 1777 approved liner must be installed.
- When connecting single wall or double wall connector pipe to the stove and chimney, use 3 screws per pipe joint including 3 screws securing the pipe to the stove. Depending on the type of double wall pipe you are using, it may also be necessary to fasten it at the chimney. Simpson Duravent's DVL double wall uses a snap lock connector and does not need screws.
- Use only approved components for Chimney and Connector. Field fabricated or "makeshift" components are not allowed and can cause a fire.
- **DO NOT USE THIS STOVE WITHOUT THE BAFFLE BOARDS AND CERAMIC INSULATION PACKAGED WITH YOUR STOVE.**
- When connecting this stove to a masonry chimney, make sure you observe all applicable clearances including walls, ceilings and other combustible material. A masonry chimney must be minimum 6" diameter and constructed with a liner according to NFPA code 211. If you have any questions about the condition or the code compliance of your masonry chimney, please speak with a qualified professional.
- HOT WHILE IN OPERATION. KEEP CHILDREN, CLOTHING AND FURNITURE AWAY. CONTACT MAY CAUSE SKIN BURNS.

SECTION 2 - SPECIFICATIONS

Listing Tag:

Installation	Clearance	Connector	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Residential	Standard	Single Wall															
Residential or Mobile home	Reduced	Double Wall															
Insert	Standard	UL 1777 Liner															
Alcove	Reduced	Double Wall															

Adjacent Wall
Side Wall
Back Wall
Adjacent Wall
Side Wall
Insert
Model
TRIM
FRONT
Insert Installation
Alcove Installation
Floor Protection
Optional Areas

INSTALL AND USE ONLY IN ACCORDANCE WITH KUMA STOVES' INSTALLATION AND OPERATION INSTRUCTIONS. CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTION IN YOUR AREA. REFER TO INSTALLATION INSTRUCTIONS FOR PRECAUTIONS REQUIRED FOR PASSING A CHIMNEY THROUGH A COMBUSTIBLE WALL OR CEILING.

ROOM HEATER, SOLID FUEL TYPE. ALSO FOR USE IN MOBILE HOMES FOR USE WITH SOLID FUEL ONLY. USE ONLY SEASONED CORDWOOD. DO NOT CONNECT THIS UNIT TO A FLUE SERVICING ANOTHER APPLIANCE. NOT TO BE USED AS A FIELD INSTALLED FIREPLACE INSERT. DIRECT VENT ONLY. FIREBRICK, FIBER GLASS ONLY WITH CERAMIC ATTACH LEGS OR PEDESTAL USING INSTALLATION INSTRUCTIONS. BLOWER ELECTRICAL RATING: 115 VOLT, 18 WATT, 60 HERTZ. DO NOT ROUTE POWER CORD BENEATH HEATER.

USE ONLY LISTED CHIMNEY SYSTEMS THAT ARE 6" DIAMETER UL 103 TYPE HT, ALL FUEL, OR SOLID FUEL, MASONRY CHIMNEY SHALL BE LISTED TO UL 1777 ONLY FOR INSERT INSTALLATION. RV OR UL 127 FACTORY BUILT FIREPLACES. INSERT INSTALLATION MUST USE LISTED STAINLESS STEEL LINER. USE ONLY 24 MSG BLACK OR 25 MSG BLUED STEEL SINGLE WALL CONNECTOR FOR STANDARD CLEARANCE USE ONLY DOUBLE WALL CONNECTOR FOR REDUCED CLEARANCE AND MOBILE HOMES. SEE DIAGRAMS FOR STANDARD AND REDUCED CLEARANCE DIMENSIONS. USE ONLY U.L. 1618 TYPE 1 (EMBER PROTECTION) OR TYPE 2 (RESILIENT) HEARTH PAD OR EQUIVALENT. SEE DIAGRAM FOR HEARTH DIMENSIONS.

This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instruction in the owner's manual

OMNI-Test Laboratories, Inc.
Portland OR. USA

MANUFACTURED BY:
KUMA STOVES
50145 N OLD HWY 95
RATHDRUM ID 83858

Emissions Test Report #: 012WM012E Safety Test Report # 012WS0125

CAUTION: HOT WHILE IN OPERATION – DO NOT TOUCH - KEEP CHILDREN AND CLOTHING AWAY – CONTACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS. KEEP FURNISHINGS AND OTHER COMBUSTIBLE MATERIALS A CONSIDERABLE DISTANCE FROM THE APPLIANCE. DO NOT OVERFIRE - IF HEATER OR CHIMNEY CONNECTOR GLOWS, YOU ARE OVERFIRING. INSPECT AND CLEAN CHIMNEY FREQUENTLY - UNDER CERTAIN CONDITIONS OF USE, CREOSOTE BUILDUP MAY OCCUR RAPIDLY. DO NOT PASS CONNECTOR PIPE THROUGH COMBUSTIBLE WALLS OR CEILINGS. DO NOT OBSTRUCT BENEATH THE HEATER.

MODEL NAME: K-250

Serial Number

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

U.S. ENVIRONMENTAL PROTECTION AGENCY: Certified to comply with 2020 particulate emission standards using cord wood. 1.13 Grams per hour. Tested to ASTM 3053-2017.

Dimensional Drawing TBD

SECTION 3 — INSTALLATION INSTRUCTIONS

WARNING
• Install and use this stove in accordance with the manufacturer's installation and operating instructions. It is highly recommended that this stove is installed by a qualified professional certified by the National Fireplace Institute. • The structural integrity of the floor, walls and ceiling/roof must be maintained. Use additional bracing if required. Never cut a load bearing wall or engineered truss. • NEVER INSTALL A STOVE IN A SLEEPING ROOM • This stove is heavy: Get help from another person and use proper lifting techniques

STOVE ASSEMBLY

Uncrate the stove. Each piece of the stove will be included in a separate box. Follow the instructions located in each box to install the components of the stove. Assemble the stove in the following order:

1. Lay the stove on to its back
2. Install the Ash Pan Kit (optional)
3. Install the Legs or Pedestal Kit
4. Carefully set the stove upright
5. Install the door
6. Install the blower (optional)

FLOOR PROTECTION REQUIREMENTS

TBD

MINIMUM CLEARANCE REQUIREMENTS

TBD

CHIMNEY AND CONNECTOR PIPE REQUIREMENTS

A properly installed and maintained venting system is critical to the safe operation of your wood stove. This stove may be connected to a factory built **all fuel chimney system** that has been safety tested to the UL-103HT standard or to a lined **masonry chimney** that meets the standards of NFPA 211. The **connector pipe** is the portion of the venting system that connects the stove to the chimney system. Chimney connector must be 24ga. single wall black stove pipe or a listed double wall connector pipe. Listed double wall connector pipe is required for mobile home installation.

When choosing the location for your stove, decide on a central location in the main living area of the home. Uninhabited areas of the home such as an uninsulated basement or a garage would be an inefficient location for the heater. Also consider not placing the chimney too close to your neighbors or in a valley that would cause a nuisance or unhealthy outdoor air quality. For proper draft, the chimney must exit the roof a minimum of 3 feet and at least 2 feet above any portion of the roof that is within 10 feet of the chimney.

Minimum Flue Height Recommendations	
No offsets in the chimney	14 ft
30° or 45° offsets in the chimney	15 ft
90° offsets in the chimney	16 ft.
90° offsets with 2-3 feet of horizontal run	20 ft.
90° offsets into exterior chimney	22 ft.

WHEN CONNECTING TO AN ALL FUEL CHIMNEY SYSTEM

WARNING

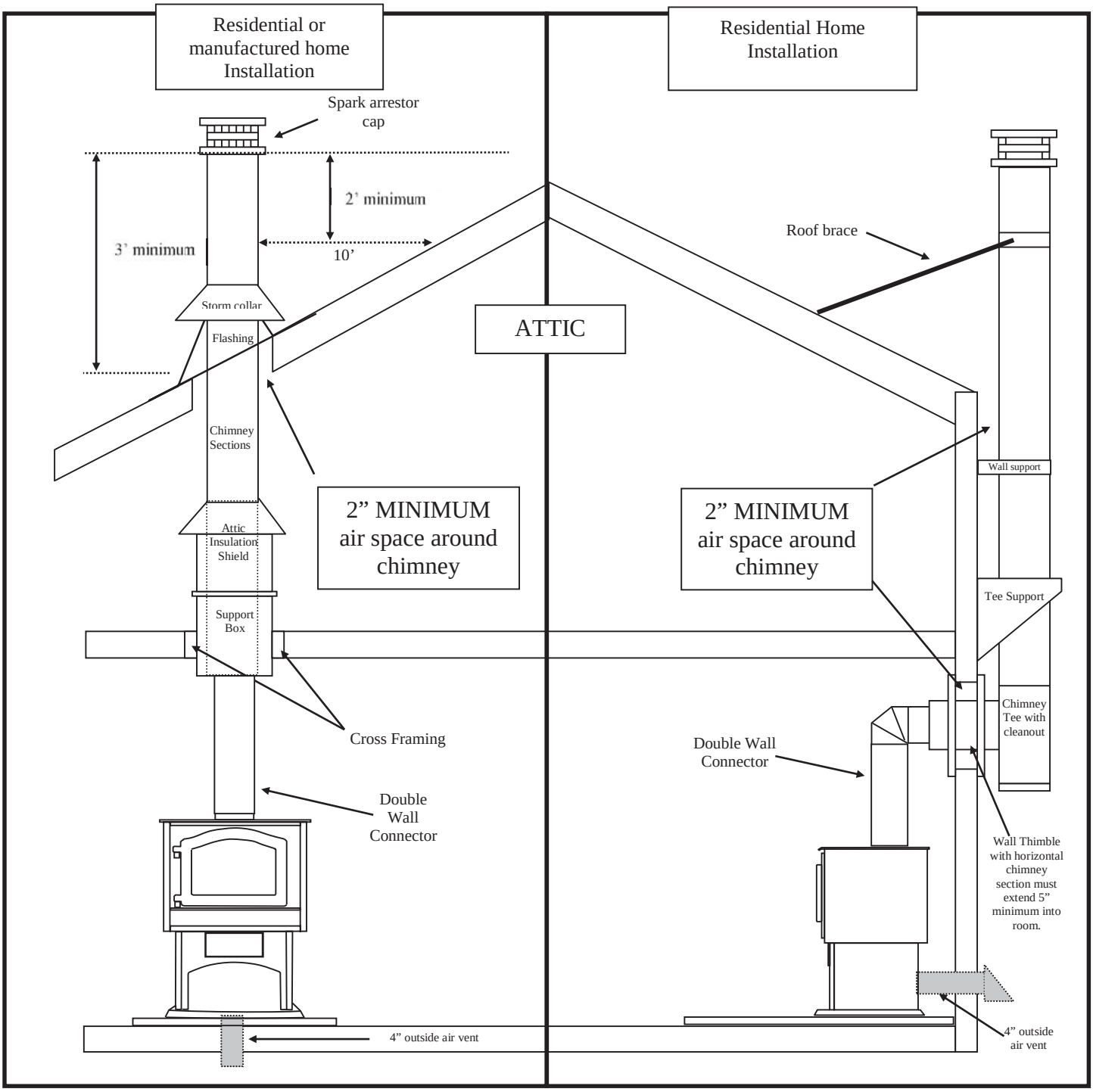
- For complete installation instructions, carefully follow the installation manual that came with your all fuel chimney system.
- Your chimney must meet the UL-103HT standard. Do not mix different brands of chimney parts.
- Do not use connector pipe to pass through an attic, closet, wall, floor or ceiling.
- Use only pre-fabricated listed chimney and connector pipe. Field fabricated or "makeshift" parts could result in a chimney or house fire.
- Inspect all chimney parts for damage. Do not use any damaged chimney parts

An all fuel chimney system consists of prefabricated metal chimney parts that have been designed and tested for use with modern wood stoves. Examples include:

- **DuraTech manufactured by DuraVent**
- **Excel manufactured by ICC Chimney**
- **Ultra Temp manufactured by Selkirk**
- **Temp/Guard manufactured by Metal-Fab**

When choosing a location for your chimney you will need to study the clearance requirements for both the stove and the chimney. Many chimney systems require a 2" air space around the pipe. Refer to the clearance diagrams in section 2 for minimum clearances around this stove. You will need to install supports, braces, shielding and firestops according to the chimney manufacturer's recommendations. When passing the chimney through an attic space an insulation shield must be used to ensure that no insulation can contact the chimney. For safety, the chimney must penetrate the roof a minimum of 3 feet AND must be at least 2 feet higher than any part of the roof that is within 10 feet of the chimney. For proper draft, the venting system (chimney + connector pipe) should be at least 14 feet from the stove top to the venting cap. If you live in a snowy region and you have a metal roof, consider adding snow breaks or diverters to your roof to prevent damage from sliding snow and ice.

Typical installation of an all fuel chimney system



ADDITIONAL REQUIREMENTS FOR MANUFACTURED (MOBILE) HOMES

WARNING

- The structual integrity of the mobile home floor, wall and ceiling/roof must be maintained.
- Do not install in a sleeping room of a mobile home.

- An outside air kit (KA OA 1) is required for all mobile home installations. Follow the instructions located in the box.
- Double wall connector pipe is required for all mobile homes.
- Using 8 gauge ground wire and appropriate connectors, you must drill through the hearth and connect the stove to the metal frame underneath the mobile home.
- When required by local code, you will need to fasten the stove to the floor of the mobile home.

WHEN CONNECTING TO A MASONRY CHIMNEY

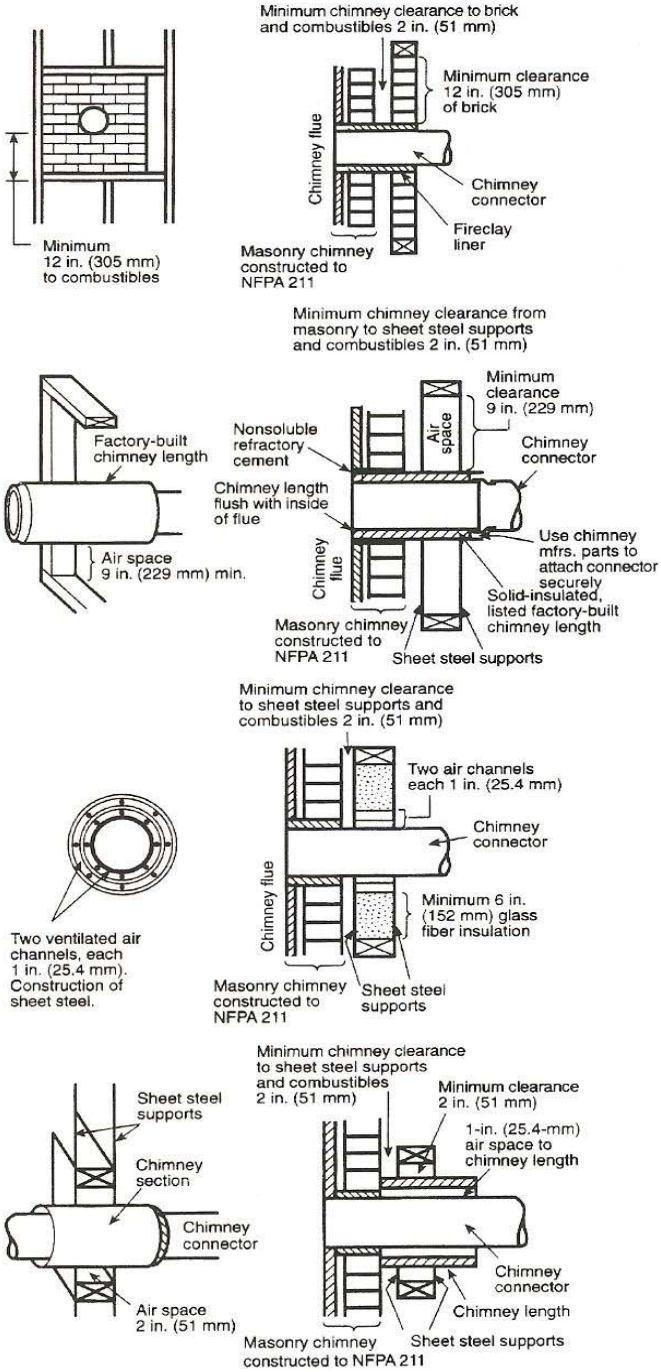
WARNING

- WHEN PENETRATING A COMBUSTIBLE WALL TO CONNECT TO AN OUTSIDE MASONRY CHIMNEY YOU MUST BE CERTAIN THAT THE WALL PASS THROUGH IS A SAFE AND LISTED METHOD.
- The connection between your chimney and this stove must be constructed according to the NFPA 211 standard. See Figure 6-7.5 from the **NFPA 211-2016, *Standard for Chimneys*** below

Your masonry chimney must be built according to the NFPA 211 standard. Visit nfpa.org for free access to the standard. Have a certified chimney sweep clean and inspect your chimney to make sure that there are no cracks, damaged mortar joints, or blockages. Your chimney must have a 5/8" thick fireclay liner. If your chimney does not have a 5/8" thick fireclay liner or it is damaged, you must install an insulated chimney liner that will meet the UL 1777 standard for chimney liners. Kuma recommends that an insulated chimney liner always be installed into a masonry chimney for improved performance and ease of cleaning.

FIGURE 6-7.5 Chimney connector systems and clearances from combustible walls for residential heating appliances.

System		Clearance (in.)/(mm)
A	Minimum 3.5 in. (90 mm) thick brick masonry wall framed into combustible wall with a minimum of 12-in. (305-mm) brick separation from clay liner to combustibles. Fireclay liner (ASTM C 315, *Standard Specification for Clay Fire Linings*, or equivalent), minimum ⅝-in. (16-mm) wall thickness, shall run from outer surface of brick wall to, but not beyond, the inner surface of chimney flue liner and shall be firmly cemented in place.	12/305
B	Solid-insulated, listed factory-built chimney length of the same inside diameter as the chimney connector and having 1 in. (25.4 mm) or more of insulation with a minimum 9-in. (229-mm) air space between the outer wall of the chimney length and combustibles. The inner end of the chimney length shall be flush with the inside of the masonry chimney flue and shall be sealed to the flue and to the brick masonry penetration with non-water-soluble refractory cement. Supports shall be securely fastened to wall surfaces on all sides. Fasteners between supports and the chimney length shall not penetrate the chimney liner.	9/229
C	Sheet steel chimney connector, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness, with a ventilated thimble, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness, having two 1-in. (25.4-mm) air channels, separated from combustibles by a minimum of 6 in. (152 mm) of glass fiber insulation. Opening shall be covered, and thimble supported with a sheet steel support, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness. Supports shall be securely fastened to wall surfaces on all sides and shall be sized to fit and hold chimney section. Fasteners used to secure chimney section shall not penetrate chimney flue liner.	6/152
D	Solid-insulated, listed factory-built chimney length with an inside diameter 2 in. (51 mm) larger than the chimney connector and having 1 in. (25 mm) or more of insulation, serving as a pass-through for a single wall sheet steel chimney connector of minimum 24 gauge [0.024 in. (0.61 mm)] thickness, with a minimum 2-in. (51-mm) air space between the outer wall of chimney section and combustibles. Minimum length of chimney section shall be 12 in. (305 mm). Chimney section concentric with and spaced 1 in. (25.4 mm) away from connector by means of sheet steel support plates on both ends of chimney section. Opening shall be covered, and chimney section supported on both sides with sheet steel supports of minimum 24 gauge [0.024 in. (0.61 mm)] thickness. Supports shall be securely fastened to wall surfaces on all sides and shall be sized to fit and hold chimney section. Fasteners used to secure chimney section shall not penetrate chimney flue liner.	2/51



Additional requirements:

1. Insulation material used as part of wall pass-through system shall be of noncombustible material and shall have a thermal conductivity of 1.0 Btu-in./hr-ft^2-°F (4.88 kg-cal/hr-m^2-°C) or less.
2. All clearances and thicknesses are minimums; larger clearances and thicknesses shall be permitted.
3. Any material used to close up an opening for the connector shall be of noncombustible material.
4. A connector to a masonry chimney, except for System B, shall extend in one continuous piece through the wall pass-through system and the chimney wall to the inner face of the flue liner, but not beyond.

WHEN CONNECTING TO A MASONRY FIREPLACE

WARNING
This stove must be connected to a code approved (e.g. NFPA 211) masonry chimney with a 6" flue liner. If the masonry chimney does not meet code, a U.L. 1777 approved liner must be installed.

This section to be completed after the safety testing certification is complete.

SECTION 4 - OPERATING INSTRUCTIONS

WARNING

- NEVER USE FLAMMABLE LIQUIDS TO START OR FRESHEN UP A FIRE
- Do not leave the stove unattended with the door open.
- DO NOT OVERFIRE THIS HEATER – Attempts to achieve heat output rates that exceed heater design specifications can result in permanent damage to the heater and to the catalytic combustor.

SELECTING WOOD

The leading cause for creosote build-up in the stove or chimney is moisture in the wood. Wood should be protected from rain and seasoned for 1 full year prior to being used. Your wood must have a moisture content of 20% or less. You will need to use a moisture meter to determine the moisture content of the wood. The recommended wood length for this heater is 18". This heater is designed to burn natural wood only. Higher efficiencies and lower emissions generally result when burning air dried seasoned hardwoods, as compared to softwoods or to green or freshly cut hardwoods.

DO NOT BURN:

a. Garbage;
b. Lawn clippings or yard waste;
c. Materials containing rubber, including tires;
d. Materials containing plastic;
e. Waste petroleum products, paints or paint thinners, or asphalt products;
f. Materials containing asbestos;
g. Construction or demolition debris;
h. Railroad ties or pressure-treated wood;
i. Manure or animal remains;
j. Salt water driftwood or other previously salt water saturated materials;
k. Unseasoned wood; or
l. Paper products, cardboard, plywood, or particleboard.

Burning these materials may result in release of toxic fumes or render the heater ineffective and cause smoke. The prohibition against burning these materials does not prohibit the use of fire starters made from paper, cardboard, saw dust, wax and similar substances.

UNDERSTANDING DRAFT

Draft is the force which moves exhaust from the appliance up through the chimney. Factors that can affect the way you stove drafts are:

- **The length of your chimney** can create excessive or inadequate draft.
- **Wind** can create excessive or inadequate draft.
- **Creosote buildup** in your chimney can create inadequate draft.
- **Nearby obstructions** or geographical features can create inadequate draft.
- **A cold chimney** can create inadequate draft.
- **Air density and moisture** in the air can create inadequate draft.

Too much draft may cause excessive temperatures in the appliance and may damage the internal components of the stove. An uncontrollable burn or excessive temperature indicates excessive draft.

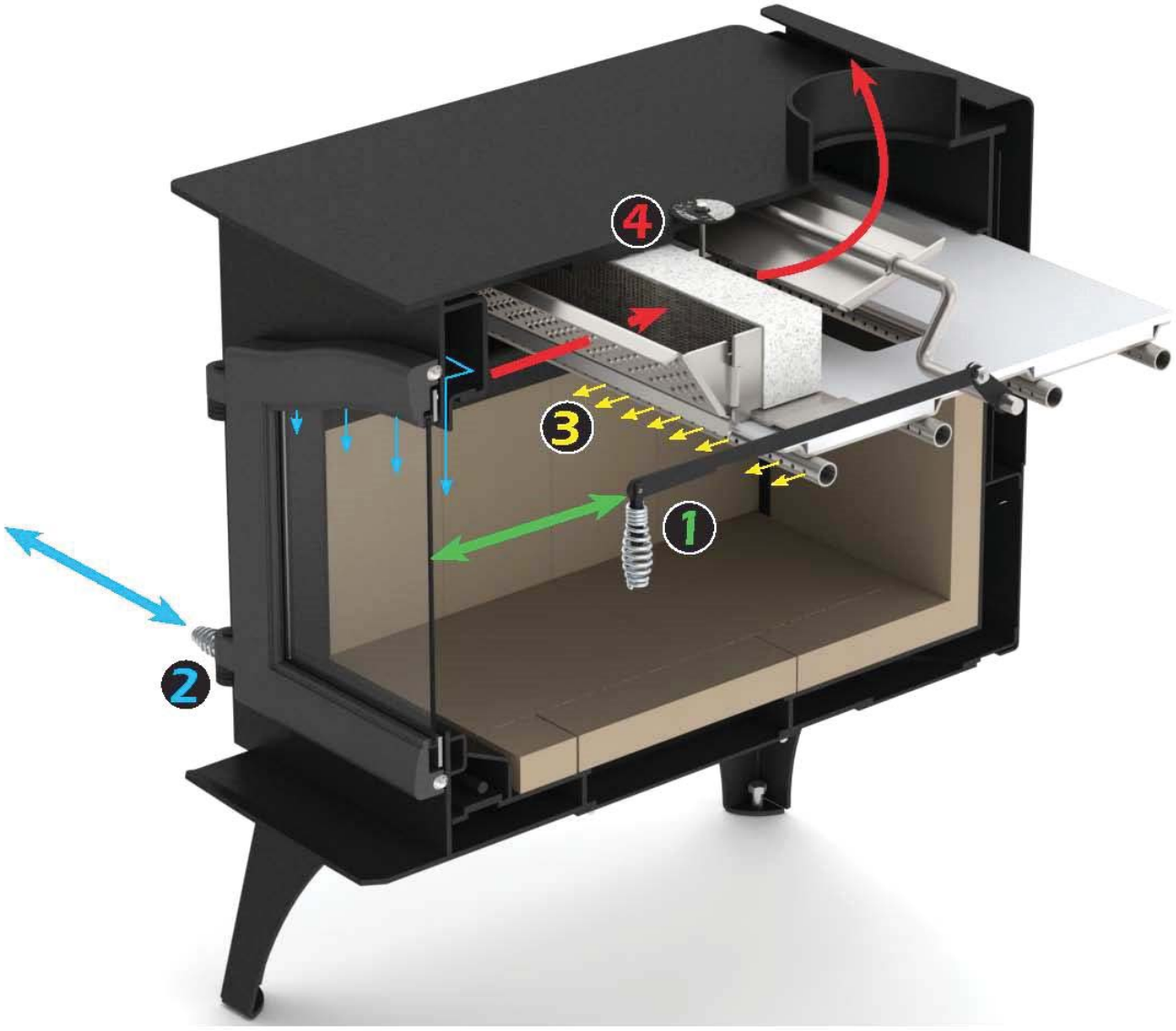
Inadequate draft may cause back puffing into the room and creosote formation in the chimney. Inadequate draft will cause the appliance to leak smoke and carbon monoxide into the room through appliance and chimney connector joints.

UNDERSTANDING HYBRID WOOD STOVE TECHNOLOGY

This stove's burn system combines the features of non-catalytic technology with the clean efficient burn of catalytic wood stove to create an easy to use, ultra-low emission hybrid appliance. Read about each feature below to help you operate your stove efficiently and beautifully

1 Bypass Control

2 Primary Air Control



3 Secondary Burn System

4 Catalytic & Catalytic Thermometer

1. **Bypass Control** – Located in the upper right side of the stove, the bypass control allows smoke and heat to temporarily bypass the hybrid burn system. This helps to quickly heat the chimney and prevent any smoke from coming into the room when the door is open. Pulling the lever towards you then down will open the bypass plate. Lifting up then pushing in will close the bypass plate.

    a. Only open the bypass when starting or re-fueling your stove. During normal operation, the bypass remains closed.

    b. Never open the wood loading door unless you have opened the bypass plate first. If you do this, smoke will spill into the room.

2. **Primary Air Control** – Located on the lower right side of the stove, this control changes the rate of burn for the stove. Slide out for high heat output and slide in for low heat output. You can operate the stove at any burn rate in between high and low.

    a. Always set the air control to high for 20 to 30 minutes when starting or refueling your stove. This allows the stove and chimney to quickly come up to operating temperature.

    b. When set to high, the primary air washes the glass as it feeds the fire to help keep it clean. If your glass has built up any smoke deposits from slow burning, set the air control to high for 20 to 30 minutes.

    c. Never over fire the stove by leaving the air control on high for too long (see Catalytic and Catalytic Thermometer below).

3. **Secondary Burn System** – There are no controls for this system. The stove will automatically draw air into the secondary burn tubes to re-burn smoke before it reaches the catalyst.

4. **Catalytic & Catalytic Thermometer** – The catalytic is a metal honeycomb shaped device that cleans up most of the remaining smoke before it travels up the chimney. The catalytic thermometer shows you the correct temperature to operate the stove at.

    a. Always operate the stove in the active range.

    b. There is a caution symbol on the probe warning you that your catalytic combustor is approaching the "too hot" zone

    c. Use the Primary Air Control to change the temperature of the stove.

    d. As your stove cools there is an "R" reminding you to reload your stove before the catalytic combustor becomes inactive.

LIGHTING A FIRE

1. Start by sliding the air control out to fully open.
2. Pull open the bypass control to the **Start/Reload Position** (A short pull forward **(about ¾")** and down will engage the bypass in the Start/Reload Position). Open the wood loading door.

3. Do not use a grate or elevate the fire – Build the wood fire directly on the fire brick. Start by loading larger pieces of wood into the firebox bottom then stack progressively smaller pieces so that the kindling pieces are at the top of the stack. You may use a fire starter such as shredded paper on top of the kindling. When starting a fire you should never use un-split pieces of wood unless they are small, such as twigs and branches.
4. Light the Fire, you can optionally leave the door slightly cracked open to aid in the start-up of your stove. Close the door once the fire is well lit. Do not leave the stove unattended with the door open.
5. After 15 minutes or Once the catalytic thermometer 1st reaches the active range, close the bypass control to the **Run Position** engaging the combustor (Simply lift the bypass control and you will feel it return to the run position).
6. Leave the air control open for 20-30 minutes so that the fire becomes well established. If you shut the stove down too soon, it may go out or the combustor may stop working.
7. Begin to regulate the heat output and burn rate by sliding in the primary air control. Use the following table to adjust your rate of burn.

Desired Burn Rate	Position of the air control	Approximate Burn Time
Low Burn	Fully Closed	10-12 hours
Medium Burn	3/32" Open*	6-8 hours
Start Up	Fully Open	2-3 hours

*This is a very small pull from the fully closed position. You will find that the most significant range in heat output and burn time happens in the 1st ½" of stroke on the primary air control.

ADDING MORE WOOD TO THE FIRE

1. Slide the air control to fully open and pull open the bypass to the **Start/Reload Position.** Wait 5 minutes to allow the coals to become active and to allow the smoke to draft up the chimney.
2. Slowly open the wood loading door and rake the coals breaking up any larger pieces. Add wood then shut the door.
3. As soon as the catalytic thermometer is in or near the active range, close the bypass control to the **Run Position** engaging the combustor.
4. Leave the air control open for 10-20 minutes so that the fire becomes well established then begin to adjust your rate of burn.

ADDITIONAL TIPS FOR BURNING EFFICIENTLY

Burning wood produces both visible emissions (e.g. particulate matter or smoke) as well as invisible

emissions (e.g. Carbon Monoxide). When operating your stove, periodically check for visible emissions coming from the chimney and adjust the burn rate and fuel load to reduce emissions. Remember to let your stove burn open for 20-30 minutes each time you reload it with wood. Shutting the air control prematurely can cause excessive creosote in the chimney. This wood heater has a manufacturer-set minimum low burn rate that must not be altered. It is against federal regulations to alter this setting or otherwise operate this wood heater in a manner inconsistent with operating instructions in this manual. Small hot fires produce less creosote than long, low smoldering fires. When you start your stove or reload your stove with more wood, open the draft fully and burn the stove at high burn for 10-30 minutes to heat up the chimney and secondary burn system. This ensures that when the draft control is pushed in for a lower, longer burn, the stove will burn cleaner.

SECTION 5 - CATALYST INFORMATION

TAMPER WARNING

This wood heater contains a catalytic combustor which needs periodic inspection and replacement for proper operation. It is against federal regulations to operate this wood stove in a manner inconsistent with the operating instructions in this manual, or if the catalytic element is deactivated or removed.

CATALYST TYPE

The combustor supplied with this wood stove is an Applied Catalysts ACI-5M combustor. Please refer to section 6 for catalyst maintenance. Refer to section 7 for catalyst troubleshooting. Refer to section 8 for catalyst warranty information.

CATALYST MONITORING

It is important to periodically monitor the operation of the catalytic combustor to ensure that it is functioning properly and to determine when it needs to be replaced. A non-functioning combustor will result in a loss of heating efficiency, and an increase in creosote and emissions. Following is a list of items that should be checked on a periodic basis:

1. Combustors should be visually inspected at least three times during the heating season to determine if physical degradation has occurred. Actual removal of the combustor is not recommended unless more detailed inspection is warranted because of decreased performance. If any of these conditions exists, refer to Catalyst Troubleshooting section of this owner's manual.
2. This hybrid heater is equipped with a temperature probe to monitor catalyst operation. Properly functioning combustors typically maintain temperatures in excess of 500°F, and often reach temperatures in excess of 1,000°F. If catalyst temperatures are not in excess of 500°F, refer to the Catalyst Troubleshooting section of this owner's manual.
3. You can get an indication of whether the catalyst is working by comparing the amount of smoke leaving the chimney when the smoke is going through the combustor and catalyst light-off has been achieved, to the amount of smoke leaving the chimney when the smoke is not routed through the combustor (bypass mode).
    - Step 1—Light stove in accordance with instructions in section 4.
    - Step 2—With smoke routed through the catalyst, go outside and observe the emissions leaving the chimney.
    - Step 3—Engage the bypass mechanism and again observe the emissions leaving the chimney.
    - Significantly more smoke will be seen when the exhaust is not routed through the combustor (bypass mode).

READING THE CATALYST PROBE

Follow the instructions in section 4 to build and maintain a fire. During normal operation the probe should read in the active range. If, during normal operation, the probe reads less than the active range, the stove should be refueled following the instruction in section 4. If the probe is climbing above the active range, you need to decrease the primary air control so that you do not over-fire the stove or catalyst.

SECTION 6 - MAINTENANCE

WARNING

- This wood heater needs periodic inspection and repair for proper operation.

FIRE EXTINGUISHER

Every home should have a type A:B:C fire extinguisher that is checked and maintained on a regular basis. The National Fire Protection Agency (nfpa.org) recommends having an extinguisher on each floor of your home. The location of the extinguisher should be known to everyone in the house.

ASH DISPOSAL

Empty the ashes when they get 3" to 4" deep. Make sure that the fire is out - Never try to empty the ashes when the stove has an active or full fire, doing so will over heat the stove. Always wear gloves while handling hot ashes. The ashes may be removed by pulling out the ash drawer (if equipped) or scooping out the loading door of the stove. Leave 1" of ash in the bottom of the stove to help maintain a hot charcoal bed. Dump the ashes into a metal container with a tight-fitting lid and keep away from the house. **NEVER EMPTY ASHES INTO A COMBUSTIBLE CONTAINER SUCH AS A PLASTIC BUCKET OR PAPER BAG. NEVER LEAVE ASHES NEAR THE HOUSE OR GARAGE.** Before replacing the ash drawer, check to see if any ashes need to be removed from the ash pan plenum. If any ashes remain in the ash plenum it will prevent the ash pan from sliding all the way in and it may not seal, resulting in air entering the ash grate which will produce a runaway fire.

CHIMNEY INSPECTION AND CLEANING

Inspect the chimney regularly. Slow exhaust and a cool chimney can cause creosote to stick to the walls of the chimney. If creosote has accumulated the chimney must be cleaned immediately. We recommend having the chimney cleaned and inspected by a licensed, professional chimney sweep. Failure to remove creosote can result in a chimney fire which can damage both the chimney and the stove. If the chimney is damaged, it must be replaced.

GASKET INSPECTION AND REPLACEMENT

Inspect the gaskets around the door, glass and ash pan (if equipped) at least once a year. Check for areas that are frayed or missing. Press the gasket with your finger to see if the gasket is somewhat soft. Gaskets that are hard will not conform to the stove and may leak air. When the stove is cold, check to see if the glass moves up and down or left to right. If the glass moves, you may need to tighten the screws around the retaining ring or replace the gasket. Replacement gaskets and service are available through your local dealer or by visiting kumastoves.com.

GLASS CLEANING AND REPLACEMENT

Never clean the glass when it is hot. Your stove is equipped with an air wash system that will self-clean. Burn the stove on high for 20 to 30 minutes every time you add fuel to the fire. This will reduce the creosote on the glass. If needed, clean the glass with a soft cloth and stove glass cleaner. Do not use steel wool, sandpaper or abrasive cleaners. If you close the door on a piece of wood that is too long, you will break the glass. If the glass breaks in your stove, shut off the primary air control and let the fire burn out. Do not leave the stove unattended with a broken glass. To replace broken glass:

1. Carefully lift the door from the stove and place it on a clean soft work area.
2. Using a Phillips screw driver, remove the retaining ring screws and the retaining ring.
3. Carefully discard the broken glass. CAUTION: BROKEN GLASS WILL BE SHARP.
4. Clean the door and set the new piece of glass into the door so that the logo reads correctly from the front side of the door. Kuma replacement glass will have the gasket pre-installed.
5. Replace the retaining ring and screws. Be careful to tighten the screws evenly and tighten just enough to hold the glass firmly

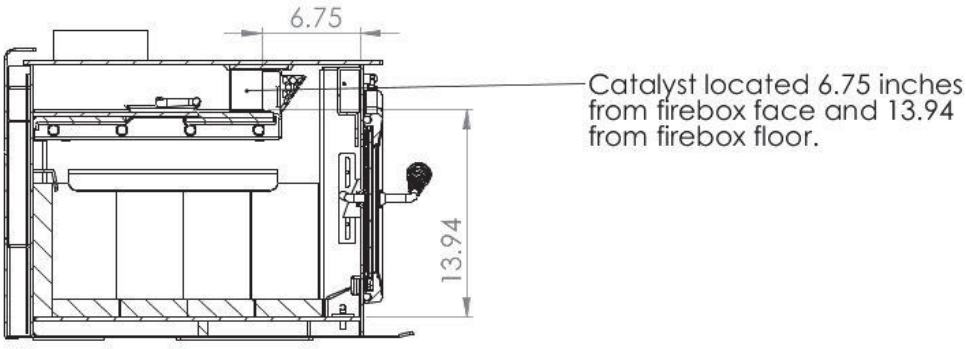
SECONDARY BURN TUBE REPLACEMENT

The burn tubes are one of two burn systems that causes your stove to operate efficiently, this stove also uses a catalyst to clean some of the remaining smoke before it leaves the stove. If your burn tubes are not physically degraded (falling apart, crushed or excessively warped) then they are functioning and will not need replacement. To remove a burn tube, un-bolt the tube using a 7/16" wrench. Pull the tube to the right then down and out of the stove. Replace the tube and re-install the bolt the holds the tube in place.

CATALYST INSPECTION, CLEANING AND REPLACEMENT

The catalyst is one of two burn systems that causes your stove to operate efficiently, this stove also uses secondary burn tubes to re-burn smoke before it reaches the catalyst. To inspect your catalyst, unhook the flame deflector from the face of the baffle by lifting up and pulling forward. If your catalyst has not physically degraded (falling apart, crushed or excessively warped) then it is likely functioning and will not need replacement. If your Catalytic combustor becomes plugged with ash, clean the catalyst **in place** using a soft brush or for deeper cleaning use a slight to moderate (~20-30 psi.) amount of air pressure blowing any ash through the cells of the catalyst. To replace the catalyst:

1. Unhook the flame deflector from the face of the baffle by lifting up and pulling forward. Set aside.
2. Pull the catalyst out using the 2 handles that the flame deflector was hooked to. You may need to wiggle the catalyst to loosen the gasket material.
3. Remove any gasket material that was left in the baffle cavity.
4. Your new catalyst will be wrapped in a gasket material that is held in place with masking tape. Do not remove the tape
5. Slide the new catalyst into the cavity until it stops. If you see any significant gaps around the sides or top of the catalyst you will need to slide the catalyst out and wrap those areas with additional gasket material (you can use masking tape to hold it in place). The gasket provided will expand 2-3 times it's original thickness once heated to seal any minor gaps



BRICK AND CERAMIC INSULATION REPLACEMENT

Bricks and ceramic insulation should be inspected and replaced if necessary at least once a year. Cracked bricks are fine as long as they remain in place. Bricks that are crumbling or falling out need to be replaced. The ceramic insulation is located on the top of the stove's baffle and is designed to keep heat in the stove and increase efficiency. As long as the insulation is in place it can be left alone. If the insulation becomes torn during cleaning, simply lay it back together tightly in that area. If the insulation tears to multiple pieces, it should be replaced. To replace the ceramic insulation, remove the 4 burn tubes allowing the entire baffle to come down and out of the stove. Mark or otherwise note the order of the tubes so they can be replaced in the same location. Lay the 2 smaller strips of insulation into the valleys of the corrugated baffle plate and lay the large piece over the entire baffle aligning the edges of the insulation with the edges of the baffle plate. Re-install the baffle and the 4 burn tubes.

MAINTENANCE PARTS LIST AND DIAGRAMS

TBD

SECTION 7 - TROUBLESHOOTING

STOVE BURNS LAZY AT START UP.

1. The chimney is still cool, allow more time to warm up.
2. Wood is not seasoned (still green). Wood should sit for about 1 year, split and loosely stacked if it was cut green.
3. Wood is well seasoned but has a lot of surface moisture. Your wood supply must be covered. Check your tarps or other covering to see that no rain or snow is getting to your wood. Wood should be covered on top, but open on the sides to allow air movement to aid in drying.
4. Stove is being shut down too soon. Leave the air open for longer. (do not leave the stove unattended with door open) See Section 4 for lighting instructions.

STOVE BACK-PUFFS OR SMOKES INTO THE ROOM AT START UP.

1. Chimney is cold. Cold chimneys can produce a "reverse draft" where cold air is rushing down the chimney into the stove. Open a door or a window for about 5 minutes to equalize pressure in the house then try restarting with small strips of newspaper. Using small strips of newspaper or an approved fast burning fire starter and small pieces of kindling will create heat faster to help reverse the cold air.
2. Chimney and/or the chimney cap needs to be cleaned. Your chimney should be checked and cleaned if necessary every few months. Even a small amount of buildup can cause a draft restriction, for example: ¼ inch of buildup on the side wall of an 8" chimney reduces the effective area of the chimney by about 20%. Pay close attention to the chimney cap, especially if it has a screen. Screened chimney caps can become blocked enough to restrict flow in just a few weeks.

STOVE SMOKES OUT THE DOOR WHEN IT IS OPEN.

1. The door was opened before the bypass rod was pulled open. Open the bypass for 1 minute before opening the door.
2. The door was opened too quickly. Crack the door open just a small amount and let the stove "breathe" a few seconds before opening all the way.
3. Chimney and/or the chimney cap needs to be cleaned. Your chimney should be checked and cleaned if necessary every few months. Even a small amount of buildup can cause a draft restriction, for example: ¼ inch of buildup on the side wall of a 6" chimney reduces the effective area of the chimney by about 20%. Pay close attention to the chimney cap, especially if it has a screen. Screened chimney caps can become blocked enough to restrict flow in just a few weeks.

STOVE WON'T SHUT DOWN.

1. Check the main door gasket and glass gasket for proper seal. See section 6 for instructions on checking your gaskets.

STOVE WON'T BURN HOT ENOUGH. LAZY BURN.

1. Wood is not seasoned (still green). Wood should sit for about 1 year, split and loosely stacked if it was cut green.
2. Wood is well seasoned but has a lot of surface moisture. Your wood supply must be covered. Check your tarps or other covering to see that no rain or snow is getting to your wood. Wood should be covered on top, but open on the sides to allow air movement to aid in drying.
3. Chimney and/or the chimney cap needs to be cleaned. Your chimney should be checked and cleaned if necessary every few months. Even a small amount of buildup can cause a draft restriction, for example:

¼ inch of buildup on the side wall of an 8" chimney reduces the effective area of the chimney by about 20%. Pay close attention to the chimney cap, especially if it has a screen. Screened chimney caps can become blocked enough to restrict flow in just a few weeks.

4. Catalytic combustor is plugged with ash. Clean the catalyst in place using a slight to moderate (~20-30 psi.) amount of air pressure blown through the baffle grid removing ash from the catalyst cells.
5. Atmospheric conditions. Occasionally, barometric episodes occur that affect draft, thereby affecting stove performance. If your stove has been working fine and performance drops suddenly, this is most likely the cause, and will usually go away within a few days.
6. Your fuel load may be too small or the wood size too large for the coal bed. A small bed of coals requires re-kindling to build up the heat, only put large chunks of wood on a very hot and active bed of coals.

BURN TIME TOO SHORT.

1. Your fuel load may be too small or the wood size too large for the coal bed. A small bed of coals requires re-kindling to build up the heat, only put large chunks of wood on a very hot and active bed of coals. If there are large chunks of charred wood left after the fire has gone out, the coal bed was not hot enough.
2. Fuel quality. Harder, denser woods produce longer burn times. Likewise, softer woods produce shorter burn times.
3. Check the main door gasket and glass gasket for proper seal. See for instructions on checking your gaskets.

CATALYST TROUBLESHOOTING.

Problem	Cause	Solution
Catalyst plugged with creosote	Burning wet wood or pushing in the bypass rod too soon.	Burn only dry, seasoned natural wood. Burn a hot fire with the bypass rod partially open to burn off the creosote buildup.
Catalyst masked with soot or fly ash.	Pushing in the bypass rod too soon. Burning improper material such as cardboard, coal or wrapping paper.	Burn a hot fire with the bypass rod partially open to burn off the creosote buildup. Burn only dry seasoned natural wood.
Lower Efficiency	Flames contacting the catalyst from excessive draft. Poisoning	Use less wood or lower the air to the stove. Install a damper to reduce draft. Do not burn material that will poison the catalyst such as colored paper, cardboard, paneling, painted or treated wood.
Catalyst is plugged with fly ash	Pushing in the bypass rod too soon. Burning material that produces fly ash and char. See section 4 for a list of improper materials	Make sure you achieve catalyst light off (see section 4) Burn only dry, seasoned natural wood.

SECTION 8 - WARRANTY

Our Promise:

If any maintenance items wear out in the first three years, we will supply you with the parts to fix it. For as long as you own your stove, if you ever have a defect in the material or workmanship of your stove's firebox, we will repair or replace it for you. See full details below:

Items Covered	Parts Coverage Period	Labor Coverage Period
Maintenance Items: Bricks, gasket, ceramic insulation and paint.	3 Years	No Labor Coverage
Blowers, ash grate, brick supports, Baffle plate and burn tubes.	5 Years	3 Years
Stove firebox, legs, glass (thermal breakage) and door casting.	Forever	3 Years

Catalyst Warranty: The combustor supplied with this heater is an Applied Catalysts ACI-5M, Long Life Combustor. Following is the catalytic combustor warranty supplied with this wood heater. Catalyst warranty claims should be addressed to: Kuma Stoves 50145 N. Old Highway 95 Rathdrum ID, 83858. Ph. 888-714-5294. All warranty claims must meet the following conditions: 1. warranty has been registered proving the date of purchase. 2. You return the catalyst to Kuma stoves. 3. The catalyst has not been abused by over-firing or using unauthorized fuels. If the catalyst loses its structural integrity within 6 years of purchase, Kuma stoves will replace the catalyst at no charge. For the next 6 years, a replacement catalyst is available for purchase from Kuma Stoves at a 50% discount from MSRP. The above 3 conditions apply when qualifying for the discounted rate. All replacement catalysts will have a 90 day warranty coverage.

Warranty Coverage:

To ensure warranty coverage, it is very important that you register your Kuma Stove warranty within 30 days of purchase at kumastoves.com or fill out and return the warranty registration in your owner's packet. Operation of this stove in a manner inconsistent with the owner's manual, especially the burning of materials for which this unit is not certified by the EPA, will void the warranty. This warranty covers your new Kuma Stove from defects in material and workmanship for the period outlined in this warranty. Kuma Stoves reserves the right to replace, repair or authorize repair of any defective part at its sole discretion. This warranty is not transferrable and covers the original owner of the product from the time of purchase. All parts that have been replaced under this warranty will have a 90 day warranty coverage. The maximum value of this warranty is the original purchase price of the product. This warranty is subject to the conditions and limitations outlined below. This warranty covers stoves purchased from an authorized Kuma Stoves dealer.

Warranty Instructions:

Please contact the dealer where you purchased your stove. You may also contact Kuma stoves directly at 50145 N. Old Highway 95, Rathdrum ID 83858 or by phone at 1-888-714-5294 or contact us online at kumastoves.com. When calling, you will need to have your proof of purchase, the model name, and the serial number of your stove. When calling please remember that shipping and handling costs are not covered under this warranty.

Warranty Exclusions:

This Warranty does not cover: 1. Changes in the color of the surface of the stove as this naturally happens during the firing of the stove and is considered normal. 2. Damage to plating due to chemical cleaners, fingerprints, or scratching. 3. Shattered glass caused from wood impact. 4. Discoloration of plating or glass. 5. Expansion and contraction of the firebox causing noise. 6. Damage caused from: power surges, unauthorized modifications, using incorrect fuel and/or accelerants, shipping/handling, failure to follow the manufacturer's installation instructions, failure to follow any local building codes. 7. Damages to any product not manufactured by Kuma Stoves. 8. Any stoves ability to heat a specific area. Heating capacity is given as a guideline and is not guaranteed. 9. Shipping costs or travel time. Please talk with an authorized dealer or Kuma representative about the potential

charges for travel or shipping. 10. This warranty is void in the case of abuse, over firing, unauthorized repair, alterations, improper installation and/or service.

Appendix A
Alt-125 E3053 Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

FEB 2 8 2018

Mr. Justin White

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Dear Mr. White,

I am writing in response to your letter dated January 12, 2018, regarding wood heaters manufactured by Hearthstone QHPP, Inc. (Hearthstone). This response, dated February 28, 2018, supercedes our previous response (dated February 26, 2018) to correct an inaccuracy regarding required changes to ASTM E3053-17.

You are requesting to use an alternative test method, using cord wood, as referenced in section 60.532(c) of 40 CFR part 60, Subpart AAA, Standards of Performance for New Residential Wood Heaters (Subpart AAA) to meet the 2020 cord wood alternative compliance option. The 2020 cord wood alternative compliance option states that each affected wood heater manufactured or sold at retail for use in the United States on or after May 15, 2020, must not discharge into the atmosphere any gases that contain particulate matter in excess of 2.5 g/hr. Compliance must be determined by a cord wood test method approved by the Administrator along with the procedures in 40 CFR 60.534. You have requested approval to use the procedures and specifications found in ASTM Method E3053-17, a cord wood test method titled, "Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters using Cordwood Test Fuel," in conjunction with ASTM E2515-11 and Canadian Standards Administration (CSA) Method CSA-B415.1-10, which are specified in 40 CFR 60.534.

We understand that Hearthstone is also requesting that the alternative method proposed above be approved to apply broadly to all wood heaters manufactured by Hearthstone meeting the requirements of Subpart AAA, from the approval date of this request until such time that Subpart AAA is revised or replaced to require a different cord wood certification method, providing all requirements of section 60.533 of Subpart AAA are met.

With the caveats set forth below, we approve your alternative test method request for certifying wood heaters using ASTM E3053-17 in conjunction with section 60.534 of Subpart AAA to meet the 2020 cord wood compliance option until such time that Subpart AAA is revised or replaced to require a different cord wood certification method. We also approve application of this alternative method to all wood heaters manufactured by Hearthstone meeting the requirements of Subpart AAA.

As required in Subpart AAA, section 60.354(d), you or your approved test laboratory must also measure the first hour of particulate matter emissions for each test run using a separate filter in one of the two parallel sampling trains. These results must be reported separately and also included in the total particulate matter emissions per run. Also, as required by Subpart AAA, section 60.534(e), you must have your approved laboratory measure the efficiency, heat output, and carbon monoxide emissions of the tested wood heater using CSA-B415.1-10. For measurement of particulate matter emission concentrations, ASTM 2515-11 must be used.

The following change to ASTM E3053-17 must be followed:

1. Coal bed conditions prior to loading test fuel. The coal bed shall be a level plane without valleys or ridges for all test runs in the high, low, and medium burn rate categories.

The following changes to ASTM E2515-11 must be followed:

1. The filter temperature must be maintained between 80 and 90 degrees F during testing.

2. Filters must be weighed in pairs to reduce weighing error propagation; see ASTM 2515-11, Section 10.2.1 Analytical Procedure.

3. Sample filters must be Pall TX-40 or equivalent Teflon-coated glass fiber, and of 47 mm, 90 mm, 100 mm, or 110 mm in diameter.

4. Only one point is allowed outside the +/- 10 percent proportionality range per test run.

A copy of this letter must be included in each certification test report where this alternative test method is utilized.

It is reasonable that this alternative test method approval be broadly applicable to all wood heaters subject to the requirements of 40 CFR part 60, Subpart AAA. For this reason, we will post this letter as ALT-125 on our website at *http://www3.epa.gov/ttn/emc/approalt.html* for use by other interested parties. As noted earlier in this letter, this alternative method approval is valid until such time that Subpart AAA is revised or replaced to require a different cord wood certification method, and at such time, this alternative will be reconsidered and possibly withdrawn.

If you have additional questions regarding this approval, please contact Michael Toney of my staff at 919-541-5247 or toney.mike@epa.gov.

Sincerely,

Steffan M. Johnson, Group Leader
Measurement Technology Group

cc: Amanda Aldridge, EPA/OAQPS/OID
Adam Baumgart-Getz, EPA/OAQPS/OID
Rafael Sanchez, EPA/OECA
Michael Toney, EPA/OAQPS/AQAD

Appendix B
Catalyst Equivalence Test Procedure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
COMPLIANCE

DEC 15 2016

Chris Neufeld
Vice President
Blaze King Industries, Inc.
146 A Street
Walla Walla, Washington 99362

RE: Blaze King Industries, Inc. (Blaze King) Request for Catalyst Suitable Replacement Procedures

Dear Mr. Neufeld:

This letter is in response to the February 3, 2016, Blaze King letter requesting the United States Environmental Protection Agency (EPA) implement a program to allow catalyst equipped wood heater manufacturers and suppliers to seek suitable replacement status during the life cycle of the product. As discussed below, replacement catalysts may be used if equivalency is properly demonstrated.

To have a catalyst deemed suitable for replacement, equivalency testing must be conducted by an EPA-approved test laboratory. Consistent with the 2015 Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces (Subpart AAA) (2015 Standards), the manufacturer must notify the EPA of the date that certification testing (catalyst equivalency testing) is scheduled to begin as stated in Section 60.534(g). This notice must be received by the EPA at least 30 days before the start of testing. EPA will consider the following steps to be adequate to demonstrate replacement catalyst equivalency:

1) The manufacturer uses the same test method as the original certification test was conducted. If the original certification test method is no longer valid, the manufacturer requests an alternative test method prior to testing.

2) The replacement catalyst is aged 50 hours prior to catalytic equivalency testing. The catalyst is tested in the same model or model line unit in which the original catalyst was tested.

3) Both a Category 1 run and Category 4 run are conducted by an EPA-approved test laboratory.

4) The new Category 1 run is compared to the original Category 1 run, and the new Category 4 run is compared to the original Category 4 run. The new runs are not more than 0.5 grams/hour greater than the original certification test results for each run. They are compared separately, with no averaging. In equation form:

Replacement catalyst category 1 ≤ (original catalyst category 1 + 0.5g/hr)

AND

Replacement catalyst category 4 ≤ (original catalyst category 4 + 0.5g/hr)

As noted in Section 60.533(k)(4)[1], the EPA Administrator must approve the change in the catalyst in advance, with proper documentation of the equivalency testing. This documentation consists of the original certification test report category 1 and 4 data and the new category 1 and 4 test data results. All demonstration test data must be sent to WoodHeaterReports@epa.gov within 60 days after the date of completing the test. EPA considers the catalyst equivalency testing to be a form of certification testing governed by the provisions in Section 60.534.

The EPA finds the request outside the scope of an applicability determination. The term "applicability determination" is limited to the Agency's formal decisions, issued in response to a non-hypothetical and site-specific request about the applicability of a specific rule to a specific facility. Therefore, the EPA considers this response to be a regulatory interpretation to a source request for clarification.[2]

This response has been prepared in consultation with the Office of Air Quality, Planning, and Standards, and the Office of General Counsel. If you have any questions, please contact Rafael Sanchez of my staff at 202-564-7028 or email at sanchez.rafael@epa.gov.

Sincerely,

Edward J. Messina, Director
Monitoring, Assistance, and Media Programs Division
Office of Compliance

[1] A change in the make, model or composition of a catalyst is presumed to affect particulate matter and carbon monoxide emissions and efficiency, unless the change has been requested by the heater manufacturer and has been approved in advance by the Administrator, based on test data that demonstrate that the replacement catalyst is equivalent to or better than the original catalyst in terms of particulate matter emission reduction.
[2] This regulatory interpretation updates EPA Applicability Determination WDS-138 (July 6, 1990).

cc: Amanda Aldridge, OAQPS
Adam Baumgart-Getz, OAQPS
Mike Toney, OAQPS
Scott Jordan, OGC
Sara Ayres, OC

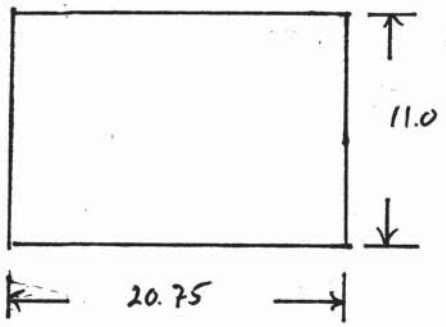
Appendix C
Firebox Volume

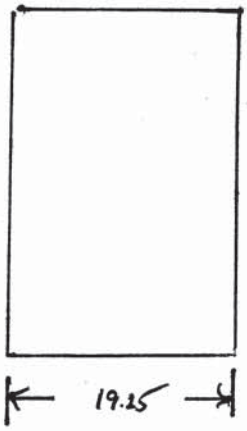
KUMA K250 series

0123WM012E. REV001

6/9/2020
B Davis
O-TL

H	W	D	
11.0	19.25	20.75 -	2.54 ft^3





Appendix D
Revision History

Date	Project No.	Tech. & Evaluator	Report Sect.	Summary of Changes
6/30/20	0123WM012E REV001	Bruce Davis	-	New project ("REV001") with separate CBI and Non-CBI Reports to address added catalyst option. Data in separate reports confirms catalyst equivalency.
10/12/20	0123WM012E REV001 Edition 001	Bruce Davis	1	Summary of Results updated with verbiage that further clarifies that the catalyst confirmation test results were found to be equivalent and that the K-250 maintains its previously certified emissions value. Based on EPA's requests during phone call dated 10/7/20.
3/10/21	0123WM012E REV001 Edition 002	Bruce Davis	1	Run summary on page 6 updated to clarify air setting for low burn was fully closed.
			Preface	Table of content updated to show addition of report history page in appendix D.
			3	Conditioning data on page 23 updated to show air control setting.
7/15/21	0123WM012E REV001 Edition 003	Bruce Davis	1	Sampling procedure updated to reference Applicability Determination WDS-138. Individual run summary on page 6 updated to clarify low burn setting. Added table 8 showing train precision.
			5	Manual page on report page 118 was replaced to fix medium burn air setting. Revision is not relevant to this report but is consistent with manual shown in original K250 report.
7/20/21	0123WM012E REV001 Edition 004	Bruce Davis	Appendix D	Updated report Revision History with additional details regarding previous report revisions.