

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

## **Catalyst Equivalence Certification Test Report**

**Kuma Stoves, Inc.**

**K-180 Series**

**Models: Aspen LE, Tamarack LE, Aberdeen LE,  
Alpine LE**

**Prepared for:** Kuma Stoves, Inc.  
50145 N Old Hwy 95  
Rathdrum ID 83858

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**Test Period:** September 14, 2020 – September 15, 2020

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**Report Number:** 0123WM011E


**Project Number:** 0123WM011E.REV002

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## **AUTHORIZED SIGNATORIES**

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

**Evaluator:**

  
Bruce Davis, Testing Manager  
OMNI-Test Laboratories

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# **Section 1**

## **Sampling Procedures and Test Results**



## INTRODUCTION

Kuma Stoves retained *OMNI* to perform U.S. Environmental Protection Agency (EPA) catalyst equivalency testing on the K-180 Series wood stove. The K-180 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 D of this report, an Applied Ceramics model ACI-5M-U3 catalyst was tested in an identically produced K-180 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 9/14/2020, then assigned and labeled with *OMNI* ID #2407. *OMNI* representative Bruce Davis conducted the certification testing and completed all testing by 9/15/2020.

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-180 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. 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-180 Series was tested for thermal efficiency and carbon monoxide (CO) emissions in accordance with CSA B415.1-10 using Douglas Fir 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 D), the results are determined to be equivalent and the K-180 Series wood stove will maintain the original certified emissions value of 0.72 grams per hour. By meeting the equivalence criteria, the Applied Ceramics model ACI-5M-U3 catalyst may be offered with the K-180 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 2.22 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. Observed burn rate was calculated at 0.64 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. Negative filter weights were found in filter train B, transfer of filter material can be seen as positive weight on the O-ring gasket. There is no evidence of filter loss, negative weight is added back into calculation or transfer weight would be counted as emissions. No additional sampling anomalies occurred, this test run was determined to be valid and appropriate for comparison to the original test results.

**Table 1 – Particulate Emissions**

<b>Run</b>	<b>Burn Rate</b> Calculated from a Hot to Hot burn cycle (kg/hr dry)	<b>Alternate Catalyst</b> <b>ASTM E3053</b> <b>Emissions</b> (g/h)	<b>Original Catalyst</b> <b>ASTM E3053</b> <b>Emissions</b> (g/h)	<b>Difference Between</b> <b>Alternate and Original</b> <b>Catalyst</b> (g/h)
1	2.22	<sup>1</sup> 2.26	2.03	0.23
2	0.64	0.39	0.39	0.0

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

**Table 2 – Particulate Emissions (First Hour)**

<b>Run</b>	<b>ASTM E2515</b> <b>Emissions – First Hour</b> (g/h)
1	2.53
2	1.71

**Table 3 – B415.1 Efficiency and CO Emissions**

<b>Run</b>	<b>Heat</b> <b>Output</b> (BTU/hr)	<b>HHV</b> <b>Efficiency</b> (%)	<b>LHV</b> <b>Efficiency</b> (%)	<b>CO Emissions</b> (g/MJ Output)	<b>CO Emissions</b> (g/kg Dry Fuel)	<b>CO Emissions</b> (g/min)
1	29,008	76.8	83.0	0.26	3.89	0.130
2	10,082	83.6	90.4	1.06	17.49	0.187

**Table 4 – Test Facility Conditions**

Run	Room Temperature (°F)		Barometric Pressure (Hg)		Air Velocity (ft/min)	
	Before	After	Before	After	Before	After
1	62	75	28.45	28.36	<50	<50
2	74	68	28.36	28.41	<50	<50

**Table 5 – Kindling and Start-up Fuel Description Summary  
Douglas Fir Cordwood**

Run	Kindling Weight Wet Basis (lbs.)	Start-up Fuel Weight Wet Basis (lbs.)	Residual Start-up fuel weight (lbs.)
1	3.4	5.1	2.0

**Table 6 – Fuel Measurement and Cordwood Description Summary – TEST  
Douglas Fir Cordwood**

Run	Test Fuel Wet Basis (lbs)	Firebox Volume (ft <sup>3</sup> )	Fuel Loading Density Wet Basis (lbs/ft <sup>3</sup> )	Test Fuel Dry Basis (lbs)	Test Fuel Consumed During Test Dry Basis (lbs)	Piece Length (in)
1	17.14	1.73	9.9	14.2 + 7.35	17.9	5@16
2	19.86	1.73	11.5	16.5	16.5	5@16

**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	243	18.13	187.2	100
2	700	17.77	188.5	85

**Table 8-Sample Train Precision**

Run Number	Train Precision ≤7.5%	Train Precision ±0.5 g/kg	Compliant
1	8.34	0.19	Yes
2	10.62	0.13	Yes

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

**Table 10 – Test Configurations**

Run	Startup Procedures	Combustion Air
1	<p><u>Fuel Loading:</u> Kindling and start-up fuel loaded together; a torch was used for 25 seconds to establish a top down fire. At 69 minutes placed fuel load into the firebox and closed the loading door. Loading required 1:45 minute to complete.</p> <p><u>Door:</u> For kindling and start-up fuel, loading door was cracked open 1” for 51 seconds, then closed. Test fuel load; fuel loading door was closed by 105 seconds.</p> <p><u>Primary Air:</u> Air control fully open for the entire test.</p> <p><u>Secondary:</u> No user control for secondary air.</p> <p><u>Fan:</u> 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.</p> <p><u>Bypass:</u> Open for first 15 minutes during kindling/startup load. Was opened for 105 seconds after fuel load was loaded then closed.</p>	Fully open for entire test.
2	<p><u>Fuel Loading:</u> Test fuel loaded onto coal bed generated by test number 1 in 1 minute and 55 seconds.</p> <p><u>Door:</u> Closed by 2 minutes.</p> <p><u>Primary Air:</u> Fully open, then set to full closed by 15 minutes.</p> <p><u>Secondary:</u> No user control for secondary air.</p> <p><u>Fan:</u> Fan turned to high from off at 30 minutes.</p> <p><u>Bypass:</u> Open until 120 seconds then closed.</p>	Fully open for first 15 minutes, then set to full closed.

## **Section 2**

### **Photographs/Appliance Description/Drawings**

**Kuma Stoves**  
**K-180 Series**  
**Test Date: September 15, 2020**





## Kuma Stoves K-180 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-180 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-180 Series – See design drawings for model similarities

**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 14.01” x 9.34” 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-U3. Each component has an outside dimension of 13.0 x 2.0 x 2.5. An Interram gasket is wrapped around the outside and the assembly is then 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.

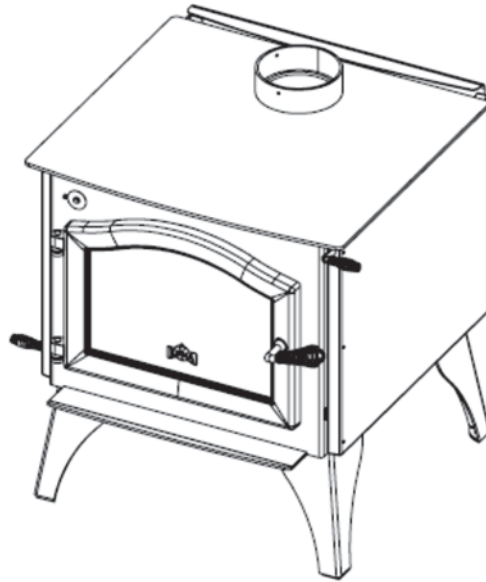
**Other Features:** Optional room air fan model DC3-C1011-4GS97 manufactured by Revcor is rated at 160 CFM. Freestanding version is offered with either legs or a pedestal and an ashpan. Decorative surround panels are offered for the Insert version of the K-180 series.

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

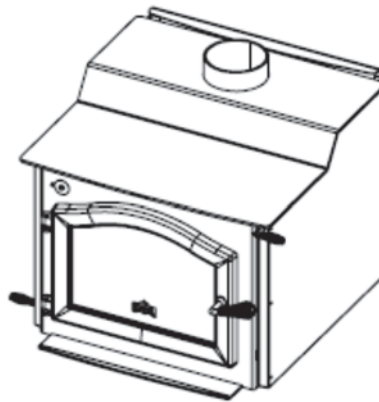
## WOOD HEATER OPERATING INSTRUCTIONS

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

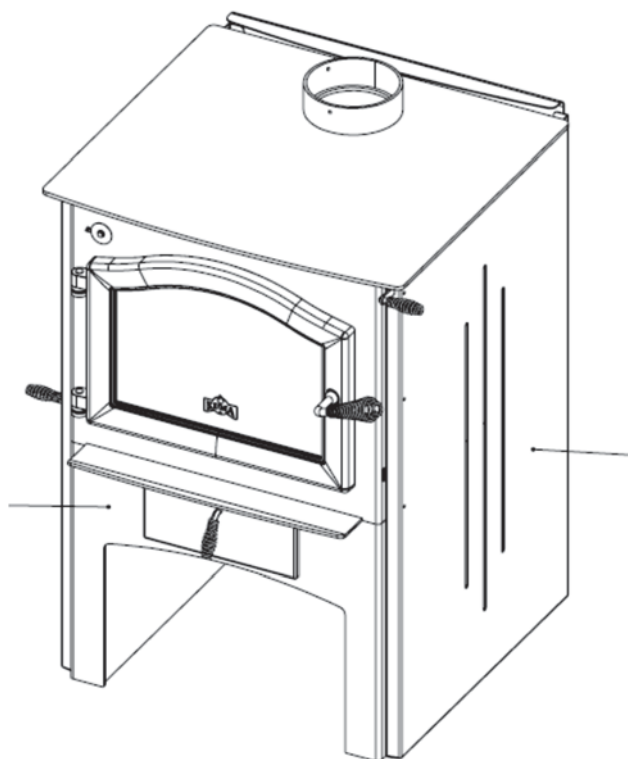
## Kuma K-180 Series Model Similarities



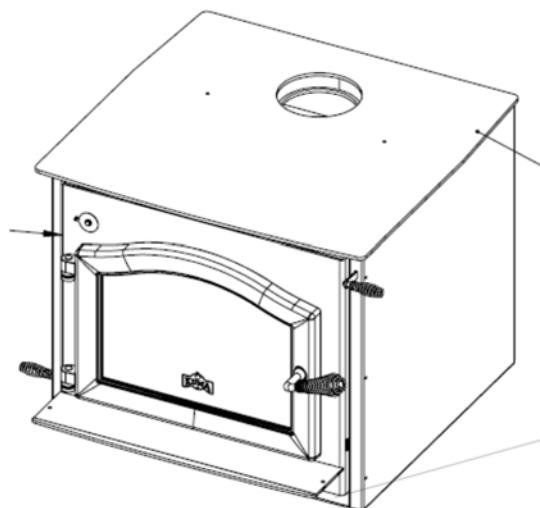
**Model Aspen:** The tested unit. A pedestal base with an ash drawer can be bolted on in lieu of the legs.



**Model Tamarack:** 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 Aberdeen:** 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 Alpine:** 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

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24 February 2019

RE: OPERATING INSTRUCTIONS FOR THE  
KUMA 2020 ASPEN HYBRID WOOD STOVE (V1)

Nominal Fuel Piece Length: 16"

Loading Orientation: N/S

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 6.00" open.

High Burn Setting: Pull the rod all the way out until the Primary Air Inlet orifice is 6.00" open. The rod should already be in this position at the end of the KS test segment, i.e., no adjustment is or 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 1.28125" (1&9/32") from the side of the stove. The PAC should be open 11/32".

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 5/16".

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. Typically the door can be closed 30 plus seconds after ignition.



High, Medium and Low Burns: Close the door as soon as the High, Medium or Low Burn fuel load has been loaded. If the fuel 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 High Burn test, adjust the PAC setting to the Medium Burn setting. As soon as possible after the end of the High Burn, rake the coal bed and pull all of the residual High burn fuel as close as possible 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. As soon as possible after the end of the High Burn, rake the coal bed and pull all of the residual High burn fuel as close as possible 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 Orifice (LPAO) as possible.

LOWER PRIMARY AIR ORIFICE (LPAO) :

Always clean the coals away from in front of the holes in the LPAO after the fuel has been loaded.

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 Low @ 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.

High, Medium and Low Burns: Close the door as soon as the High, Medium or Low Burn fuel load has been loaded. If the fuel 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 High Burn test, adjust the PAC setting to the Medium Burn setting. As soon as possible after the end of the High Burn, rake the coal bed and pull all of the residual High burn fuel as close as possible 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. As soon as possible after the end of the High Burn, rake the coal bed and pull all of the residual High burn fuel as close as possible 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 Orifice (LPAO) as possible.

LOWER PRIMARY AIR ORIFICE (LPAO):

Always clean the coals away from in front of the holes in the LPAO after the fuel has been loaded.

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 Low @ 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.



## FUEL LOADS:

### KS Cold Start:

ALWAYS use a Top Down start fuel configuration with the smallest fuel pieces at the top of the fuel pile. Load all of the Kindling and Start-Up fuel into the stove prior to ignition. Always load the smaller pieces in the Kindling and Start-Up fuel on top of the larger pieces in the Kindling and Start-Up fuel. And always load the Kindling pieces on top of the Start-Up fuel. There should be 2 layers (6-8 pieces) in the Start-Up fuel and 4-5 layers in the Kindling fuel. The Kindling fuel pieces should become larger in each layer, small on top, larger below.

### High, Medium and Low Burns:

Prior to actual loading, lay the pieces out on the floor, look at them and determine the best way to load them into the stove. Try to load the larger pieces in each fuel load against the 2 outside walls and then place a smaller piece on top of the larger pieces. Use the natural configuration of the fuel pieces to keep them in position. The smallest piece, or one of the smallest pieces, in the fuel load should be loaded in the middle of the stove. Try to leave a gap on each side of the piece in the center to allow flames to reach the baffle and ignite the secondaries.

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

Mark Freeman  
KUMA Stoves

K-180 Stove Aging			Technician: Jack Freeman
			Conditioning Dates: 3/6/2020 - 3/20/2020
Elapsed Time (hours)	Flue Gas Temp (°F)	Catalyst Exit Temp (°F)	Operated for 50 hours at a medium burn rate Notes (time weight and moisture content for fuel loading):
0	637	1096	3/6/2020 7:43 AM - Fuel: 14 lbs.Tamarack 18.3% moisture
1	714	1166	
2	472	808	
3	339	671	3/6/2020 10:45 AM - Fuel: 25 lbs.Tamarack 20.2% moisture
4	518	906	
5	389	659	
6	328	573	
7	301	520	
8	370	623	3/6/2020 4:00 PM - Fuel: 15 lbs.Tamarack 18.5% moisture
9	439	790	
10	642	828	3/9/2020 7:10 AM - Fuel: 21 lbs.Tamarack 20.4% moisture
11	530	746	
12	490	743	
13	362	619	3/9/2020 10:33 AM - Fuel: 25 lbs.Tamarack 21.6% moisture
14	605	1054	
15	328	687	
16	331	604	
17	330	637	
18	325	621	
19	313	609	
20	296	547	3/10/2020 7:19 AM - Fuel: 24.5 lbs. Douglas Fir 20.2% moisture
21	689	1060	
22	451	721	
23	421	660	3/10/2020 10:35 AM - Fuel: 22.5 lbs.Tamarack 22.9% moisture
24	356	666	
25	670	1112	
26	449	782	
27	306	690	
28	337	552	
29	333	528	
30	787	903	3/18/2020 8:31 AM - Fuel 13 lbs Tamarack 19.8% moisture
31	649	905	
32	640	934	
33	647	1012	
34	672	1028	3/18/2020 12:35 AM - Fuel 21 lbs. Tamarack 18.9% moisture
35	503	947	
36	465	864	
37	409	668	
38	702	900	3/19/2020 8:13 AM - Fuel 14 lbs. Tamarack 21.2% moisture
39	538	809	
40	902	1050	3/19/2020 10:25 AM - Fuel 21.5 lbs Tamarack 21.8% moisture
41	549	831	
42	390	643	
43	593	983	3/19/2020 1:21 PM - Fuel 19 lbs. Tamarack 22.5% moisture
44	567	843	
45	394	662	
46	614	852	3/20/2020 7:35 AM - 16 lbs. Tamarack 20.5% moisture
47	504	716	
48	741	1137	3/20/2020 9:40 AM - 24 lbs. Tamarack 20% moisture
49	325	599	
50	480	570	

# **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: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 000  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.75 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.00 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP 0.068 0.068 0.072 0.070 0.070 0.072 0.066 0.062 0.070  
Temp: 66 66 66 66 66 66 66 66 66  
V<sub>stack</sub> 17.74 ft/sec V<sub>source</sub> 17.93 ft/sec F<sub>p</sub> 0.989

Technician Signature: 

Particulate Sampling Data																	Fuel Weight (lb)		Temperature Data (°F)																	Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (in)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice d#2 (in)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (H <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)						
0	0.000	0.000			2.24	67	-0.83	2.12	67	-1.4	68	0.070			8.5		61	59	60	60	60	60	61	62	81	61	81	59	62	-0.004	0.05	0						
1	0.177	0.158	0.16	0.16	2.24	67	-0.83	2.12	67	-1.4	68	0.070	99	91	8.3	-0.13	61	59	60	60	60	60	61	62	81	61	81	59	62	-0.004	0.05	0						
2	0.345	0.315	0.17	0.16	2.21	68	-1.2	1.76	67	-1.8	70	0.070	94	83	8.3	-0.01	65	59	60	60	60	60	61	97	113	80	61	80	60	62	-0.020	3.03	0.29					
3	0.517	0.480	0.17	0.17	2.17	68	-1.51	1.73	67	-1.6	70	0.070	96	96	8.3	-0.03	67	60	60	60	60	61	112	118	80	61	80	60	62	-0.024	3.79	0.25						
4	0.687	0.642	0.17	0.16	2.16	68	-1.45	1.72	67	-1.7	70	0.070	95	94	8.3	-0.02	72	60	61	61	61	63	138	124	81	61	80	61	62	-0.026	3.85	0.28						
5	0.859	0.807	0.17	0.17	2.27	68	-1.4	1.76	67	-1.7	70	0.070	96	96	8.2	-0.04	75	60	62	61	61	64	151	134	81	61	81	61	62	-0.031	4.36	0.3						
6	1.033	0.973	0.17	0.17	2.28	68	-1.48	1.77	67	-1.7	71	0.070	97	97	8.2	-0.04	81	60	63	62	62	66	171	146	82	62	82	61	62	-0.032	4.11	0.15						
7	1.205	1.139	0.17	0.17	2.25	68	-1.52	1.76	67	-1.6	72	0.070	96	97	8.1	-0.06	87	60	64	64	63	68	202	166	83	62	83	61	62	-0.038	4.01	0.12						
8	1.377	1.304	0.17	0.17	2.23	68	-1.64	1.75	67	-1.6	73	0.070	96	96	8.1	-0.08	93	60	65	65	64	69	225	192	84	62	83	61	62	-0.045	5.02	0.22						
9	1.548	1.468	0.17	0.16	2.23	68	-1.54	1.73	67	-1.7	74	0.070	96	96	8.0	-0.04	99	60	67	66	65	71	224	215	85	62	84	62	62	-0.047	5.02	0.22						
10	1.719	1.632	0.17	0.16	2.23	68	-1.32	1.73	67	-1.7	75	0.070	96	96	8.0	-0.07	106	60	69	68	66	74	233	222	85	63	85	62	62	-0.049	5.07	0.18						
11	1.890	1.797	0.17	0.17	2.25	68	-1.25	1.83	67	-1.8	77	0.070	96	97	7.9	-0.08	114	60	71	70	67	76	250	247	86	63	86	62	62	-0.054	5.14	0.11						
12	2.066	1.961	0.16	0.16	2.22	68	-1.24	1.83	67	-2	79	0.070	99	96	7.8	-0.09	123	60	74	72	69	80	274	272	85	63	85	62	62	-0.059	5.36	0.17						
13	2.240	2.125	0.17	0.16	2.22	68	-1.62	1.80	67	-2	81	0.070	98	97	7.7	-0.11	134	60	76	74	71	83	300	302	85	63	84	62	62	-0.062	6.1	0.19						
14	2.415	2.291	0.18	0.17	2.29	68	-1.31	1.78	67	-1.8	83	0.060	107	106	7.5	-0.13	145	60	80	76	73	87	319	322	84	64	84	62	62	-0.065	6.76	0.36						
15	2.589	2.456	0.17	0.17	2.27	68	-1.47	1.78	67	-2	83	0.070	98	97	7.4	-0.09	157	61	83	78	75	91	340	335	83	64	83	63	62	-0.063	6.71	0.37						
16	2.760	2.622	0.17	0.17	2.26	68	-1.65	1.77	67	-2	81	0.070	97	98	7.4	-0.08	167	61	87	81	77	95	363	276	83	64	82	63	62	-0.066	7.15	0.35						
17	2.933	2.787	0.17	0.17	2.26	68	-1.36	1.76	67	-1.9	81	0.060	105	105	7.3	-0.10	180	61	92	84	80	99	441	267	82	64	82	63	62	-0.056	7.54	0.08						
18	3.104	2.953	0.17	0.17	2.26	68	-1.72	1.75	67	-2	81	0.070	97	98	7.2	-0.09	193	61	98	88	83	105	493	267	82	65	81	63	62	-0.057	7.63	0.05						
19	3.276	3.118	0.17	0.17	2.24	68	-1.31	1.74	67	-2	82	0.070	97	97	7.1	-0.10	207	61	104	92	87	110	548	274	81	65	81	63	62	-0.059	8.26	0.03						
20	3.448	3.282	0.17	0.16	2.24	68	-1.47	1.74	67	-1.8	83	0.060	105	104	7.0	-0.11	223	61	110	97	91	116	591	284	81	65	80	63	62	-0.061	8.59	0.01						
21	3.619	3.447	0.17	0.17	2.24	68	-1.3	1.74	68	-1.9	83	0.060	104	105	6.9	-0.08	240	62	116	101	95	123	636	295	80	66	80	64	62	-0.062	9.39	0.01						
22	3.789	3.612	0.17	0.17	2.24	68	-1.3	1.72	68	-2	84	0.060	104	105	6.8	-0.11	258	62	122	107	100	130	658	300	80	66	79	64	63	-0.063	9.8	0						
23	3.959	3.776	0.17	0.16	2.21	69	-1.31	1.71	68	-2	85	0.070	96	97	6.6	-0.17	274	62	128	112	105	136	678	308	80	66	79	64	63	-0.064	9.31	0						
24	4.131	3.941	0.17	0.17	2.28	69	-1.78	1.78	68	-1.9	86	0.070	97	97	6.5	-0.05	291	63	134	118	110	143	685	309	80	66	80	64	63	-0.064	9.06	0						
25	4.304	4.107	0.17	0.17	2.29	69	-1.79	1.78	68	-1.9	86	0.060	106	106	6.5	-0.09	305	63	140	124	116	150	684	312	80	67	80	64	63	-0.064	8.81	0						
26	4.478	4.273	0.17	0.17	2.27	69	-1.68	1.78	68	-2.1	86	0.060	106	106	6.4	-0.09	318	64	146	130	121	156	686	313	81	67	81	64	63	-0.064	8.21	0						
27	4.651	4.440	0.17	0.17	2.27	69	-1.62	1.78	68	-1.8	87	0.070	98	99	6.3	-0.10	330	65	152	136	127	162	697	316	81	67	82	64	63	-0.065	8.49	0						
28	4.824	4.606	0.17	0.17	2.26	69	-1.57	1.78	68	-2	88	0.060	106	106	6.2	-0.10	342	65	158	142	133	168	715	318	81	67	84	65	63	-0.065	8.39	0						
29	4.997	4.771	0.17	0.17	2.25	69	-1.39	1.77	68	-2.1	88	0.060	106	105	6.1	-0.10	353	66	163	148	138	174	730	321	81	67	85	65	63	-0.065	8.53	0						
30	5.170	4.937	0.17	0.17	2.26	69	-1.53	1.77	68	-2.1	88	0.060	106	106	6.0	-0.11	363	67	169	154	143	179	735	322	82	68	86	65	63	-0.066	8.53	0						
31	5.342	5.103	0.17	0.17	2.25	69	-1.4	1.77	68	-2.1	89	0.060	105	106	5.8	-0.11	373	67	174	160	148	184	745	327	82	68	86	65	63	-0.067	9.07	0						
32	5.514	5.268	0.17	0.17	2.24	69	-1.81	1.76	68	-2.1	90	0.060	106	106	5.7	-0.10	382	68	180	166	153	190	749	330	82	68	86	65	63	-0.067	8.89	0						
33	5.686	5.433	0.17	0.17	2.25	69	-1.54	1.76	68	-2.1	91	0.060	106	106	5.6	-0.15	393	69	186	171	158	195	791	340	82	68	87	65	63	-0.068	9.91	0						

Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)


Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.78 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.00 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %

	PL1	PL2	PL3	PL4	PL5	PL6	PL7	PL8	Center
Initial dP	0.068	0.068	0.072	0.070	0.070	0.072	0.068	0.062	0.070
Temp	66	66	66	66	66	66	66	66	65
V <sub>stack</sub>	17.74 ft/sec				V <sub>source</sub> 17.93 ft/sec				F <sub>p</sub> 0.989

Technician Signature: 

Particulate Sampling Data																	Fuel Weight (lb)		Temperature Data (°F)										Stack Gas Data			
Elapsed Time (min)	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice d#1.5 (H <sub>2</sub> O)	Meter 2 Temp (°F)	Meter 2 Vacuum (°Hg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (H <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)
34	5.858	5.999	0.17	0.17	2.26	69	-1.61	1.75	68	-1.9	91	0.060	106	106	5.5	-0.08	401	70	191	177	163	200	760	239	82	68	86	65	63	-0.068	9.18	0
35	6.031	5.765	0.17	0.17	2.24	69	-1.52	1.76	68	-2	91	0.070	98	98	5.4	-0.13	408	71	197	182	168	205	766	239	83	68	86	66	64	-0.069	9.05	0
36	6.202	5.929	0.17	0.16	2.24	69	-1.63	1.76	68	-1.9	93	0.060	105	105	5.3	-0.10	419	73	202	187	173	211	806	246	83	69	85	66	64	-0.069	9.61	0.01
37	6.374	6.094	0.17	0.17	2.24	69	-1.55	1.74	68	-2	93	0.070	98	98	5.3	0.06	429	74	207	192	179	216	819	255	83	69	85	66	64	-0.070	9.86	0.01
38	6.545	6.259	0.17	0.17	2.25	69	-1.78	1.73	68	-2.1	93	0.060	105	106	5.2	-0.12	437	75	213	197	184	221	805	259	83	69	84	66	64	-0.071	9.72	0
39	6.716	6.425	0.17	0.17	2.23	70	-1.77	1.73	68	-2	95	0.060	105	107	5.1	-0.11	447	77	218	202	190	227	815	259	84	69	83	66	64	-0.071	9.8	0
40	6.888	6.589	0.17	0.16	2.23	70	-1.74	1.74	68	-1.9	95	0.060	106	105	5.0	-0.13	456	78	223	207	196	232	828	262	84	69	83	66	64	-0.071	9.91	0.01
41	7.059	6.754	0.17	0.16	2.24	70	-1.83	1.74	68	-2	95	0.060	105	106	4.9	-0.09	464	80	228	212	201	237	817	265	84	69	83	66	64	-0.071	9.85	0.01
42	7.229	6.919	0.17	0.17	2.25	70	-1.42	1.75	68	-2.1	96	0.060	105	106	4.8	-0.13	471	82	232	217	207	242	806	265	84	69	82	66	64	-0.072	9.83	0.01
43	7.401	7.085	0.17	0.17	2.24	70	-1.42	1.73	69	-2	96	0.070	98	99	4.6	-0.15	477	84	237	222	213	247	809	264	84	69	82	66	65	-0.071	9.89	0.01
44	7.572	7.249	0.17	0.16	2.23	70	-1.45	1.73	69	-2.1	97	0.060	105	105	4.5	-0.10	484	87	242	226	219	252	832	266	84	70	81	66	65	-0.072	10.11	0.01
45	7.742	7.414	0.17	0.17	2.23	70	-1.46	1.73	69	-2.1	97	0.060	105	106	4.4	-0.13	491	89	247	231	225	257	863	270	84	70	81	67	65	-0.073	10.15	0
46	7.913	7.579	0.17	0.17	2.24	70	-1.72	1.72	69	-2.2	97	0.060	105	106	4.2	-0.14	501	92	252	236	230	262	893	276	84	70	82	67	65	-0.073	11.01	0
47	8.084	7.744	0.17	0.17	2.23	70	-1.51	1.73	69	-2	98	0.060	106	106	4.1	-0.11	509	95	256	241	236	267	878	277	84	70	82	67	65	-0.073	10.71	0
48	8.255	7.909	0.17	0.17	2.22	70	-1.46	1.73	69	-2.1	98	0.060	106	106	4.0	-0.12	516	98	261	246	242	273	876	277	84	70	82	67	65	-0.073	10.92	0
49	8.424	8.073	0.17	0.16	2.23	70	-1.46	1.74	69	-1.9	98	0.060	104	106	3.9	-0.15	524	101	266	251	247	278	895	280	84	70	83	67	65	-0.073	11.16	0.01
50	8.597	8.239	0.17	0.17	2.30	70	-1.77	1.78	69	-2	99	0.060	107	107	3.7	-0.11	532	105	270	257	252	283	908	281	85	70	83	67	65	-0.074	10.82	0
51	8.771	8.407	0.17	0.17	2.29	70	-1.69	1.78	69	-2.2	99	0.060	107	108	3.6	-0.11	540	108	275	262	258	289	920	282	85	70	84	67	66	-0.074	10.93	0
52	8.944	8.574	0.17	0.17	2.29	70	-1.55	1.78	69	-2.3	99	0.060	107	108	3.5	-0.15	548	111	281	267	263	294	932	286	85	70	84	67	66	-0.074	10.79	0
53	9.118	8.741	0.17	0.17	2.27	71	-1.91	1.79	69	-2.1	100	0.060	107	108	3.4	-0.10	554	115	286	272	268	299	918	285	86	70	85	67	66	-0.074	10.46	0
54	9.291	8.908	0.17	0.17	2.28	71	-1.89	1.78	69	-2	100	0.060	107	108	3.2	-0.14	560	119	291	277	273	304	916	285	86	70	85	67	66	-0.074	10.36	0
55	9.464	9.075	0.17	0.17	2.29	71	-1.49	1.78	69	-2.3	100	0.060	107	108	3.2	-0.08	565	122	296	282	278	309	920	288	86	71	85	67	66	-0.073	10.7	0
56	9.637	9.242	0.17	0.17	2.30	71	-1.54	1.78	69	-2	101	0.060	107	108	3.0	-0.13	569	126	302	286	282	313	916	286	86	70	85	67	66	-0.073	10.56	0
57	9.811	9.409	0.17	0.17	2.29	71	-1.49	1.79	69	-2	100	0.060	107	108	2.9	-0.10	572	130	307	291	286	317	922	284	86	71	84	68	66	-0.073	10.37	0
58	9.984	9.578	0.17	0.17	2.27	71	-1.67	1.78	69	-2	101	0.060	107	108	2.8	-0.10	576	134	313	296	290	322	929	283	85	71	84	68	66	-0.073	10.38	0
59	10.157	9.743	0.17	0.17	2.28	71	-1.59	1.77	69	-2.3	101	0.060	107	108	2.8	-0.08	580	137	318	301	294	326	935	283	85	71	84	68	66	-0.073	10.79	0
60	10.330	9.910	0.17	0.17	2.28	71	-1.91	1.77	70	-2	99	0.060	107	107	2.7	-0.10	582	141	324	306	298	330	920	281	85	71	83	68	66	-0.073	10.4	0
61	10.510	10.077	0.18	0.17	2.29	71	-1.87	1.82	70	-2	100	0.070	103	99	2.6	-0.07	584	145	329	310	302	334	904	280	83	71	83	68	66	-0.071	9.97	0
62	10.689	10.244	0.18	0.17	2.30	71	-1.49	1.88	70	-2	98	0.070	102	99	2.5	-0.10	584	149	334	315	306	338	887	276	83	71	83	68	66	-0.072	9.85	0
63	10.867	10.411	0.18	0.17	2.29	71	-1.78	1.82	70	-1.8	99	0.070	102	99	2.4	-0.10	584	153	339	319	309	341	898	272	83	71	82	68	67	-0.071	9.51	0
64	11.042	10.578	0.17	0.17	2.27	71	-1.85	1.82	70	-1.8	100	0.070	100	99	2.3	-0.06	581	157	344	324	313	344	852	269	83	71	82	68	66	-0.071	9.44	0
65	11.218	10.745	0.18	0.17	2.29	71	-1.77	1.82	70	-1.9	100	0.070	101	99	2.2	-0.06	579	161	350	328	316	347	848	268	83	71	82	68	66	-0.070	9.67	0
66	11.392	10.912	0.17	0.17	2.29	71	-1.79	1.81	70	-2.1	100	0.070	99	99	2.2	-0.09	578	165	355	332	320	350	862	268	83	71	81	68	66	-0.071	10.34	0
67	11.567	11.080	0.18	0.17	2.29	71	-1.56	1.81	70	-1.9	100	0.070	100	100	2.1	-0.08	577	170	360	336	323	353	850	266	83	71	81	68	66	-0.069	10.14	0

Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)


Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.75 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.50 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 2.9025 ft<sup>2</sup>  
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %

	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center
Initial dP	0.068	0.068	0.072	0.070	0.070	0.072	0.068	0.062	0.070
Temp	66	66	66	66	66	66	66	66	65
V <sub>stack</sub>	17.74 ft/sec				V <sub>source</sub> 17.93 ft/sec				F <sub>p</sub> 0.989

Technician Signature: 

Particulate Sampling Data																	Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice d#2 (H <sub>2</sub> O)	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 <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)		
68	11.743	11.247	0.18	0.17	2.28	72	-1.49	1.80	70	-2	100	0.070	100	99	2.0	-0.08	575	174	366	339	327	356	826	363	83	71	81	68	66	-0.071	9.44	0		
69	11.916	11.413	0.17	0.17	2.28	72	-1.73	1.81	70	-1.9	166	0.060	113	113	19.1	17.08	568	186	371	344	332	360	603	427	85	71	83	68	66	-0.071	5.49	-0.08		
70	12.091	11.579	0.17	0.17	2.24	72	-1.76	1.80	70	-1.8	115	0.060	109	108	18.8	-0.32	553	187	378	349	336	361	565	341	85	71	82	68	66	-0.069	2.3	0.23		
71	12.266	11.745	0.18	0.17	2.24	72	-1.65	1.80	70	-2.1	110	0.070	101	100	18.7	-0.11	547	189	383	352	340	362	766	362	85	71	82	68	66	-0.073	5.8	0.01		
72	12.441	11.910	0.18	0.17	2.24	72	-1.95	1.82	70	-2	107	0.070	100	99	18.6	-0.12	544	191	386	355	343	364	835	372	84	71	81	68	66	-0.073	6.86	0		
73	12.616	12.076	0.17	0.17	2.22	72	-1.95	1.80	70	-2	106	0.070	100	99	18.4	-0.11	542	194	389	356	346	365	846	379	84	71	81	68	66	-0.073	7.12	0		
74	12.791	12.240	0.18	0.16	2.20	72	-1.99	1.80	70	-1.9	104	0.070	100	98	18.3	-0.17	516	199	383	356	351	361	888	380	84	71	81	68	66	-0.074	7.93	0		
75	12.966	12.404	0.17	0.16	2.26	72	-1.7	1.81	70	-1.8	103	0.070	100	98	18.2	-0.08	500	201	378	356	354	358	875	381	84	72	80	69	66	-0.074	8.01	0		
76	13.140	12.570	0.17	0.17	2.26	72	-1.96	1.81	70	-1.8	102	0.070	99	99	18.1	-0.11	486	202	372	356	356	354	881	381	84	72	80	69	66	-0.074	8.07	0		
77	13.315	12.736	0.17	0.17	2.23	72	-2.01	1.80	70	-2.1	102	0.070	100	99	18.0	-0.09	475	204	366	356	357	352	882	379	83	72	81	69	67	-0.073	7.86	0		
78	13.491	12.900	0.18	0.16	2.21	72	-1.69	1.81	71	-2.1	102	0.070	101	98	17.9	-0.12	465	207	360	355	357	349	891	378	83	72	82	69	66	-0.073	8.08	0		
79	13.665	13.066	0.17	0.17	2.24	72	-2.16	1.81	71	-2	102	0.070	99	99	17.8	-0.12	457	209	354	354	357	348	895	379	83	72	83	69	67	-0.074	8.05	0		
80	13.840	13.231	0.18	0.16	2.21	72	-1.96	1.80	71	-2	103	0.070	100	98	17.8	-0.11	451	211	348	353	356	344	928	365	83	72	84	69	67	-0.075	9.01	0		
81	14.016	13.397	0.18	0.17	2.20	72	-2.23	1.81	71	-2	102	0.070	101	99	17.5	-0.13	447	212	342	352	356	342	923	367	83	72	85	69	67	-0.074	9.08	0		
82	14.190	13.560	0.17	0.16	2.20	72	-2.11	1.81	71	-1.8	102	0.070	99	97	17.4	-0.13	442	213	336	351	355	339	917	364	83	72	85	69	67	-0.073	8.95	0		
83	14.364	13.726	0.17	0.17	2.25	72	-2.39	1.81	71	-1.8	102	0.070	99	99	17.3	-0.11	437	214	331	350	354	337	912	363	82	72	86	69	67	-0.074	8.78	0		
84	14.540	13.891	0.18	0.16	2.25	72	-2.43	1.81	71	-1.9	103	0.070	101	98	17.1	-0.12	433	215	326	350	354	336	910	362	82	72	87	69	67	-0.074	8.77	0		
85	14.714	14.057	0.17	0.17	2.22	73	-2.56	1.81	71	-1.9	102	0.070	99	99	17.0	-0.10	429	216	320	349	353	333	906	361	82	72	87	69	67	-0.072	8.94	0		
86	14.889	14.223	0.17	0.17	2.23	73	-2.61	1.81	71	-1.8	102	0.070	100	99	16.9	-0.12	426	218	315	349	353	332	906	378	82	72	87	69	67	-0.072	8.39	0		
87	15.064	14.387	0.18	0.16	2.19	73	-2.86	1.81	71	-2.1	102	0.070	100	98	16.8	-0.11	424	217	311	349	354	331	916	378	82	72	86	69	67	-0.072	9.36	0		
88	15.239	14.552	0.18	0.16	2.19	73	-3.05	1.80	71	-1.8	101	0.070	100	98	16.7	-0.11	424	217	306	349	354	330	925	377	82	72	86	69	67	-0.072	9.13	0		
89	15.414	14.719	0.17	0.17	2.23	73	-3.1	1.80	71	-1.9	102	0.070	100	99	16.6	-0.11	423	217	302	349	354	329	925	378	82	72	86	69	67	-0.072	9.03	0		
90	15.589	14.883	0.16	0.16	2.19	73	-3.29	1.79	71	-1.8	102	0.070	100	98	16.5	-0.13	423	217	298	349	355	328	928	378	82	72	86	69	67	-0.072	9.12	0		
91	15.764	15.046	0.17	0.17	2.19	73	-3.61	1.82	71	-1.8	102	0.070	100	98	16.4	-0.09	424	217	294	350	355	328	939	379	82	72	86	69	67	-0.073	9.31	0		
92	15.939	15.213	0.18	0.16	2.61	73	-4.9	1.80	71	-1.8	102	0.070	100	98	16.2	-0.13	426	218	291	350	355	328	941	378	82	72	86	69	67	-0.072	9.88	0		
93	16.114	15.376	0.18	0.16	2.14	73	-8.99	1.81	71	-1.9	102	0.070	100	97	16.1	-0.14	428	218	287	351	355	328	956	379	82	72	84	69	67	-0.074	10.68	0		
94	16.289	15.544	0.18	0.17	2.22	73	-8.13	1.81	71	-2.1	102	0.070	100	100	16.0	-0.14	434	218	284	351	354	328	965	379	82	73	84	70	68	-0.074	12	0		
95	16.463	15.709	0.17	0.16	2.23	73	-8.88	1.81	71	-1.8	102	0.070	99	98	15.8	-0.12	440	218	281	352	354	329	960	378	83	73	84	70	68	-0.074	11.69	0		
96	16.638	15.875	0.18	0.17	2.23	73	-9.04	1.80	71	-2.1	102	0.070	100	99	15.7	-0.11	446	218	279	353	353	330	952	374	83	73	84	70	68	-0.073	11.3	0		
97	16.813	16.039	0.17	0.16	2.49	73	-9.6	1.79	71	-1.9	102	0.070	100	98	15.6	-0.13	451	219	276	355	353	331	949	373	83	73	83	70	68	-0.073	10.88	0		
98	16.987	16.205	0.17	0.17	2.21	73	-9.67	1.81	71	-1.9	101	0.070	99	99	15.5	-0.13	455	218	273	356	352	331	944	370	83	73	83	70	68	-0.073	10.72	0		
99	17.162	16.368	0.18	0.16	2.14	73	-9.96	1.80	72	-2	102	0.070	100	97	15.3	-0.12	459	218	271	357	352	331	949	369	83	74	83	70	68	-0.073	9.98	0		
100	17.338	16.533	0.18	0.17	2.22	73	-10.78	1.80	72	-2	101	0.070	100	98	15.3	-0.09	460	217	269	357	351	331	938	366	84	74	83	70	68	-0.072	9.68	0		
101	17.512	16.698	0.17	0.16	2.23	73	-11.14	1.81	72	-1.8	102	0.070	99	98	15.1	-0.12	460	217	266	358	350	330	927	365	84	74	83	70	68	-0.073	9.6	0		



Wood Heater Test Data  
High Burn Emissions Data

Run: 1  
Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/dry-mole  
Dilution Tunnel MW(wet): 29.75 lb/dry-mole  
Dilution Tunnel H<sub>2</sub>O: 2.50 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP: 0.068 0.068 0.072 0.070 0.070 0.072 0.068 0.062 0.070  
Temp: 66 66 66 66 66 66 66 66 66  
V<sub>stack</sub>: 17.74 ft/sec V<sub>source</sub>: 17.93 ft/sec F<sub>p</sub>: 0.989

Technician Signature: 

Particulate Sampling Data																	Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice d#2 (H <sub>2</sub> O)	Meter 2 Temp (°F)	Meter 2 Vacuum (°Hg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (H <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)		
102	17.687	18.861	0.18	0.16	2.16	73	-11.27	1.79	72	-1.8	102	0.070	100	97	15.0	-0.10	460	217	284	358	349	330	925	365	84	74	83	70	69	-0.073	9.87	0		
103	17.884	17.023	0.18	0.16	2.16	74	-11.45	1.90	72	-1.8	102	0.070	101	96	15.0	-0.08	458	217	262	358	348	329	917	364	84	74	83	70	68	-0.073	9.84	0		
104	18.040	17.185	0.18	0.16	2.11	74	-11.51	1.81	72	-2.1	101	0.070	100	96	14.8	-0.13	457	217	280	358	347	328	916	363	84	74	83	70	68	-0.072	9.82	0		
105	18.218	17.345	0.18	0.16	2.07	74	-11.45	1.78	72	-1.6	101	0.070	101	95	14.7	-0.12	455	217	258	358	346	327	916	363	3218	74	83	70	69	-0.072	9.62	0		
106	18.392	17.504	0.17	0.16	2.05	74	-11.52	1.80	72	-2	101	0.070	99	94	14.6	-0.11	454	217	257	358	345	326	913	361	85	74	83	70	69	-0.072	9.52	0		
107	18.566	17.672	0.17	0.17	2.26	74	-1.44	1.79	72	-1.7	101	0.070	99	100	14.5	-0.12	453	217	255	358	344	325	916	361	85	73	83	70	69	-0.072	9.41	0		
108	18.740	17.839	0.17	0.17	2.28	74	-1.71	1.78	72	-1.8	101	0.070	99	99	14.4	-0.09	452	216	254	358	344	325	919	362	85	72	83	70	69	-0.072	9.35	0		
109	18.915	18.006	0.18	0.17	2.28	74	-1.71	1.78	72	-2	101	0.070	99	99	14.3	-0.08	451	217	253	358	343	324	922	364	85	72	83	70	69	-0.072	9.38	0		
110	19.089	18.174	0.17	0.17	2.29	74	-1.56	1.79	72	-1.8	102	0.070	99	100	14.2	-0.13	452	216	252	358	342	324	934	366	85	73	83	70	69	-0.073	9.76	0		
111	19.263	18.341	0.17	0.17	2.27	74	-1.58	1.78	72	-1.7	102	0.070	99	99	14.1	-0.12	453	216	251	358	341	324	941	370	85	73	82	70	69	-0.073	9.91	0		
112	19.437	18.508	0.17	0.17	2.28	74	-1.34	1.78	72	-1.7	102	0.070	99	99	14.0	-0.10	453	216	250	359	340	324	941	371	85	73	82	70	69	-0.073	10.02	0		
113	19.611	18.676	0.17	0.17	2.27	74	-1.64	1.79	72	-1.7	103	0.070	99	99	13.9	-0.09	453	216	249	360	339	323	933	371	85	73	82	70	69	-0.073	10.15	0		
114	19.785	18.842	0.17	0.17	2.27	74	-1.31	1.79	72	-1.9	103	0.070	99	99	13.8	-0.11	453	216	249	361	338	323	933	373	85	73	82	70	69	-0.074	10.32	0		
115	19.959	19.009	0.17	0.17	2.28	74	-1.89	1.78	72	-1.7	102	0.070	99	99	13.6	-0.12	453	216	249	363	337	324	938	373	85	73	82	70	69	-0.074	10.42	0		
116	20.133	19.176	0.17	0.17	2.29	74	-1.33	1.78	72	-1.7	102	0.070	99	99	13.5	-0.13	453	216	249	366	336	324	932	372	85	73	82	70	69	-0.073	10.4	0		
117	20.307	19.344	0.17	0.17	2.27	74	-1.44	1.79	72	-1.8	102	0.070	99	100	13.4	-0.09	453	216	250	368	335	324	929	372	85	73	82	71	69	-0.072	10.4	0		
118	20.481	19.511	0.17	0.17	2.27	74	-1.72	1.78	72	-1.7	103	0.070	99	99	13.3	-0.14	453	216	251	371	334	325	940	374	85	73	82	71	69	-0.073	10.45	0		
119	20.655	19.678	0.17	0.17	2.26	74	-1.33	1.77	72	-1.7	103	0.070	99	99	13.2	-0.09	454	216	253	374	333	326	941	375	85	73	82	71	69	-0.073	10.44	0		
120	20.830	19.845	0.17	0.17	2.28	75	-1.72	1.78	73	-1.7	103	0.070	99	99	13.1	-0.13	455	216	254	376	333	327	943	376	85	73	82	71	69	-0.072	10.45	0		
121	21.003	20.012	0.17	0.17	2.28	75	-1.32	1.78	73	-2	103	0.070	98	99	13.0	-0.10	456	216	256	379	332	328	939	375	85	73	82	71	69	-0.073	10.56	0		
122	21.176	20.180	0.17	0.17	2.28	75	-1.69	1.78	73	-2	103	0.070	98	100	12.8	-0.12	457	216	258	382	332	329	942	376	85	73	82	71	70	-0.073	10.71	0		
123	21.351	20.347	0.18	0.17	2.28	75	-1.61	1.77	73	-1.9	103	0.070	99	99	12.7	-0.10	458	216	259	384	331	330	939	375	85	73	82	71	70	-0.072	11.04	0		
124	21.525	20.514	0.17	0.17	2.27	75	-1.59	1.78	73	-1.7	103	0.070	99	99	12.6	-0.15	459	217	261	387	331	331	942	375	84	73	83	71	70	-0.073	11.33	0		
125	21.698	20.681	0.17	0.17	2.27	75	-1.47	1.78	73	-2	103	0.070	98	99	12.5	-0.11	462	217	263	389	330	332	951	376	84	73	83	71	70	-0.072	11.62	0		
126	21.873	20.848	0.18	0.17	2.27	75	-1.32	1.78	73	-1.8	104	0.070	100	99	12.3	-0.13	466	217	265	391	330	334	952	377	84	73	83	71	70	-0.073	11.77	0		
127	22.047	21.015	0.17	0.17	2.28	75	-1.32	1.78	73	-1.8	103	0.070	99	99	12.2	-0.10	470	217	268	394	330	336	952	378	84	73	83	71	70	-0.073	11.5	0		
128	22.221	21.182	0.17	0.17	2.28	75	-1.71	1.77	73	-1.8	104	0.070	99	99	12.1	-0.12	473	218	270	396	330	337	957	377	84	73	84	71	70	-0.073	11.33	0		
129	22.395	21.350	0.17	0.17	2.26	75	-1.44	1.78	73	-1.9	104	0.070	99	100	12.0	-0.09	475	218	273	398	330	339	954	378	83	73	84	71	70	-0.072	11.23	0		
130	22.569	21.517	0.17	0.17	2.26	75	-1.31	1.77	73	-1.8	104	0.070	99	99	11.9	-0.12	476	218	275	400	329	340	944	378	83	73	84	71	70	-0.072	11.24	0		
131	22.744	21.684	0.18	0.17	2.27	75	-1.51	1.78	73	-2	103	0.070	99	99	11.8	-0.12	476	219	277	402	330	341	937	377	83	73	84	71	70	-0.072	11.22	0		
132	22.917	21.851	0.17	0.17	2.27	75	-1.33	1.79	73	-2	104	0.070	98	99	11.7	-0.13	476	219	280	404	330	342	937	375	83	73	84	71	70	-0.071	11.19	0		
133	23.091	22.018	0.17	0.17	2.27	75	-1.63	1.78	73	-1.7	104	0.070	99	99	11.6	-0.09	476	220	282	406	330	343	945	376	83	73	85	71	70	-0.072	11.39	0		
134	23.266	22.185	0.17	0.17	2.28	75	-1.32	1.79	73	-1.7	105	0.070	100	99	11.4	-0.12	477	220	284	407	330	344	951	379	83	73	85	71	70	-0.072	11.7	0		
135	23.439	22.353	0.17	0.17	2.27	75	-1.67	1.78	73	-2	104	0.070	98	100	11.3	-0.10	479	221	286	409	330	345	959	379	83	73	85	71	70	-0.072	11.88	0		

Wood Heater Test Data  
High Burn Emissions Data

Run: 1  
Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 006  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.75 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.00 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19235 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP 0.068 0.068 0.072 0.070 0.070 0.072 0.068 0.062 0.070  
Temp: 66 66 66 66 66 66 66 66 66  
V<sub>stack</sub> 17.74 ft/sec V<sub>source</sub> 17.93 ft/sec F<sub>p</sub> 0.989

Technician Signature: 

Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data				
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (in)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice d#2 (in)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (inH <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)
136	23.613	22.926	0.17	0.17	2.27	75	-1.38	1.78	73	-1.9	104	0.070	99	99	11.2	-0.15	481	221	288	411	331	346	967	379	83	73	85	71	71	-0.072	12.01	0
137	23.787	22.687	0.17	0.17	2.27	75	-1.72	1.78	73	-1.8	105	0.070	99	99	11.1	-0.12	484	222	290	413	331	348	972	379	83	73	85	71	71	-0.072	12.21	0
138	23.962	22.854	0.18	0.17	2.27	75	-1.33	1.78	73	-1.8	105	0.070	100	99	11.0	-0.11	487	223	293	415	332	350	971	380	83	74	85	71	71	-0.072	12.17	0
139	24.136	23.021	0.17	0.17	2.28	75	-1.51	1.79	73	-2	104	0.070	99	99	10.9	-0.11	488	223	295	418	332	351	966	378	83	74	85	71	71	-0.072	12.02	0
140	24.310	23.188	0.17	0.17	2.28	75	-1.75	1.78	73	-2	105	0.070	99	99	10.7	-0.11	490	224	297	420	333	353	963	378	83	73	85	71	71	-0.073	11.83	0
141	24.485	23.358	0.18	0.17	2.28	76	-1.71	1.79	73	-2	105	0.070	99	100	10.6	-0.13	491	225	300	423	333	354	959	376	83	74	85	71	71	-0.073	11.63	0
142	24.659	23.524	0.17	0.17	2.28	76	-1.75	1.79	74	-2	105	0.070	99	100	10.5	-0.11	491	226	303	425	334	356	957	375	83	74	85	72	71	-0.072	11.51	0
143	24.833	23.691	0.17	0.17	2.28	76	-1.34	1.78	74	-1.8	105	0.070	99	99	10.4	-0.08	491	227	305	427	334	357	953	373	83	74	85	72	71	-0.071	11.36	0
144	25.007	23.858	0.17	0.17	2.27	76	-1.7	1.78	74	-2	105	0.070	99	99	10.3	-0.13	491	228	307	430	335	358	947	372	83	74	85	72	71	-0.071	11.24	0
145	25.182	24.025	0.17	0.17	2.28	76	-1.7	1.79	74	-1.9	105	0.070	99	99	10.2	-0.11	490	229	310	432	335	359	943	372	83	74	85	72	71	-0.071	11.11	0
146	25.355	24.192	0.17	0.17	2.28	76	-1.55	1.79	74	-1.7	104	0.070	98	99	10.1	-0.10	489	230	313	434	336	360	948	373	83	74	85	72	71	-0.071	11.1	0
147	25.530	24.361	0.18	0.17	2.29	76	-1.51	1.78	74	-2	105	0.070	99	100	10.1	-0.01	488	231	315	435	336	361	944	371	83	74	85	72	71	-0.070	10.98	0
148	25.705	24.528	0.17	0.17	2.27	76	-1.57	1.78	74	-1.7	105	0.070	99	99	10.0	-0.09	487	232	318	437	337	362	940	372	83	74	85	72	71	-0.070	10.81	0
149	25.879	24.698	0.17	0.17	2.28	76	-1.66	1.78	74	-2	105	0.070	99	100	9.9	-0.09	486	233	320	439	337	363	938	370	83	74	85	72	71	-0.070	10.73	0
150	26.053	24.863	0.17	0.17	2.27	76	-1.68	1.79	74	-1.9	105	0.070	99	99	9.8	-0.09	485	234	323	440	337	364	939	370	83	74	85	72	71	-0.070	10.66	0
151	26.227	25.030	0.17	0.17	2.28	76	-1.67	1.77	74	-2	105	0.070	99	99	9.7	-0.11	484	235	325	442	337	365	935	371	83	74	84	72	71	-0.071	10.54	0
152	26.402	25.198	0.18	0.17	2.28	76	-1.36	1.79	74	-2	105	0.070	99	100	9.6	-0.09	482	237	327	444	338	366	932	371	83	74	84	72	72	-0.071	10.47	0
153	26.576	25.366	0.17	0.17	2.29	76	-1.53	1.79	74	-1.8	105	0.070	99	100	9.5	-0.10	480	238	329	445	338	366	938	370	83	74	85	72	72	-0.070	10.5	0
154	26.750	25.534	0.17	0.17	2.28	76	-1.33	1.78	74	-1.7	105	0.070	99	100	9.4	-0.09	479	239	331	447	338	367	944	370	83	74	84	72	72	-0.070	10.54	0
155	26.925	25.701	0.18	0.17	2.28	76	-1.41	1.79	74	-1.7	105	0.070	99	99	9.3	-0.08	479	241	332	449	338	368	951	370	83	74	85	72	72	-0.070	10.47	0
156	27.099	25.889	0.17	0.17	2.27	76	-1.4	1.78	74	-1.8	105	0.070	99	100	9.2	-0.14	479	242	334	451	338	369	952	370	83	74	85	72	72	-0.071	10.53	0
157	27.273	26.036	0.17	0.17	2.27	76	-1.73	1.78	74	-1.9	105	0.070	99	99	9.1	-0.08	479	244	335	453	338	370	955	372	83	74	84	72	72	-0.070	10.4	0
158	27.448	26.203	0.18	0.17	2.28	77	-1.56	1.78	74	-2	105	0.070	99	99	9.0	-0.10	479	245	336	455	338	371	959	373	83	74	85	72	72	-0.070	10.37	0
159	27.622	26.371	0.17	0.17	2.28	77	-1.44	1.79	74	-2	105	0.070	99	100	8.9	-0.10	480	246	338	457	338	372	969	373	83	74	85	72	72	-0.070	10.32	0
160	27.797	26.539	0.18	0.17	2.29	77	-1.67	1.78	74	-1.7	106	0.070	99	100	8.8	-0.09	480	248	339	459	338	373	973	374	83	74	85	72	72	-0.071	10.15	0
161	27.971	26.707	0.17	0.17	2.27	77	-1.76	1.78	74	-1.9	106	0.070	99	100	8.7	-0.04	481	249	340	461	338	374	977	376	83	74	85	72	72	-0.070	10.02	0
162	28.146	26.876	0.18	0.17	2.27	77	-1.5	1.79	75	-2	106	0.070	99	100	8.7	-0.10	481	251	341	463	337	375	978	379	83	74	85	72	72	-0.071	9.91	0
163	28.320	27.042	0.17	0.17	2.27	77	-1.38	1.78	75	-1.9	106	0.070	99	99	8.6	-0.08	481	252	342	465	337	375	977	379	83	74	85	72	72	-0.071	9.74	0
164	28.494	27.209	0.17	0.17	2.27	77	-1.33	1.78	75	-2	106	0.070	99	99	8.5	-0.07	481	254	342	467	337	376	976	380	83	74	85	72	72	-0.071	9.68	0
165	28.669	27.377	0.18	0.17	2.29	77	-1.52	1.78	75	-1.7	106	0.070	99	100	8.4	-0.13	480	255	343	469	336	377	984	380	83	74	85	72	72	-0.071	9.73	0
166	28.843	27.545	0.17	0.17	2.28	77	-1.53	1.78	75	-1.8	106	0.070	99	100	8.3	-0.06	480	256	343	471	336	377	988	381	83	74	85	72	72	-0.071	9.84	0
167	29.017	27.713	0.17	0.17	2.28	77	-1.55	1.78	75	-1.8	106	0.070	99	100	8.2	-0.11	481	258	343	472	335	378	972	382	83	74	85	72	72	-0.071	9.89	0
168	29.192	27.881	0.18	0.17	2.28	77	-1.68	1.78	75	-1.9	106	0.070	99	100	8.1	-0.07	480	259	344	474	335	378	968	383	83	74	85	72	72	-0.071	9.93	0
169	29.366	28.049	0.17	0.17	2.28	77	-1.35	1.79	75	-2	106	0.070	99	100	8.0	-0.10	480	260	345	476	334	379	968	383	83	74	84	72	72	-0.070	10	0

Wood Heater Test Data  
High Burn Emissions Data

Run: 1  
Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.75 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.00 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP: 0.068 0.068 0.072 0.070 0.070 0.072 0.068 0.062 0.070  
Temp: 66 66 66 66 66 66 66 66 65  
V<sub>stack</sub>: 17.74 ft/sec V<sub>source</sub>: 17.93 ft/sec F<sub>p</sub>: 0.989


Technician Signature: 

Particulate Sampling Data																	Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice d#1 (H <sub>2</sub> O)	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 <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)		
170	29.540	28.216	0.17	0.17	2.27	77	-1.41	1.77	75	-2	107	0.070	99	99	7.9	-0.10	480	262	346	477	334	380	970	384	83	74	84	72	72	-0.070	10.05	0		
171	29.715	28.384	0.18	0.17	2.27	77	-1.68	1.78	75	-1.7	107	0.070	99	100	7.9	-0.07	480	263	346	479	333	380	972	384	83	74	84	72	72	-0.070	10.05	0		
172	29.890	28.552	0.18	0.17	2.28	77	-1.76	1.78	75	-1.7	107	0.070	99	100	7.8	-0.11	479	264	347	480	333	381	970	382	83	74	84	73	72	-0.069	9.99	0		
173	30.064	28.720	0.17	0.17	2.29	77	-1.58	1.79	75	-1.9	106	0.070	99	100	7.7	-0.09	479	265	348	482	332	381	965	382	83	74	84	73	72	-0.069	9.94	0		
174	30.238	28.888	0.17	0.17	2.29	77	-1.47	1.78	75	-1.7	106	0.070	99	100	7.6	-0.08	478	266	349	484	331	382	960	381	83	74	84	73	72	-0.069	9.94	0		
175	30.413	29.056	0.18	0.17	2.28	77	-1.72	1.79	75	-1.7	107	0.070	99	100	7.6	-0.05	477	267	349	486	331	382	958	379	83	74	84	73	72	-0.069	9.91	0		
176	30.588	29.223	0.18	0.17	2.27	77	-1.41	1.78	75	-1.8	107	0.070	99	99	7.5	-0.09	475	268	350	487	330	382	951	379	83	74	84	73	72	-0.068	9.92	0		
177	30.762	29.391	0.17	0.17	2.28	77	-1.53	1.78	75	-1.7	107	0.070	99	100	7.4	-0.08	474	270	351	489	330	383	948	377	83	74	84	73	72	-0.068	9.94	0		
178	30.937	29.559	0.18	0.17	2.28	77	-1.56	1.78	75	-1.8	106	0.070	99	100	7.3	-0.09	473	271	352	490	329	383	940	376	84	74	84	73	72	-0.068	10.03	0		
179	31.111	29.727	0.17	0.17	2.28	77	-1.76	1.79	75	-1.8	107	0.070	99	100	7.2	-0.08	472	272	353	492	329	384	948	375	84	74	84	73	72	-0.068	10.62	0.02		
180	31.285	29.895	0.17	0.17	2.29	78	-1.51	1.78	75	-1.7	107	0.070	99	100	7.1	-0.11	475	273	354	494	328	385	949	376	84	74	84	73	73	-0.067	11.99	0.13		
181	31.460	30.063	0.18	0.17	2.29	78	-1.76	1.77	75	-1.7	107	0.070	99	100	7.0	-0.08	462	274	355	495	327	387	1018	379	84	74	84	73	72	-0.068	11.79	0.13		
182	31.635	30.231	0.18	0.17	2.27	78	-1.37	1.79	75	-1.8	107	0.070	99	100	6.9	-0.10	468	275	356	497	327	389	1013	381	84	74	84	73	73	-0.070	11.82	0.19		
183	31.809	30.398	0.17	0.17	2.28	78	-1.75	1.79	75	-1.8	107	0.070	99	99	6.8	-0.09	463	276	358	499	327	391	1010	381	84	74	84	73	73	-0.069	11.67	0.18		
184	31.983	30.566	0.17	0.17	2.27	78	-1.38	1.78	75	-1.7	107	0.070	99	100	6.7	-0.09	468	277	359	500	326	392	1010	381	84	74	84	73	73	-0.068	11.62	0.18		
185	32.158	30.734	0.18	0.17	2.28	78	-1.36	1.78	76	-2	107	0.070	99	100	6.7	-0.09	502	278	360	502	326	394	1007	380	84	74	84	73	73	-0.069	11.53	0.19		
186	32.332	30.902	0.17	0.17	2.28	78	-1.52	1.79	76	-2	107	0.070	99	100	6.6	-0.09	505	279	361	504	326	395	1009	380	84	74	84	73	73	-0.070	11.47	0.17		
187	32.507	31.070	0.17	0.17	2.28	78	-1.65	1.77	76	-1.8	107	0.070	99	100	6.5	-0.10	507	280	363	507	326	397	1009	381	84	74	84	73	73	-0.069	11.53	0.2		
188	32.681	31.238	0.17	0.17	2.30	78	-1.4	1.78	76	-2	107	0.070	99	100	6.4	-0.08	509	281	364	509	325	398	1010	379	84	74	84	73	73	-0.070	11.45	0.15		
189	32.856	31.406	0.18	0.17	2.26	78	-1.39	1.79	76	-1.9	107	0.070	99	100	6.3	-0.09	511	282	365	511	325	399	1011	380	84	74	84	73	73	-0.069	11.52	0.21		
190	33.030	31.574	0.17	0.17	2.27	78	-1.58	1.78	76	-1.7	107	0.070	99	100	6.2	-0.10	512	283	366	513	325	400	1002	379	84	74	85	73	73	-0.069	11.44	0.19		
191	33.205	31.742	0.17	0.17	2.27	78	-1.75	1.78	76	-1.8	107	0.070	99	100	6.1	-0.06	512	284	367	515	325	401	999	377	84	74	85	73	73	-0.068	11.3	0.12		
192	33.380	31.909	0.18	0.17	2.28	78	-1.5	1.79	76	-1.9	107	0.070	99	99	6.0	-0.10	512	285	368	518	325	402	988	375	84	74	85	73	73	-0.068	10.94	0.03		
193	33.554	32.077	0.17	0.17	2.28	78	-1.34	1.78	76	-1.9	107	0.070	99	100	6.0	-0.07	512	286	370	520	325	403	979	371	84	74	85	73	73	-0.068	10.82	0.04		
194	33.728	32.245	0.17	0.17	2.29	78	-1.6	1.78	76	-2	106	0.070	99	99	5.9	-0.04	510	287	371	522	325	403	964	370	84	74	85	73	73	-0.068	10.42	0.03		
195	33.903	32.413	0.17	0.17	2.29	78	-1.33	1.78	76	-2	106	0.070	99	99	5.9	-0.08	508	288	372	524	325	403	949	368	84	74	85	73	73	-0.068	10.18	0.02		
196	34.077	32.582	0.17	0.17	2.28	78	-1.75	1.78	76	-2	106	0.070	99	100	5.8	-0.07	504	289	373	526	326	404	931	364	84	74	85	73	73	-0.067	9.98	0		
197	34.252	32.750	0.18	0.17	2.29	78	-1.34	1.78	76	-2	106	0.070	99	99	5.7	-0.07	500	290	374	528	326	404	917	360	84	74	85	73	74	-0.067	9.93	0		
198	34.426	32.918	0.17	0.17	2.27	78	-1.36	1.77	76	-1.8	106	0.070	99	99	5.6	-0.07	495	291	374	529	326	403	905	357	84	74	85	73	73	-0.067	9.84	0		
199	34.601	33.086	0.17	0.17	2.27	78	-1.48	1.79	76	-1.9	106	0.070	99	99	5.6	-0.05	491	292	375	531	326	403	898	354	84	74	85	73	73	-0.067	9.76	0		
200	34.775	33.254	0.17	0.17	2.28	78	-1.61	1.78	76	-1.8	105	0.070	99	99	5.5	-0.05	486	293	376	533	326	403	892	351	84	74	85	73	73	-0.066	9.8	0		
201	34.950	33.422	0.18	0.17	2.29	78	-1.39	1.77	76	-1.8	105	0.070	99	99	5.5	-0.07	482	294	377	534	326	403	893	351	84	74	85	73	73	-0.066	9.74	0		
202	35.126	33.590	0.18	0.17	2.28	78	-1.77	1.79	76	-1.8	105	0.070	100	99	5.4	-0.10	478	295	378	535	327	403	889	349	84	74	85	73	73	-0.065	9.67	0		
203	35.300	33.759	0.17	0.17	2.28	78	-1.33	1.78	76	-1.8	105	0.070	99	100	5.4	-0.03	474	296	379	537	327	403	885	347	84	74	85	73	74	-0.064	9.53	0		

Wood Heater Test Data  
High Burn Emissions Data

Run: 1  
Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.75 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.00 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 18.13 ft/sec  
Initial Tunnel Flow: 185.1 scfm  
Average Tunnel Flow: 187.2 scfm  
Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP 0.068 0.068 0.072 0.070 0.070 0.072 0.068 0.062 0.070  
Temp: 66 66 66 66 66 66 66 66 65  
V<sub>stack</sub> 17.74 ft/sec V<sub>source</sub> 17.93 ft/sec F<sub>p</sub> 0.989

Technician Signature: 

Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Particulate Sampling Data										Fuel Weight (lb)										Temperature Data (°F)										Stack Gas Data			
			Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice d#1 (H <sub>2</sub> O)	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 <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)				
204	35.474	33.927	0.17	0.17	2.28	79	-1.34	1.78	76	-2	105	0.070	98	99	5.3	-0.06	470	297	380	538	327	402	882	345	84	74	85	73	73	-0.064	9.39	0				
205	35.649	34.095	0.18	0.17	2.28	79	-1.59	1.78	76	-1.9	105	0.070	99	99	5.3	0.04	466	298	381	539	328	402	884	343	84	74	85	73	74	-0.064	9.35	0				
206	35.824	34.263	0.17	0.17	2.27	79	-1.72	1.78	76	-2	105	0.070	99	99	5.3	-0.05	463	299	382	539	328	402	881	343	84	74	85	73	74	-0.064	9.24	0				
207	35.998	34.431	0.17	0.17	2.28	79	-1.55	1.78	76	-1.7	105	0.070	98	99	5.3	-0.04	460	300	383	540	328	402	875	342	84	74	85	73	74	-0.064	9.18	0				
208	36.173	34.599	0.18	0.17	2.28	79	-1.36	1.78	77	-1.9	104	0.070	99	99	5.2	-0.07	455	301	383	540	329	402	868	340	84	74	85	73	73	-0.063	9.14	0				
209	36.348	34.767	0.17	0.17	2.29	79	-1.34	1.78	77	-1.9	104	0.070	99	99	5.1	-0.05	451	302	384	540	329	401	869	339	84	74	85	73	74	-0.064	9.19	0				
210	36.522	34.935	0.17	0.17	2.29	79	-1.38	1.78	77	-1.9	105	0.070	98	99	5.1	-0.04	448	303	385	541	330	401	870	339	85	74	85	74	74	-0.064	9.09	0				
211	36.697	35.104	0.18	0.17	2.29	79	-1.43	1.77	77	-2	105	0.070	99	100	5.0	-0.05	446	304	385	541	331	401	876	338	84	74	85	73	74	-0.065	9.17	0				
212	36.872	35.272	0.17	0.17	2.28	79	-1.36	1.78	77	-1.8	105	0.070	99	99	5.0	-0.07	444	305	386	540	331	401	881	340	85	74	85	74	74	-0.063	9.29	0				
213	37.046	35.440	0.17	0.17	2.29	79	-1.37	1.78	77	-2	105	0.070	98	99	4.9	-0.06	442	307	386	541	332	402	874	340	85	74	85	74	74	-0.063	9.06	0				
214	37.221	35.608	0.17	0.17	2.27	79	-1.37	1.77	77	-2	104	0.070	99	99	4.9	-0.03	440	308	387	540	333	402	867	338	85	74	86	74	74	-0.063	8.97	0				
215	37.397	35.776	0.18	0.17	2.28	79	-1.63	1.79	77	-2	105	0.070	98	99	4.8	-0.05	439	309	387	540	334	402	877	339	85	74	86	74	74	-0.064	9.01	0				
216	37.571	35.944	0.17	0.17	2.27	79	-1.39	1.78	77	-2	104	0.070	98	99	4.8	-0.08	437	310	387	540	334	402	869	340	85	74	86	74	74	-0.064	8.99	0				
217	37.745	36.112	0.17	0.17	2.28	79	-1.76	1.78	77	-2	104	0.070	98	99	4.7	-0.03	435	311	388	540	335	402	858	337	85	74	86	74	74	-0.062	8.38	0				
218	37.921	36.281	0.18	0.17	2.29	79	-1.44	1.78	77	-1.8	105	0.070	99	100	4.7	-0.08	432	312	387	539	337	401	849	336	85	74	86	74	74	-0.062	8.22	0				
219	38.095	36.450	0.17	0.17	2.30	79	-1.77	1.78	77	-1.8	104	0.070	98	100	4.6	-0.04	429	312	387	538	338	401	841	335	85	74	86	74	74	-0.062	8.06	0				
220	38.269	36.618	0.17	0.17	2.28	79	-1.34	1.78	77	-1.7	104	0.070	98	99	4.6	-0.03	426	313	387	537	339	400	830	333	85	74	86	74	74	-0.062	8	0				
221	38.444	36.786	0.18	0.17	2.27	79	-1.75	1.78	77	-1.7	104	0.070	99	99	4.5	-0.04	422	314	387	536	340	400	826	331	85	74	86	74	74	-0.061	7.93	0				
222	38.619	36.954	0.17	0.17	2.27	79	-1.41	1.78	77	-1.9	104	0.070	99	99	4.5	-0.07	418	315	386	535	341	399	821	329	85	74	86	74	74	-0.061	7.97	0				
223	38.793	37.122	0.17	0.17	2.27	79	-1.43	1.78	77	-2	104	0.070	98	99	4.4	-0.04	415	316	386	534	342	399	815	329	85	74	86	74	74	-0.061	7.93	0				
224	38.968	37.290	0.18	0.17	2.28	79	-1.35	1.77	77	-1.8	104	0.070	99	99	4.4	-0.04	411	316	385	533	343	398	812	328	85	74	86	74	74	-0.060	7.9	0				
225	39.143	37.458	0.17	0.17	2.28	79	-1.58	1.78	77	-2	104	0.070	99	99	4.3	-0.06	408	317	384	532	344	397	807	327	85	74	86	74	74	-0.060	7.86	0				
226	39.317	37.627	0.17	0.17	2.29	79	-1.57	1.78	77	-1.9	104	0.070	98	100	4.3	-0.05	405	317	383	531	344	396	802	326	85	74	86	74	74	-0.060	7.84	0				
227	39.492	37.796	0.17	0.17	2.29	79	-1.35	1.77	77	-1.9	104	0.070	99	99	4.2	-0.04	401	318	383	529	345	395	796	324	85	74	86	74	74	-0.060	7.83	0				
228	39.668	37.964	0.18	0.17	2.29	79	-1.49	1.78	77	-1.8	104	0.070	99	100	4.2	-0.05	398	319	382	527	346	394	790	323	85	74	86	74	74	-0.060	7.84	0				
229	39.842	38.132	0.17	0.17	2.27	79	-1.35	1.78	77	-2	104	0.070	98	99	4.2	-0.03	396	319	381	526	347	394	792	322	85	74	86	74	74	-0.060	7.79	0				
230	40.016	38.300	0.17	0.17	2.27	79	-1.69	1.78	77	-1.9	103	0.070	98	99	4.1	-0.06	393	320	380	525	347	393	794	322	85	74	86	74	74	-0.060	7.78	0				
231	40.192	38.468	0.18	0.17	2.28	79	-1.56	1.78	77	-1.8	104	0.070	99	99	4.1	-0.04	391	320	379	523	348	392	798	322	85	74	86	74	74	-0.060	7.76	0				
232	40.368	38.636	0.17	0.17	2.28	79	-1.36	1.78	77	-2	103	0.070	98	99	4.1	0.04	390	321	378	522	349	392	801	323	85	74	86	74	74	-0.060	7.84	0				
233	40.540	38.804	0.17	0.17	2.28	80	-1.42	1.78	77	-2	104	0.070	98	99	4.1	-0.02	389	321	377	520	350	391	807	324	85	74	86	74	74	-0.060	8.03	0				
234	40.715	38.973	0.18	0.17	2.28	80	-1.74	1.78	77	-2	104	0.070	99	100	4.0	-0.06	388	322	377	518	350	391	812	324	85	74	86	74	74	-0.060	8.23	0				
235	40.890	39.141	0.17	0.17	2.28	80	-1.76	1.78	78	-1.8	104	0.070	99	99	4.0	-0.05	388	322	375	517	351	391	818	327	85	74	86	74	75	-0.060	8.19	0				
236	41.065	39.310	0.17	0.17	2.28	80	-1.73	1.78	78	-2	104	0.070	99	100	3.9	-0.06	387	323	375	515	353	391	814	325	85	74	86	74	74	-0.060	8.35	0				
237	41.239	39.478	0.17	0.17	2.28	80	-1.64	1.77	78	-2	104	0.070	98	99	3.9	-0.04	387	324	374	513	354	390	814	325	85	74	86	74	75	-0.060	8.61	0				

Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves

Model: K180 Series

Tracking No.: 2407

Project No.: D123VND11E REV 000

Test Date: 15-Sep-20

Beginning Clock Time: 11:19

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)

Barometric Pressure: Begin Middle End Average

28.45 28.36 28.41 0

OMNI Equipment Numbers:

Total Sampling Time: 243 min

Recording Interval: 1 min

Background Sample Volume: 61.149 cubic feet

PM Control Modules: 371, 372

Dilution Tunnel MW(dry): 29.00 lb/b-mole

Dilution Tunnel MW(wet): 28.75 lb/b-mole

Dilution Tunnel H<sub>2</sub>O: 2.00 percent

Dilution Tunnel Static: -0.108 "H<sub>2</sub>O

Tunnel Area: 0.19035 ft<sup>2</sup>

Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 18.13 ft/sec

Initial Tunnel Flow: 125.1 scfm


Average Tunnel Flow: 187.2 scfm

Post-Test Leak Check (1): 0.000 cfm @ 13 in. Hg

Post-Test Leak Check (2): 0.000 cfm @ 10 in. Hg

Average Test Piece Fuel Moisture: 20.70 Dry Basis %

Velocity Traverse Data															
	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center						
Initial dP	0.068	0.068	0.072	0.070	0.070	0.072	0.068	0.062	0.070						
Temp	66	66	66	66	66	66	66	66	65						
V <sub>stair</sub>		17.74		ft/sec		V <sub>scout</sub>		17.93		ft/sec		F <sub>p</sub>		0.989	

Technician Signature: 

Elapsed Time (min)	Particulate Sampling Data										Fuel Weight (lb)		Temperature Data (°F)													Stack Gas Data						
	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 (ft <sup>2</sup> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice dH 2 (ft <sup>2</sup> O)	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 (ft <sup>2</sup> O)	CO <sub>2</sub> (%)	CO (%)
238	41.414	39.646	0.18	0.17	2.27	80	-1.34	1.78	78	-1.9	104	0.070	99	99	3.8	-0.05	388	324	373	512	355	390	813	324	85	74	86	74	75	-0.060	8.47	0
239	41.589	39.814	0.17	0.17	2.28	80	-1.77	1.78	78	-2	104	0.070	99	99	3.8	-0.04	388	325	372	510	356	390	811	324	85	74	86	74	75	-0.060	8.39	0
240	41.763	39.982	0.17	0.17	2.27	80	-1.47	1.77	78	-2	104	0.070	98	99	3.7	-0.05	388	325	372	509	357	390	809	323	85	74	86	74	75	-0.060	8.2	0
241	41.939	40.151	0.18	0.17	2.28	80	-1.6	1.78	78	-1.8	104	0.070	99	100	3.7	-0.04	388	326	371	507	358	390	811	323	85	74	86	74	74	-0.060	8.08	0
242	42.113	40.320	0.17	0.17	2.29	80	-1.68	1.78	78	-2	104	0.070	98	100	3.6	-0.04	388	327	371	505	360	390	813	323	85	74	86	74	75	-0.060	8.03	0
243	42.287	40.488	0.17	0.17	2.29	80	-1.43	1.78	78	-2	103	0.070	98	99	3.6	-0.05	388	327	370	503	360	390	813	323	85	75	86	74	75	-0.060	8.05	0
Avg Tot	42.287	40.488	0.17	0.17	2.28	74		1.78	72		100	0.068	100	100								329.6				72	84	70	69	-0.067		

## Wood Heater Lab Data

Manufacturer: Kuma Stoves      Equipment Numbers: \_\_\_\_\_  
 Model: K180 Series      \_\_\_\_\_  
 Tracking No.: 2407      \_\_\_\_\_  
 Project No.: 0123WN011E.REV 002      \_\_\_\_\_  
 Run #: 1      \_\_\_\_\_  
 Date: 9/15/20      \_\_\_\_\_

### TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	T273S	99.3	97.1	2.2
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe				0.0
E. Filter seals catch*	Seals				0.0

**Sub-Total**      Total Particulate, mg:      2.2

### TRAIN 1 (Post First Hour Change-out)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	T285AP	194.1	191.6	2.5
C. Rear filter catch	Filter	T274 T275	191.3	189.2	2.1
D. Probe catch*	Probe	7	114982.9	114981.6	1.3
E. Filter seals catch*	Seals	S021	4105.5	4104.9	0.6

**Sub-Total**      Total Particulate, mg:      6.5

**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	T285BP	195.5	190.9	4.6
B. Rear filter catch	Filter	T276S	92.7	91.0	1.7
C. Probe catch*	Probe	8	115598.3	115597.5	0.8
D. Filter seals catch*	Seals	S022	3352.9	3352.9	0.0

Total Particulate, mg:      7.1

### AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter	E052	119.6	119.5	0.1

Total Particulate, mg:      0.1

\*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: K180 Series  
Project No.: 0123WN011E.REV 002  
Tracking No.: 2407  
Run: 1  
Test Date: 09/15/20

Burn Rate	2.00 kg/hr dry
Average Tunnel Temperature	100 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	18.13 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11231.2 dscf/hour
Average Delta p	0.068 inches H2O
Total Time of Test	243 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	61.149 cubic feet	42.287 cubic feet	40.488 cubic feet	10.330 cubic feet
Average Gas Meter Temperature	69 degrees Fahrenheit	74 degrees Fahrenheit	72 degrees Fahrenheit	69 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	58.843 dscf	39.655 dscf	38.200 dscf	9.781 dscf
Total Particulates - m <sub>T</sub>	0.1 mg	8.7 mg	7.1 mg	2.2 mg
Particulate Concentration (dry-standard) - C <sub>p</sub> /C <sub>s</sub>	0.000002 grams/dscf	0.00022 grams/dscf	0.00019 grams/dscf	0.00022 grams/dscf
Total Particulate Emissions - E <sub>T</sub>	0.08 grams	9.90 grams	8.38 grams	2.53 grams
Particulate Emission Rate	0.02 grams/hour	2.44 grams/hour	2.07 grams/hour	2.53 grams/hour
Emissions Factor		1.22 g/kg	1.03 g/kg	1.15 g/kg
Difference from Average Total Particulate Emissions		0.76 grams	0.76 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E <sub>T</sub>	9.14 grams
Particulate Emission Rate	2.26 grams/hour
Emissions Factor	1.13 grams/kg
First Hour Emissions	
Total Particulate Emissions - E <sub>T</sub>	2.53 grams
Particulate Emission Rate	2.53 grams/hour
Emissions Factor	1.15 grams/kg
7.5% of Average Total Particulate Emissions	0.69 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

Technician Signature: 

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

Cordwood Fuel Load Calculators - 10 lb/ft<sup>3</sup> 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 <sup>3</sup>		
Usable Firebox Volume	1.73	ft <sup>3</sup>		
Total Nom. Load Wt. Target	17.30	lb		
Total Load Wt. Allowable Range	16.40	to 18.20	lb	
Core Target Wt. Allowable Range	7.80	to 11.20	lb	
Remainder Load Wt. Allowable Range	6.10	to 9.50	lb	
				Mid-Point
Core Load Pc. Wt. Allowable Range	2.60	to 4.30	lb	3.45
Remainder Load Pc. Wt. Allowable Range	1.70	to 9.50	lb	5.60
	Pc. #			
Core Load Piece Wt. Actual	1	3.31	lb	In Range
	2	3.76	lb	In Range
	3	2.75	lb	In Range
Core Load Total. Wt. Actual		9.82	lb	In Range
	Pc. #			
Remainder Load Piece Wt.	1	2.46	lb	In Range
(1 to 3 Pcs.)	2	4.86	lb	In Range
	3		lb	NA
Remainder Load Tot. Wt. Act		7.32	lb	In Range
Total Load Wt. Actual		17.14	lb	In Range
Core % of Total Wt.		57%		In Range 45-65%
Remainder % of Total Wt.		43%		In Range 35-55%
Actual Load % of Nominal Target		99%		In Range 95-105%
Actual Fuel Load Density		9.9	lb/ft <sup>3</sup>	
Kindling and Start-up Fuel				
Maximum Kindling Wt. (20% of Tot. Load Wt.)		3.43	lb	
Actual Kindling Wt.		3.43	lb	In Range 20.0%
Maximum Start-up Fuel Wt. (30% of Tot. Load Wt.)		5.14	lb	
Actual Start-up Fuel Wt.		5.14	lb	In Range 30.0%
Allowable Residual Start-up Fuel Wt. Range	1.7	to 3.4	lb	Mid-Point
Actual Residual Start-up Fuel Wt.		2	lb	In Range 2.6
Total Wt. All Fuel Added (wet basis)		25.71	lb	
High Fire Test Run End Point Range				
Based on Fuel Load Wt. (w/tares)	Low	1.5	to 1.9	lb Mid-Point 1.7
Actual Fuel Load Ending Wt.		1.6	lb	In Range

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Fuel Piece Moisture Reading (%-dry basis)							
1	2	3	Ave.		Pc. Wt. Dry Basis		
20	20	19.3	19.8	In Range	2.77	lb	1.25 kg
17.2	19.9	19.7	18.9	In Range	3.16	lb	1.43 kg
21.6	25.1	21.4	22.7	In Range	2.24	lb	1.02 kg
21.6	21.6	21.5	21.6	In Range	2.03	lb	0.92 kg
23.4	21.4	18.8	21.2	In Range	4.01	lb	1.82 kg
			NA	NA	NA	lb	NA kg
Total Load Ave. MC (%-dry basis)				20.7	In Range		
Total Load Ave. MC % (wet basis)				17.2			
Total Test Load Weight (dry basis)					14.20	lb	6.44 kg
Kindling Moisture (%-dry basis)							
11.055	11.055	11.055	11.1	In Range	3.09	lb	1.40 kg
Start-up Fuel Moisture Readings (%-dry basis)							
20.833	20.833	20.833	20.8	In Range	4.26	lb	1.93 kg
Total Wt. All Fuel Added (dry basis)					21.54	lb	9.77 kg
Total Wt. All Fuel Burned (dry basis)					17.9	lb	8.1 kg



## Wood Heater Run Sheets

Client: Kuma StovesProject Number: 0123WM011E.REV002 Run Number: 1Model: K-180Tracking Number: 2407Date: 9/15/20Test Crew: B Davis

OMNI Equipment ID numbers: \_\_\_\_\_

## Wood Heater Supplemental Data

Start Time: 1119Booth #: N/AStop Time: 1523

## Stack Gas Leak Check:

Initial: good Final: good

## Sample Train Leak Check:

A: 0.0 @ 13 "HgB: 0.0 @ 10 "HgCalibrations: Span Gas CO<sub>2</sub>: 12.4 CO: 2.48

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>1045</u>	<u>1046</u>	<u>1553</u>	<u>1553</u>
CO <sub>2</sub>	<u>0.00</u>	<u>12.47</u>	<u>6.08</u>	<u>12.31</u>
CO	<u>0.00</u>	<u>2.49</u>	<u>-0.04</u>	<u>2.39</u>

Air Velocity (ft/min): Initial: 250 Final: 253Scale Audit (lbs): Initial: 10.0 Final: 10.5Pitot Tube Leak Test: Initial: good Final: goodStack Diameter (in): 6"Induced Draft: 0.0% Smoke Capture: 100%

Flue Pipe Cleaned Prior to First Test in Series:

Date: 9/14/20 Initials: BS

	Initial	Middle	Ending
P <sub>b</sub> (in/Hg)	<u>28.45</u>		<u>28.36</u>
RH (%)	<u>60</u>		<u>47</u>
Ambient (°F)	<u>62</u>		<u>75</u>

Tunnel Traverse		
Microtector Reading	dP (in H <sub>2</sub> O)	T(°F)
	<u>.066</u>	<u>66</u>
	<u>.068</u>	<u>66</u>
	<u>.072</u>	<u>66</u>
	<u>.070</u>	<u>66</u>
	<u>.070</u>	<u>66</u>
	<u>.062</u>	<u>66</u>
	<u>.072</u>	<u>66</u>
	<u>.066</u>	<u>66</u>
	<u>.062</u>	<u>66</u>
Center:		
	<u>.070</u>	<u>65</u>

Background Filter Volume: 61.149

Tunnel Static Pressure (in H <sub>2</sub> O):	
Beginning of Test	End of Test
<u>-1.08</u>	<u>-1.08</u>

Technician Signature: BSDate: 9/29/20

**Wood Heater Run Sheets**Client: Kuma StovesProject Number: 0123WM011E.REV002 Run Number: 1Model: K-180Tracking Number: 2407Date: 9/15/20Test Crew: B. Davis

OMNI Equipment ID numbers: \_\_\_\_\_

**Wood Heater Run Notes****Air Control Settings**

Primary:

Fully open

Secondary:

fixed

Tertiary/Pilot:

N/A

Fan:

On High 2**Preburn Notes**

Time	Notes
Ø	Torch used for 25' for a top down burn. Door closed by 51, bypass closed at 15 minutes. Fan off during startup/kindling burn.

**Test Notes**

Sketch test fuel configuration:

See photo

Start up procedures &amp; Timeline:

Bypass:

closed by 1:45

Fuel loaded by:

1:45

Door closed at:

1:45

Primary air:

Fully open entire test

Notes:

Fan on high 5 min after start of test

Time	Notes
60	changed front filter in fan - A.

Technician Signature: B. DavisDate: 9/29/20

# **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 Emissions Data

Run: 1  
Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1 (Amb)  
Background Sample Volume: 61.149 cubic feet  
Total Sampling Time: 174 min  
Recording Interval: 1 min  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(wet): 29.90 lb/b-mole  
Dilution Tunnel MW(wet): 29.78 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.50 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
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): cfm @ in. Hg  
Post-Test Leak Check (2): cfm @ in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP: #DIV/0! "H<sub>2</sub>O  
Temp: #DIV/0! °F  
V<sub>stack</sub>: #DIV/0! ft/sec  
V<sub>scout</sub>: #DIV/0! ft/sec  
F<sub>p</sub>: #DIV/0!

Technician Signature: 

Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 (in <sub>H<sub>2</sub>O</sub> )	Particulate Sampling Data										Fuel Weight (lb)										Temperature Data (°F)										Stack Gas Data			
						Meter 1 Vacuum (inHg)	Orifice dH 2 (in <sub>H<sub>2</sub>O</sub> )	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	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 (inH <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)								
0	0.000																15.5		568	186	371	344	332	360	803	427	85	71	83	68	66	-0.071	5.49	0.09					
1																	15.2	-0.32	553	187	378	349	336	361	865	341	85	71	82	66	66	-0.069	2.3	0.23					
2																	15.1	-0.11	547	189	383	352	340	362	786	362	85	71	82	66	66	-0.073	5.8	0.01					
3																	15.0	-0.12	544	191	386	355	343	364	835	372	84	71	81	68	66	-0.073	6.66	0					
4																	14.8	-0.11	542	194	389	356	346	365	848	379	84	71	81	69	66	-0.073	7.12	0					
5																	14.7	-0.17	516	199	383	356	351	361	868	380	84	71	81	69	66	-0.074	7.93	0					
6																	14.6	-0.08	500	201	378	356	354	358	875	381	84	72	80	69	66	-0.074	8.01	0					
7																	14.5	-0.11	486	202	372	356	356	354	881	381	84	72	80	69	66	-0.074	8.07	0					
8																	14.4	-0.09	475	204	366	356	357	352	882	379	83	72	81	69	67	-0.073	7.86	0					
9																	14.3	-0.12	465	207	360	355	357	349	891	378	83	72	82	69	66	-0.073	8.08	0					
10																	14.2	-0.12	457	209	354	354	357	348	895	379	83	72	83	69	67	-0.074	8.05	0					
11																	14.0	-0.11	451	211	348	353	356	344	926	365	83	72	84	69	67	-0.075	9.01	0					
12																	13.9	-0.13	447	212	342	352	356	342	923	367	83	72	85	69	67	-0.074	9.08	0					
13																	13.8	-0.13	442	213	336	351	355	339	917	364	83	72	85	69	67	-0.073	8.95	0					
14																	13.7	-0.11	437	214	331	350	354	337	912	363	82	72	86	69	67	-0.074	8.78	0					
15																	13.5	-0.12	433	215	326	350	354	336	910	362	82	72	87	69	67	-0.074	8.77	0					
16																	13.4	-0.10	429	216	320	349	353	333	906	361	82	72	87	69	67	-0.072	8.94	0					
17																	13.3	-0.12	426	216	315	349	353	332	908	378	82	72	87	69	67	-0.072	9.39	0					
18																	13.2	-0.11	424	217	311	349	354	331	916	378	82	72	86	69	67	-0.072	9.36	0					
19																	13.1	-0.11	424	217	306	349	354	330	925	377	82	72	86	69	67	-0.072	9.13	0					
20																	13.0	-0.11	423	217	302	349	354	329	925	378	82	72	86	69	67	-0.072	9.03	0					
21																	12.9	-0.13	423	217	298	349	355	328	928	378	82	72	85	69	67	-0.072	9.12	0					
22																	12.8	-0.09	424	217	294	350	355	328	939	379	82	72	85	69	67	-0.073	9.31	0					
23																	12.6	-0.13	425	218	291	350	355	328	941	378	82	72	85	69	67	-0.072	9.88	0					
24																	12.5	-0.14	426	218	287	351	355	328	958	379	82	72	84	69	67	-0.074	10.68	0					
25																	12.4	-0.14	434	218	284	351	354	328	965	379	82	73	84	70	68	-0.074	12	0					
26																	12.2	-0.12	440	218	281	352	354	329	960	378	83	73	84	70	68	-0.074	11.69	0					
27																	12.1	-0.11	446	218	279	353	353	330	952	374	83	73	84	70	68	-0.073	11.3	0					
28																	12.0	-0.13	451	219	276	355	353	331	949	373	83	73	83	70	68	-0.073	10.88	0					
29																	11.9	-0.13	455	218	273	356	352	331	944	370	83	73	83	70	68	-0.073	10.72	0					
30																	11.7	-0.12	459	218	271	357	352	331	949	369	83	74	83	70	68	-0.073	9.98	0					
31																	11.7	-0.09	460	217	269	357	351	331	938	366	84	74	83	70	68	-0.072	9.68	0					
32																	11.5	-0.12	460	217	266	358	350	330	927	365	84	74	83	70	68	-0.073	9.6	0					
33																	11.4	-0.10	460	217	264	358	349	330	925	365	84	74	83	70	69	-0.073	9.67	0					

Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves

Model: K180 Series

Tracking No.: 2407

Project No.: D123VND11E REV 000

Test Date: 15-Sep-20

Beginning Clock Time: 11:19

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average

28.45 28.36 28.41 0

OMNI Equipment Numbers:

Total Sampling Time: 174 min

Recording Interval: 1 min

Background Sample Volume: 61.149 cubic feet

PM Control Modules: 371, 372

Dilution Tunnel MW(wet): 29.00 lb/b-mole

Dilution Tunnel MW(wet): 29.75 lb/b-mole

Dilution Tunnel H<sub>2</sub>O: 2.50 percent

Dilution Tunnel Static: -0.108 "H<sub>2</sub>O

Tunnel Area: 3.19035 ft<sup>2</sup>

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): cfm @ in. Hg

Post-Test Leak Check (2): cfm @ in. Hg


Average Test Piece Fuel Moisture: 20.70 Dry Basis %

Velocity Traverse Data									
	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center
Initial dP									H <sub>2</sub> O
Temp:									°F

V<sub>stair</sub> ft/sec

V<sub>scout</sub> ft/sec

F<sub>p</sub>

Technician Signature: 

Particulate Sampling Data															Fuel Weight (lb)		Temperature Data (°F)															Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (in)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice d#2 (in)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	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 <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)		
34															11.4	-0.08	458	217	282	358	348	329	917	364	84	74	83	70	68	-0.073	9.64	0		
35															11.2	-0.13	457	217	260	358	347	328	916	363	84	74	83	70	68	-0.072	9.62	0		
36															11.1	-0.12	455	217	258	358	346	327	916	363	3218	74	83	70	69	-0.072	9.62	0		
37															11.0	-0.11	454	217	257	358	345	326	913	361	85	74	83	70	69	-0.072	9.62	0		
38															10.9	-0.12	453	217	255	358	344	325	916	361	85	73	83	70	69	-0.072	9.41	0		
39															10.8	-0.09	452	216	254	358	344	325	919	362	85	72	83	70	69	-0.072	9.35	0		
40															10.7	-0.08	451	217	253	358	343	324	922	364	85	72	83	70	69	-0.072	9.38	0		
41															10.6	-0.13	452	216	252	358	342	324	934	366	85	73	83	70	69	-0.073	9.76	0		
42															10.5	-0.12	453	216	251	358	341	324	941	370	85	73	82	70	69	-0.073	9.91	0		
43															10.4	-0.10	453	216	250	359	340	324	941	371	85	73	82	70	69	-0.073	10.02	0		
44															10.3	-0.09	453	216	249	360	339	323	933	371	85	73	82	70	69	-0.073	10.15	0		
45															10.2	-0.11	453	216	249	361	338	323	933	373	85	73	82	70	69	-0.074	10.32	0		
46															10.0	-0.12	453	216	249	363	337	324	935	373	85	73	82	70	69	-0.074	10.42	0		
47															9.9	-0.13	453	216	248	366	336	324	932	372	85	73	82	70	69	-0.073	10.4	0		
48															9.8	-0.09	453	216	250	368	335	324	929	372	85	73	82	71	69	-0.072	10.4	0		
49															9.7	-0.14	453	216	251	371	334	325	940	374	85	73	82	71	69	-0.073	10.45	0		
50															9.6	-0.09	454	216	253	374	333	326	941	375	85	73	82	71	69	-0.073	10.44	0		
51															9.5	-0.13	455	216	254	376	333	327	943	376	85	73	82	71	69	-0.072	10.45	0		
52															9.4	-0.10	456	216	256	379	332	328	939	375	85	73	82	71	69	-0.073	10.56	0		
53															9.2	-0.12	457	216	258	382	332	329	942	376	85	73	82	71	70	-0.073	10.71	0		
54															9.1	-0.10	458	216	259	384	331	330	939	375	85	73	82	71	70	-0.072	11.04	0		
55															9.0	-0.15	459	217	261	387	331	331	942	375	84	73	83	71	70	-0.073	11.33	0		
56															8.9	-0.11	462	217	263	399	330	332	951	376	84	73	83	71	70	-0.072	11.62	0		
57															8.7	-0.13	466	217	265	391	330	334	962	377	84	73	83	71	70	-0.073	11.77	0		
58															8.6	-0.10	470	217	268	394	330	336	962	378	84	73	83	71	70	-0.073	11.5	0		
59															8.5	-0.12	473	218	270	396	330	337	957	377	84	73	84	71	70	-0.073	11.33	0		
60															8.4	-0.09	475	218	273	398	330	339	954	378	83	73	84	71	70	-0.072	11.23	0		
61															8.3	-0.12	476	218	275	400	329	340	944	378	83	73	84	71	70	-0.072	11.24	0		
62															8.2	-0.12	476	219	277	402	330	341	937	377	83	73	84	71	70	-0.072	11.22	0		
63															8.1	-0.13	476	219	280	404	330	342	937	375	83	73	84	71	70	-0.071	11.19	0		
64															8.0	-0.09	476	220	282	406	330	343	945	376	83	73	85	71	70	-0.072	11.39	0		
65															7.8	-0.12	477	220	284	407	330	344	951	379	83	73	85	71	70	-0.072	11.7	0		
66															7.7	-0.10	479	221	286	409	330	345	959	379	83	73	85	71	70	-0.072	11.88	0		
67															7.6	-0.15	481	221	288	411	331	346	967	379	83	73	86	71	71	-0.072	12.01	0		

Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E-REV 000  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19

Total Sampling Time: 174 min  
Recording Interval: 1 min  
Background Sample Volume: 61.149 cubic feet

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0


OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(wet): 29.90 lb/b-mole  
Dilution Tunnel MW(wet): 28.75 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.50 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
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): cfm @ in. Hg  
Post-Test Leak Check (2): cfm @ in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %

Velocity Traverse Data									
	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center
Initial dP									"H <sub>2</sub> O
Temp:									°F

V<sub>stack</sub> ft/sec V<sub>scout</sub> ft/sec F<sub>p</sub>

Technician Signature: 

Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)														Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice dH 2 (H <sub>2</sub> O)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	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 <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)
68															7.5	-0.12	484	222	290	413	331	348	972	379	83	73	85	71	71	-0.072	12.21	0
69															7.4	-0.11	487	223	293	415	332	350	971	380	83	74	85	71	71	-0.072	12.17	0
70															7.3	-0.11	488	223	295	418	332	351	966	378	83	74	85	71	71	-0.072	12.02	0
71															7.1	-0.11	490	224	297	420	333	353	963	378	83	73	85	71	71	-0.073	11.83	0
72															7.0	-0.13	491	225	300	423	333	354	959	376	83	74	85	71	71	-0.073	11.63	0
73															6.9	-0.11	491	226	303	425	334	356	957	375	83	74	85	72	71	-0.072	11.51	0
74															6.8	-0.08	491	227	305	427	334	357	953	373	83	74	85	72	71	-0.071	11.36	0
75															6.7	-0.13	491	228	307	430	335	358	947	372	83	74	85	72	71	-0.071	11.24	0
76															6.6	-0.11	490	229	310	432	335	359	943	372	83	74	85	72	71	-0.071	11.11	0
77															6.5	-0.10	489	230	313	434	336	360	948	373	83	74	85	72	71	-0.071	11.1	0
78															6.5	-0.01	488	231	315	435	336	361	944	371	83	74	85	72	71	-0.070	10.98	0
79															6.4	-0.09	487	232	318	437	337	362	941	371	83	74	85	72	71	-0.070	10.81	0
80															6.3	-0.09	486	233	320	439	337	363	938	370	83	74	85	72	71	-0.070	10.73	0
81															6.2	-0.09	485	234	323	440	337	364	939	370	83	74	85	72	71	-0.070	10.66	0
82															6.1	-0.11	484	235	325	442	337	365	935	371	83	74	84	72	71	-0.071	10.54	0
83															6.0	-0.09	482	237	327	444	338	366	932	371	83	74	84	72	72	-0.071	10.47	0
84															5.9	-0.10	480	238	329	445	338	366	938	370	83	74	85	72	72	-0.070	10.5	0
85															5.8	-0.09	479	239	331	447	338	367	944	370	83	74	84	72	72	-0.070	10.54	0
86															5.7	-0.08	479	241	332	449	338	368	951	370	83	74	85	72	72	-0.070	10.47	0
87															5.6	-0.14	479	242	334	451	338	369	962	370	83	74	85	72	72	-0.071	10.53	0
88															5.5	-0.08	479	244	335	453	338	370	965	372	83	74	84	72	72	-0.070	10.4	0
89															5.4	-0.10	479	245	336	455	338	371	968	373	83	74	85	72	72	-0.070	10.37	0
90															5.3	-0.10	480	246	338	457	338	372	969	373	83	74	85	72	72	-0.070	10.32	0
91															5.2	-0.09	480	248	339	459	338	373	973	374	83	74	85	72	72	-0.071	10.16	0
92															5.2	-0.04	481	249	340	461	338	374	977	376	83	74	85	72	72	-0.070	10.02	0
93															5.1	-0.10	481	251	341	463	337	375	978	379	83	74	85	72	72	-0.071	9.91	0
94															5.0	-0.08	481	252	342	465	337	375	977	379	83	74	85	72	72	-0.071	9.74	0
95															4.9	-0.07	481	254	342	467	337	376	976	380	83	74	85	72	72	-0.071	9.68	0
96															4.8	-0.13	480	255	343	469	336	377	964	380	83	74	85	72	72	-0.071	9.73	0
97															4.7	-0.06	480	256	343	471	336	377	968	381	83	74	85	72	72	-0.071	9.84	0
98															4.6	-0.11	481	258	343	472	335	378	972	382	83	74	85	72	72	-0.071	9.89	0
99															4.5	-0.07	480	259	344	474	335	378	968	383	83	74	85	72	72	-0.071	9.93	0
100															4.4	-0.10	480	260	345	476	334	379	968	383	83	74	84	72	72	-0.070	10	0
101															4.3	-0.10	480	262	345	477	334	380	970	384	83	74	84	72	72	-0.070	10.05	0

Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves

Model: K180 Series

Tracking No.: 2407

Project No.: D123VND11E REV 000

Test Date: 15-Sep-20

Beginning Clock Time: 11:19

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average

28.45 28.36 28.41 0

OMNI Equipment Numbers:

Total Sampling Time: 174 min

Recording Interval: 1 min

Background Sample Volume: 61.149 cubic feet

PM Control Modules: 371, 372

Dilution Tunnel MW(wet): 29.00 lb/b-mole

Dilution Tunnel MW(wet): 28.75 lb/b-mole

Dilution Tunnel H<sub>2</sub>O: 2.50 percent

Dilution Tunnel Static: -0.108 "H<sub>2</sub>O

Tunnel Area: 0.19035 ft<sup>2</sup>

Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 18.00 ft/sec


Initial Tunnel Flow: 18.00 cfm

Average Tunnel Flow: 18.00 cfm @

Post-Test Leak Check (1): cfm @

Post-Test Leak Check (2): cfm @

Average Test Piece Fuel Moisture: 20.70 Dry Basis %

Technician Signature: 

Velocity Traverse Data									
	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center
Initial dP									H <sub>2</sub> O
Temp:									°F

V<sub>start</sub> ft/sec

V<sub>scout</sub> ft/sec


F<sub>p</sub>

Elapsed Time (min)	Particulate Sampling Data													Fuel Weight (lb)		Temperature Data (°F)																Stack Gas Data		
	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (1/4")	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice d#2 (1/4")	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	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 (inHg)	CO <sub>2</sub> (%)	CO (%)		
102															4.3	-0.07	480	283	348	479	333	380	972	384	83	74	84	72	72	-0.070	10.05	0		
103															4.2	-0.11	479	264	347	480	333	381	970	382	83	74	84	73	72	-0.069	9.99	0		
104															4.1	-0.09	479	265	348	482	332	381	965	382	83	74	84	73	72	-0.069	9.94	0		
105															4.0	-0.06	478	266	349	484	331	382	960	381	83	74	84	73	72	-0.069	9.9	0		
106															4.0	-0.05	477	267	349	486	331	382	958	379	83	74	84	73	72	-0.069	9.91	0		
107															3.9	-0.09	475	268	350	487	330	382	951	379	83	74	84	73	72	-0.068	9.92	0		
108															3.8	-0.08	474	270	351	489	330	383	948	377	83	74	84	73	72	-0.068	9.94	0		
109															3.7	-0.09	473	271	352	490	329	383	940	376	84	74	84	73	72	-0.068	10.03	0		
110															3.6	-0.08	472	272	353	492	329	384	948	375	84	74	84	73	72	-0.068	10.62	0.02		
111															3.5	-0.11	475	273	354	494	328	385	989	376	84	74	84	73	73	-0.067	11.79	0.13		
112															3.4	-0.09	482	274	355	495	327	387	1016	379	84	74	84	73	72	-0.068	11.79	0.13		
113															3.3	-0.10	488	275	356	497	327	389	1013	381	84	74	84	73	73	-0.070	11.82	0.19		
114															3.2	-0.09	493	276	358	499	327	391	1010	381	84	74	84	73	73	-0.069	11.67	0.18		
115															3.1	-0.09	498	277	359	500	326	392	1010	381	84	74	84	73	73	-0.068	11.62	0.18		
116															3.1	-0.09	502	278	360	502	326	394	1007	380	84	74	84	73	73	-0.069	11.53	0.19		
117															3.0	-0.09	505	279	361	504	326	395	1009	380	84	74	84	73	73	-0.070	11.47	0.17		
118															2.9	-0.10	507	280	363	507	326	397	1009	381	84	74	84	73	73	-0.069	11.53	0.2		
119															2.8	-0.08	509	281	364	509	325	398	1010	379	84	74	84	73	73	-0.070	11.45	0.15		
120															2.7	-0.09	511	282	365	511	325	399	1011	380	84	74	84	73	73	-0.069	11.52	0.21		
121															2.6	-0.10	512	283	366	513	325	400	1002	379	84	74	85	73	73	-0.069	11.44	0.19		
122															2.5	-0.06	512	284	367	515	325	401	990	377	84	74	85	73	73	-0.068	11.3	0.12		
123															2.4	-0.10	512	285	368	518	325	402	988	375	84	74	85	73	73	-0.068	10.94	0.03		
124															2.4	-0.07	512	286	370	520	325	403	979	371	84	74	85	73	73	-0.068	10.82	0.04		
125															2.3	-0.04	510	287	371	522	325	403	964	370	84	74	85	73	73	-0.068	10.42	0.03		
126															2.3	-0.08	508	288	372	524	325	403	949	368	84	74	85	73	73	-0.068	10.18	0.02		
127															2.2	-0.07	504	289	373	526	326	404	931	364	84	74	85	73	73	-0.067	9.98	0		
128															2.1	-0.07	500	290	374	528	326	404	917	360	84	74	85	73	74	-0.067	9.93	0		
129															2.0	-0.07	495	291	374	529	326	403	905	357	84	74	85	73	73	-0.067	9.84	0		
130															2.0	-0.05	491	292	375	531	326	403	898	354	84	74	85	73	73	-0.067	9.76	0		
131															1.9	-0.05	486	293	376	533	326	403	892	351	84	74	85	73	73	-0.066	9.8	0		
132															1.9	-0.07	482	294	377	534	326	403	893	351	84	74	85	73	73	-0.066	9.74	0		
133															1.8	-0.10	478	295	378	535	327	403	889	349	84	74	85	73	73	-0.065	9.67	0		
134															1.8	-0.03	474	296	379	537	327	403	885	347	84	74	85	73	74	-0.064	9.53	0		
135															1.7	-0.06	470	297	380	538	327	402	882	345	84	74	85	73	73	-0.064	9.39	0		

Wood Heater Test Data  
High Burn Emissions Data

Run: 1  
Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123VND11E REV 002  
Test Date: 15-Sep-20  
Beginning Clock Time: 11:19  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1 (Amb)  
Background Sample Volume: 61.149 cubic feet  
Barometric Pressure: Begin Middle End Average  
28.45 28.36 28.41 0  
OMNI Equipment Numbers:

PM Control Modules: 371, 372  
Dilution Tunnel MW(wet): 29.90 lb/b-mole  
Dilution Tunnel MW(wet): 29.78 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.50 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 18.00 ft/sec  
Initial Tunnel Flow: 18.00 cfm  
Average Tunnel Flow: 18.00 cfm @ 1 in. Hg  
Post-Test Leak Check (1): 0.000 cfm @ 1 in. Hg  
Post-Test Leak Check (2): 0.000 cfm @ 1 in. Hg  
Average Test Piece Fuel Moisture: 20.70 Dry Basis %  
Velocity Traverse Data  
Initial dP: 0.00  
Temp: 0.00  
V<sub>flow</sub>: 18.00 ft/sec  
V<sub>scout</sub>: 18.00 ft/sec  
F<sub>p</sub>: 0.00

Technician Signature: 

Particulate Sampling Data														Fuel Weight (lb)		Temperature Data (°F)																	Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d1 (in.)	Meter 1 Temp (°F)	Meter 1 Vacuum (in.Hg)	Orifice d1 2 (in.)	Meter 2 Temp (°F)	Meter 2 Vacuum (in.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 (in.H <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)			
136															1.7	0.04	466	298	381	539	328	402	884	343	84	74	85	73	74	-0.064	9.35	0			
137															1.7	-0.05	463	299	382	539	328	402	881	343	84	74	85	73	74	-0.064	9.24	0			
138															1.7	-0.04	460	300	383	540	328	402	875	342	84	74	85	73	74	-0.064	9.16	0			
139															1.6	-0.07	455	301	383	540	329	402	868	340	84	74	85	73	73	-0.063	9.14	0			
140															1.5	-0.05	451	302	384	540	329	401	869	339	84	74	85	73	74	-0.064	9.19	0			
141															1.5	-0.04	448	303	385	541	330	401	870	339	85	74	85	74	74	-0.064	9.09	0			
142															1.4	-0.05	446	304	385	541	331	401	876	338	84	74	85	73	74	-0.065	9.17	0			
143															1.4	-0.07	444	305	386	540	331	401	881	340	85	74	85	74	74	-0.063	9.29	0			
144															1.3	-0.06	442	307	386	541	332	402	874	340	85	74	85	74	74	-0.063	9.06	0			
145															1.3	-0.03	440	308	387	540	333	402	867	338	85	74	86	74	74	-0.063	8.97	0			
146															1.2	-0.05	439	309	387	540	334	402	877	339	85	74	86	74	74	-0.064	9.01	0			
147															1.2	-0.08	437	310	387	540	334	402	869	340	85	74	86	74	74	-0.064	8.90	0			
148															1.1	-0.03	435	311	388	540	335	402	858	337	85	74	86	74	74	-0.062	8.38	0			
149															1.1	-0.08	432	312	387	539	337	401	849	336	85	74	86	74	74	-0.062	8.22	0			
150															1.0	-0.04	429	312	387	538	338	401	841	335	85	74	86	74	74	-0.062	8.06	0			
151															1.0	-0.03	426	313	387	537	339	400	830	333	85	74	86	74	74	-0.062	8	0			
152															0.9	-0.04	422	314	387	536	340	400	826	331	85	74	86	74	74	-0.061	7.93	0			
153															0.9	-0.07	418	315	386	535	341	399	821	329	85	74	86	74	74	-0.061	7.97	0			
154															0.8	-0.04	415	316	386	534	342	399	815	329	85	74	86	74	74	-0.061	7.93	0			
155															0.8	-0.04	411	316	385	533	343	398	812	328	85	74	86	74	74	-0.060	7.9	0			
156															0.7	-0.06	408	317	384	532	344	397	807	327	85	74	86	74	74	-0.060	7.86	0			
157															0.7	-0.05	405	317	383	531	344	396	802	326	85	74	86	74	74	-0.060	7.84	0			
158															0.6	-0.04	401	318	383	529	345	395	795	324	85	74	86	74	74	-0.060	7.83	0			
159															0.6	-0.05	398	319	382	527	346	394	790	323	85	74	86	74	74	-0.060	7.84	0			
160															0.6	-0.03	396	319	381	526	347	394	792	322	85	74	86	74	74	-0.060	7.79	0			
161															0.5	-0.06	393	320	380	525	347	393	794	322	85	74	86	74	74	-0.060	7.84	0			
162															0.5	-0.04	391	320	379	523	348	392	798	322	85	74	86	74	74	-0.060	7.76	0			
163															0.5	0.04	390	321	378	522	349	392	801	323	85	74	86	74	74	-0.060	7.84	0			
164															0.5	-0.02	389	321	377	520	350	391	807	324	85	74	86	74	74	-0.060	8.03	0			
165															0.4	-0.06	388	322	377	518	350	391	812	324	85	74	86	74	74	-0.060	8.23	0			
166															0.4	-0.05	388	322	375	517	351	391	818	327	85	74	86	74	75	-0.060	8.19	0			
167															0.3	-0.06	387	323	375	515	353	391	814	325	85	74	86	74	74	-0.060	8.35	0			
168															0.3	-0.04	387	324	374	513	354	390	814	325	85	74	86	74	75	-0.060	8.61	0			
169															0.2	-0.05	388	324	373	512	355	390	813	324	85	74	86	74	75	-0.060	8.47	0			



Wood Heater Test Data  
High Burn Emissions Data

Run: 1

Manufacturer: Kuma Stoves

Model: K180 Series

Tracking No.: 2407

Project No.: 0123VND011E-REV 000

Test Date: 15-Sep-20

Beginning Clock Time: 11:19

Total Sampling Time: 174 min

Recording Interval: 1 min

Background Sample Volume: 61.149 cubic feet

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1 (Amb)

Barometric Pressure: Begin Middle End Average

28.45 28.36 28.41 0

OMNI Equipment Numbers:

PM Control Modules: 371, 372

Dilution Tunnel MW(wet): 29.00 lb/b-mole

Dilution Tunnel MW(wet): 28.75 lb/b-mole

Dilution Tunnel H<sub>2</sub>O: 2.00 percent

Dilution Tunnel Static: -0.108 "H<sub>2</sub>O

Tunnel Area: 0.19035 ft<sup>2</sup>

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): cfm @ in. Hg

Post-Test Leak Check (2): cfm @ in. Hg


Average Test Piece Fuel Moisture: 20.70 Dry Basis %

Velocity Traverse Data									
	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center
Initial dP									"H <sub>2</sub> O
Temp:									"F

V<sub>stair</sub> ft/sec

V<sub>scout</sub> ft/sec

F<sub>p</sub>

Technician Signature: 

Particulate Sampling Data															Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data			
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (in)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice d#2 (in)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (inH <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)
170															0.2	-0.04	388	325	372	810	356	390	811	324	85	74	86	74	75	-0.060	8.39	0
171															0.1	-0.05	388	325	372	509	357	390	809	323	85	74	86	74	75	-0.060	8.2	0
172															0.1	-0.04	388	326	371	507	358	390	811	323	85	74	86	74	74	-0.060	8.08	0
173															0.0	-0.04	388	327	371	505	360	390	813	323	85	74	86	74	75	-0.060	8.03	0
174															0.0	-0.05	388	327	370	503	360	390	813	323	85	75	86	74	75	-0.060	8.05	0
Avg Tot	0.100	0.000	0.00	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!																		

Wood Heater Test Results

Manufacturer: Kuma Stoves  
Model: K180 Series  
Project No.: 0123WN011E.REV 002  
Tracking No.: 2407  
Run: 1  
Test Date: 09/15/20

Burn Rate	2.22 kg/hr dry
Average Tunnel Temperature	#DIV/0! degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	#DIV/0! feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	#DIV/0! dscf/hour
Average Delta p	#DIV/0! inches H2O
Total Time of Test	174 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	61.149 cubic feet	0.100 cubic feet	0.000 cubic feet	0.100 cubic feet
Average Gas Meter Temperature	71 degrees Fahrenheit	#DIV/0! degrees Fahrenheit	#DIV/0! degrees Fahrenheit	#DIV/0! degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	57.694 dscf	#DIV/0! dscf	#DIV/0! dscf	#DIV/0! dscf
Total Particulates - m <sub>n</sub>	0.1 mg	9 mg	8 mg	2.2 mg
Particulate Concentration (dry-standard) - C <sub>p</sub> /C <sub>s</sub>	0.000002 grams/dscf	#DIV/0! grams/dscf	#DIV/0! grams/dscf	#DIV/0! grams/dscf
Total Particulate Emissions - E <sub>T</sub>	#DIV/0! grams	#DIV/0! grams	#DIV/0! grams	#DIV/0! grams
Particulate Emission Rate	#DIV/0! grams/hour	#DIV/0! grams/hour	#DIV/0! grams/hour	#DIV/0! grams/hour
Emissions Factor		#DIV/0! g/kg	#DIV/0! g/kg	#DIV/0! g/kg
Difference from Average Total Particulate Emissions		#DIV/0! grams	#DIV/0! grams	

	#DIV/0!
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FINAL AVERAGE RESULTS	
Complete Test Run	
Total Particulate Emissions - E <sub>T</sub>	#DIV/0! grams
Particulate Emission Rate	#DIV/0! grams/hour
Emissions Factor	#DIV/0! grams/kg
First Hour Emissions	
Total Particulate Emissions - E <sub>T</sub>	#DIV/0! grams
Particulate Emission Rate	#DIV/0! grams/hour
Emissions Factor	#DIV/0! grams/kg
7.5% of Average Total Particulate Emissions	#DIV/0! grams

QUALITY CHECKS	
Filter Temps < 90 °F	NOT ACCEPTABLE
Filter Face Velocity (47 mm)	OK
Dryer Exit Temp < 80F	OK
Leakage Rate	#DIV/0!
Ambient Temp (55-90°F)	OK
Negative Probe Weight Eval.	OK
Pro-Rate Variation	#DIV/0!

Technician Signature: 

# Wood Heater Efficiency Results - CSA B415.1

**Manufacturer:** Kuma Stoves  
**Model:** K180 Series  
**Date:** 09/15/20  
**Run:** 1  
**Control #:** 3WN011E.REV 002  
**Test Duration:** 174  
**Output Category:** IV

**Technician Signature:**



## Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	76.8%	83.0%
Combustion Efficiency	99.5%	99.5%
Heat Transfer Efficiency	77%	83.5%

Output Rate (kJ/h)	30,579	29,008	(Btu/h)
Burn Rate (kg/h)	2.01	4.43	(lb/h)
Input (kJ/h)	39,801	37,756	(Btu/h)

Test Load Weight (dry kg)	5.83	12.84	dry lb
MC wet (%)	17.14995857		
MC dry (%)	20.70		
Particulate (g )			
CO (g)	23		
Test Duration (h)	2.90		

Emissions	Particulate	CO
g/MJ Output		0.26
g/kg Dry Fuel		3.89
g/h		7.82
lb/MM Btu Output		0.59

Air/Fuel Ratio (A/F)	11.44
----------------------	-------

VERSION:

2.2

12/14/2009

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

Cordwood Fuel Load Calculators - 10 lb/ft<sup>3</sup> 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 <sup>3</sup>		
Usable Firebox Volume	1.73	ft <sup>3</sup>		
Total Nom. Load Wt. Target	17.30	lb		
Total Load Wt. Allowable Range	16.40	to 18.20	lb	
Core Target Wt. Allowable Range	7.80	to 11.20	lb	
Remainder Load Wt. Allowable Range	6.10	to 9.50	lb	
				Mid-Point
Core Load Pc. Wt. Allowable Range	2.60	to 4.30	lb	3.45
Remainder Load Pc. Wt. Allowable Range	1.70	to 9.50	lb	5.60
	Pc. #			
Core Load Piece Wt. Actual	1	3.31	lb	In Range
	2	3.76	lb	In Range
	3	2.75	lb	In Range
Core Load Total. Wt. Actual		9.82	lb	In Range
	Pc. #			
Remainder Load Piece Wt.	1	2.46	lb	In Range
(1 to 3 Pcs.)	2	4.86	lb	In Range
	3		lb	NA
Remainder Load Tot. Wt. Act		7.32	lb	In Range
Total Load Wt. Actual		17.14	lb	In Range
Core % of Total Wt.		57%		In Range 45-65%
Remainder % of Total Wt.		43%		In Range 35-55%
Actual Load % of Nominal Target		99%		In Range 95-105%
Actual Fuel Load Density		9.9	lb/ft <sup>3</sup>	
Kindling and Start-up Fuel				
Maximum Kindling Wt. (20% of Tot. Load Wt.)		3.43	lb	
Actual Kindling Wt.		3.43	lb	In Range 20.0%
Maximum Start-up Fuel Wt. (30% of Tot. Load Wt.)		5.14	lb	
Actual Start-up Fuel Wt.		5.14	lb	In Range 30.0%
Allowable Residual Start-up Fuel Wt. Range	1.7	to 3.4	lb	Mid-Point
Actual Residual Start-up Fuel Wt.		2	lb	In Range 2.6
Total Wt. All Fuel Added (wet basis)		25.71	lb	
High Fire Test Run End Point Range				
Based on Fuel Load Wt. (w/tares)	Low 1.5	to	High 1.9	lb Mid-Point 1.7
Actual Fuel Load Ending Wt.		1.6	lb	In Range

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Fuel Piece Moisture Reading (%-dry basis)					Pc. Wt. Dry Basis	
1	2	3	Ave.			
20	20	19.3	19.8	In Range	2.77	lb 1.25 kg
17.2	19.9	19.7	18.9	In Range	3.16	lb 1.43 kg
21.6	25.1	21.4	22.7	In Range	2.24	lb 1.02 kg
21.6	21.6	21.5	21.6	In Range	2.03	lb 0.92 kg
23.4	21.4	18.8	21.2	In Range	4.01	lb 1.82 kg
			NA	NA	NA	lb kg
Total Load Ave. MC (%-dry basis)				20.7	In Range	
Total Load Ave. MC % (wet basis)				17.2		
Total Test Load Weight (dry basis)					14.20	lb 6.44 kg
Kindling Moisture (%-dry basis)						
11.055	11.055	11.055	11.1	In Range	3.09	lb 1.40 kg
Start-up Fuel Moisture Readings (%-dry basis)						
20.833	20.833	20.833	20.8	In Range	4.26	lb 1.93 kg
Total Wt. All Fuel Added (dry basis)					21.54	lb 9.77 kg
Total Wt. All Fuel Burned (dry basis)					17.9	lb 8.1 kg

**Wood Heater Run Sheets**Client: Kuma StovesProject Number: 0123WM011E.REV002 Run Number: 1Model: K-180Tracking Number: 2407Date: 9/15/20Test Crew: B Davis

OMNI Equipment ID numbers: \_\_\_\_\_

**Wood Heater Supplemental Data**Start Time: 1119Booth #: N/AStop Time: 1523**Stack Gas Leak Check:**Initial: good Final: good**Sample Train Leak Check:**A: 0.0 @ 13 "HgB: 0.0 @ 10 "HgCalibrations: Span Gas CO<sub>2</sub>: 12.4 CO: 2.48

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>1045</u>	<u>1046</u>	<u>1553</u>	<u>1553</u>
CO <sub>2</sub>	<u>0.00</u>	<u>12.47</u>	<u>6.08</u>	<u>12.31</u>
CO	<u>0.00</u>	<u>2.49</u>	<u>-0.04</u>	<u>2.39</u>

Air Velocity (ft/min): Initial: 250 Final: 253Scale Audit (lbs): Initial: 10.0 Final: 10.5Pitot Tube Leak Test: Initial: good Final: goodStack Diameter (in): 6"Induced Draft: 0.0% Smoke Capture: 100%

Flue Pipe Cleaned Prior to First Test in Series:

Date: 9/14/20 Initials: BS

	Initial	Middle	Ending
P <sub>b</sub> (in/Hg)	<u>28.45</u>		<u>28.36</u>
RH (%)	<u>60</u>		<u>47</u>
Ambient (°F)	<u>62</u>		<u>75</u>

Tunnel Traverse		
Microtector Reading	dP (in H <sub>2</sub> O)	T(°F)
	<u>.066</u>	<u>66</u>
	<u>.064</u>	<u>66</u>
	<u>.072</u>	<u>66</u>
	<u>.070</u>	<u>66</u>
	<u>.070</u>	<u>66</u>
	<u>.062</u>	<u>66</u>
	<u>.072</u>	<u>66</u>
	<u>.066</u>	<u>66</u>
	<u>.062</u>	<u>66</u>
Center:		
	<u>.070</u>	<u>65</u>

Background Filter Volume: 61.149

Tunnel Static Pressure (in H <sub>2</sub> O):	
Beginning of Test	End of Test
<u>-1.08</u>	<u>-1.08</u>

Technician Signature: BSDate: 9/29/20

**Wood Heater Run Sheets**Client: Kuma StovesProject Number: 0123WM011E.REV002 Run Number: 1Model: K-180Tracking Number: 2407Date: 9/15/20Test Crew: B. Davis

OMNI Equipment ID numbers: \_\_\_\_\_

**Wood Heater Run Notes****Air Control Settings**

Primary:

Fully open

Secondary:

fixed

Tertiary/Pilot:

N/A

Fan:

On High 2**Preburn Notes**

Time	Notes
Ø	Torch used for 25' for a top down burn. Door closed by 51, bypass closed at 15 minutes. Fan off during startup/kindling burn.

**Test Notes**

Sketch test fuel configuration:

See photo

Start up procedures &amp; Timeline:

Bypass:

closed by 1:45

Fuel loaded by:

1:45

Door closed at:

1:45

Primary air:

Fully open entire test

Notes:

Fan on high 5 min after start of test

Time	Notes
60	changed front filter in fan - A.

Technician Signature: B. DavisDate: 9/29/20

## **Run 2**

## **Low Burn**

Wood Heater Test Data  
High Burn Emissions Data

Run: 2

Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123WNO11E REV 002  
Test Date: 11-Jun-20  
Beginning Clock Time: 16:08  
Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)  
Background Sample Volume: 178.944 cubic feet  
Total Sampling Time: 700 min  
Recording Interval: 10 min  
Barometric Pressure: Begin Middle End Average  
28.38 28.41 28.39 0  
OMNI Equipment Numbers: \_\_\_\_\_

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/d-mole  
Dilution Tunnel MW(wet): 28.75 lb/d-mole  
Dilution Tunnel H<sub>2</sub>O: 2.50 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99  
Avg. Tunnel Velocity: 17.77 ft/sec  
Initial Tunnel Flow: 188.6 scfm  
Average Tunnel Flow: 188.5 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: 20.00 Dry Basis %  
Velocity Traverse Data  
Initial dP: 0.065 0.070 0.070 0.066 0.070 0.072 0.066 0.060 0.072 H<sub>2</sub>O  
Temp: 94 94 94 94 94 94 94 94 94 °F  
V<sub>stack</sub>: 18.16 ft/sec V<sub>source</sub>: 18.71 ft/sec F<sub>p</sub>: 0.971

Technician Signature: B. K. 2.

Particulate Sampling Data													Fuel Weight (lb)				Temperature Data (°F)										Stack Gas Data					
Elapsed Time (min)	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d#1 (in)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice d#2 (in)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (inH <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)
0	0.000	0.000			2.40	80	-1.49	1.99	78	-1.4	94	0.070			19.9		386	337	382	440	387	386	995	171	86	70	84	89	74	-0.009	6.1	0.01
10	1.870	1.745	0.17	0.17	2.26	80	-1.87	1.80	79	-1.6	107	0.070	102	101	18.5	-1.4	422	305	362	404	360	371	893	367	87	72	82	71	74	-0.048	9.43	0.01
20	3.344	3.481	0.17	0.17	2.24	80	-1.78	1.77	79	-1.5	100	0.070	101	100	17.6	-0.8	524	301	341	369	332	373	785	242	86	74	81	72	74	-0.031	5.64	0
30	5.015	5.232	0.17	0.17	2.24	80	-1.86	1.76	79	-1.8	98	0.070	101	100	17.2	-0.4	479	294	322	344	311	350	754	213	84	75	86	74	74	-0.026	6.47	0
40	6.688	6.968	0.17	0.17	2.23	81	-1.82	1.75	79	-1.6	95	0.080	94	93	16.8	-0.5	441	285	299	328	299	330	798	206	83	75	84	75	74	-0.024	8.03	0.01
50	8.357	8.706	0.17	0.17	2.22	81	-1.74	1.75	79	-1.8	94	0.070	100	99	16.3	-0.5	429	276	277	312	286	316	791	201	83	76	82	75	74	-0.022	8.23	0.01
60	10.028	10.442	0.17	0.17	2.24	81	-1.44	1.75	80	-1.6	94	0.070	100	99	15.8	-0.5	448	266	263	300	275	310	877	207	83	76	86	76	74	-0.025	9.69	0.02
70	11.702	12.197	0.17	0.18	2.23	81	-1.64	1.80	80	-1.6	94	0.070	101	100	15.4	-0.5	446	258	254	291	267	303	809	201	83	76	86	76	74	-0.023	8.38	0.02
80	13.375	13.957	0.17	0.18	2.22	82	-1.85	1.79	80	-1.9	93	0.070	100	100	14.9	-0.5	434	251	249	282	262	296	801	197	83	76	86	77	74	-0.023	8.11	0.02
90	15.047	15.715	0.17	0.18	2.24	82	-1.85	1.78	80	-1.8	93	0.070	100	100	14.4	-0.5	434	245	247	274	258	292	821	198	82	77	86	77	74	-0.023	8.76	0.02
100	16.721	17.475	0.17	0.18	2.24	82	-1.63	1.80	81	-1.6	93	0.070	100	100	14.1	-0.3	446	241	247	266	256	291	845	200	82	77	86	77	75	-0.023	9.26	0.02
110	18.396	19.233	0.17	0.18	2.25	82	-1.49	1.79	81	-1.6	93	0.070	100	100	13.6	-0.5	454	238	249	261	257	292	852	201	82	77	86	77	75	-0.024	9.61	0.02
120	20.070	20.992	0.17	0.18	2.23	83	-1.86	1.80	81	-1.8	93	0.070	100	100	13.1	-0.5	465	237	251	257	260	294	874	203	82	76	84	76	75	-0.024	10.13	0.03
130	21.745	22.751	0.17	0.18	2.28	83	-1.54	1.79	81	-1.7	93	0.070	100	100	12.5	-0.6	489	236	257	256	266	301	921	208	82	76	81	75	75	-0.025	11.03	0.03
140	23.419	24.510	0.17	0.18	2.24	83	-1.84	1.79	81	-1.8	93	0.070	100	100	12.0	-0.5	507	236	264	255	273	307	924	209	82	75	81	74	75	-0.026	10.75	0.03
150	25.095	26.268	0.17	0.18	2.24	83	-1.55	1.78	81	-1.6	93	0.070	100	100	11.5	-0.5	518	237	272	256	280	313	935	210	82	74	89	73	75	-0.026	11.14	0.03
160	26.770	28.023	0.17	0.18	2.24	83	-1.63	1.78	81	-1.8	93	0.070	100	100	10.9	-0.6	531	238	281	256	287	319	954	210	82	73	92	72	75	-0.026	11.37	0.03
170	28.445	29.779	0.17	0.18	2.24	83	-1.85	1.78	81	-1.9	93	0.070	100	100	10.4	-0.5	547	239	290	258	294	326	976	213	82	73	89	71	74	-0.027	11.87	0.03
180	30.119	31.536	0.17	0.18	2.24	83	-1.44	1.79	81	-1.9	93	0.070	100	100	9.8	-0.6	587	241	298	280	302	338	1053	221	82	72	84	70	75	-0.028	13.78	0.06
190	31.794	33.294	0.17	0.18	2.23	83	-1.75	1.78	81	-1.9	93	0.070	100	100	9.1	-0.7	629	243	307	263	313	351	1006	234	82	72	84	70	74	-0.031	15.59	1.24
200	33.467	35.051	0.17	0.18	2.25	83	-1.59	1.79	81	-1.6	94	0.070	100	100	8.1	-0.9	597	246	326	270	334	355	937	236	82	72	83	69	75	-0.032	15.03	2.88
210	35.141	36.810	0.17	0.18	2.24	83	-1.81	1.79	81	-1.7	94	0.070	100	100	7.3	-0.8	592	248	343	282	360	365	933	228	82	72	82	69	75	-0.030	15.57	1.63
220	36.816	38.569	0.17	0.18	2.25	83	-1.8	1.79	81	-1.7	93	0.070	100	100	6.6	-0.7	602	251	362	292	381	378	930	217	82	72	82	69	75	-0.027	14.2	0.01
230	38.490	40.331	0.17	0.18	2.24	83	-1.64	1.80	81	-1.8	92	0.070	100	100	6.2	-0.5	570	255	378	297	394	379	882	206	82	71	82	69	75	-0.024	12.48	0.01
240	40.167	42.093	0.17	0.18	2.23	83	-1.8	1.80	81	-1.6	92	0.070	100	100	5.8	-0.4	541	259	390	298	403	376	875	199	82	71	81	69	75	-0.021	12.56	0.01
250	41.842	43.856	0.17	0.18	2.24	83	-1.75	1.79	81	-1.6	90	0.070	100	100	5.4	-0.3	512	265	395	296	411	376	812	189	84	71	83	68	75	-0.019	11.75	0.01
260	43.518	45.618	0.17	0.18	2.25	82	-1.86	1.80	81	-1.9	90	0.070	100	100	5.1	-0.3	487	272	395	295	416	373	790	183	85	70	83	68	75	-0.017	11.71	0.01
270	45.193	47.382	0.17	0.18	2.25	82	-1.48	1.81	81	-1.6	89	0.070	100	100	4.8	-0.3	476	277	394	294	418	372	783	178	85	70	82	68	74	-0.016	11.54	0.02
280	46.870	49.147	0.17	0.18	2.25	82	-1.78	1.80	80	-1.8	88	0.070	100	100	4.6	-0.2	468	282	394	293	417	371	776	176	85	69	81	67	75	-0.015	11.29	0.02
290	48.546	50.912	0.17	0.18	2.25	82	-1.74	1.80	80	-1.6	88	0.070	100	100	4.3	-0.3	454	286	394	291	414	368	756	172	86	69	82	67	74	-0.014	11.3	0.01
300	50.224	52.676	0.17	0.18	2.23	82	-1.48	1.80	80	-1.6	88	0.070	100	100	4.1	-0.2	448	290	394	290	410	366	756	171	86	69	84	67	74	-0.014	11.19	0.02
310	51.899	54.440	0.17	0.18	2.24	82	-1.73	1.80	80	-1.7	87	0.070	100	100	3.8	-0.3	444	294	393	290	407	366	752	170	86	69	85	67	75	-0.014	11.13	0.02
320	53.576	56.204	0.17	0.18	2.24	81	-1.78	1.80	80	-1.7	86	0.070	100	100	3.6	-0.2	435	296	392	289	403	363	726	169	85	69	85	67	75	-0.014	9.4	0.01
330	55.252	57.968	0.17	0.18	2.25	81	-1.65	1.80	80	-1.6	86	0.070	100	100	3.4	-0.2	420	298	385	288	393	357	710	166	84	69	84	67	74	-0.014	9.36	0.01



OMNI-Test Laboratories, Inc.

### Wood Heater Test Data High Burn Emissions Data

Run: 2

Manufacturer: Kuma Stoves  
Model: K180 Series  
Tracking No.: 2407  
Project No.: D123WNO11E REV 002  
Test Date: 11-Jun-20  
Beginning Clock Time: 16:08

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)

Total Sampling Time: 700 min  
Recording Interval: 10 min

Background Sample Volume: 178.944 cubic feet

Barometric Pressure: Begin Middle End Average  
28.38 28.41 28.39 0

OMNI Equipment Numbers: \_\_\_\_\_

PM Control Modules: 371, 372  
Dilution Tunnel MW(dry): 29.00 lb/b-mole  
Dilution Tunnel MW(wet): 28.78 lb/b-mole  
Dilution Tunnel H<sub>2</sub>O: 2.00 percent  
Dilution Tunnel Static: -0.108 "H<sub>2</sub>O  
Tunnel Area: 0.19035 ft<sup>2</sup>  
Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.77 ft/sec  
Initial Tunnel Flow: 188.6 scfm  
Average Tunnel Flow: 188.5 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: 20.00 Dry Basis %

Technician Signature: B. K. 2.

	Pl.1	Pl.2	Pl.3	Pl.4	Pl.5	Pl.6	Pl.7	Pl.8	Center
Initial dP	0.065	0.070	0.070	0.066	0.070	0.072	0.066	0.060	0.072
Temp	94	94	94	94	94	94	94	94	94
V <sub>stack</sub>	18.16				18.71				F <sub>p</sub> 0.971

Particulate Sampling Data																	Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data		
Elapsed Time (min)	Gas Meter 1 (ft³)	Gas Meter 2 (ft³)	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice dH 1 (in)	Meter 1 Temp (°F)	Meter 1 Vacuum (inHg)	Orifice dH 2 (in)	Meter 2 Temp (°F)	Meter 2 Vacuum (inHg)	Dilution Tunnel Temp (°F)	Dilution Tunnel Center dP	Pro. Rate 1	Pro. Rate 2	Scale Reading	Weight Change	Firebox Top	Firebox Bottom	Firebox Back	Firebox Left	Firebox Right	Avg. Stove Surface	Catalyst Exit	Stack	Filter 1	Dryer Exit 1	Filter 2	Dryer Exit 2	Ambient	Draft (H <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)	
340	58.930	59.732	0.17	0.18	2.25	81	-1.43	1.80	79	-1.6	85	0.070	100	100	3.2	-0.2	405	300	375	287	382	350	898	163	84	69	84	67	74	-0.013	9.06	0.01	
350	58.608	61.497	0.17	0.18	2.24	81	-1.43	1.81	79	-1.9	85	0.070	100	100	3.0	-0.2	391	302	367	288	373	344	858	158	83	69	83	67	74	-0.011	8.71	0.01	
360	60.286	63.262	0.17	0.18	2.25	81	-1.44	1.81	79	-1.7	84	0.070	100	100	2.9	-0.1	374	303	360	288	365	338	817	153	83	69	83	67	74	-0.010	8.16	0.01	
370	61.965	65.028	0.17	0.18	2.26	81	-1.42	1.80	79	-1.8	83	0.070	100	100	2.7	-0.1	367	303	354	289	358	332	590	149	82	69	83	67	74	-0.008	7.89	0.01	
380	63.644	66.793	0.17	0.18	2.25	81	-1.43	1.81	79	-1.5	82	0.070	100	100	2.6	-0.1	345	303	349	288	351	327	564	145	82	69	82	67	74	-0.008	7.95	0.01	
390	65.324	68.558	0.17	0.18	2.27	81	-1.46	1.80	79	-1.6	82	0.070	100	100	2.5	-0.1	337	302	344	287	344	323	553	143	83	69	82	67	73	-0.007	7.92	0.01	
400	67.004	70.324	0.17	0.18	2.25	81	-1.43	1.81	79	-1.9	82	0.070	100	100	2.4	-0.1	332	302	339	286	339	320	542	142	83	69	82	67	73	-0.007	8.28	0.02	
410	68.684	72.091	0.17	0.18	2.26	80	-1.85	1.81	79	-1.7	81	0.070	100	100	2.3	-0.1	328	299	331	287	334	316	539	141	83	69	82	68	73	-0.006	8.1	0.02	
420	70.364	73.857	0.17	0.18	2.27	80	-1.42	1.81	78	-1.5	81	0.070	100	100	2.2	-0.1	327	294	321	290	330	312	532	140	84	69	82	68	73	-0.006	8.51	0.01	
430	72.043	75.623	0.17	0.18	2.25	80	-1.54	1.82	78	-1.8	81	0.070	100	100	2.1	-0.1	323	290	314	295	326	310	523	138	84	69	83	68	73	-0.006	8.97	0.01	
440	73.722	77.392	0.17	0.18	2.27	80	-1.82	1.81	78	-1.8	80	0.070	100	100	2.0	-0.1	322	286	307	302	322	308	521	137	84	69	84	68	73	-0.005	8.38	0.01	
450	75.403	79.161	0.17	0.18	2.26	80	-1.56	1.82	78	-1.8	80	0.070	100	100	1.9	-0.1	321	282	302	305	319	308	514	136	83	69	85	68	73	-0.005	7.43	0.02	
460	77.085	80.931	0.17	0.18	2.25	80	-1.65	1.82	78	-1.7	79	0.070	100	100	1.8	-0.1	311	280	296	296	305	315	501	134	83	69	85	68	72	-0.005	7.23	0.01	
470	78.765	82.700	0.17	0.18	2.26	80	-1.42	1.81	78	-1.7	79	0.070	100	100	1.7	0.0	304	277	290	303	308	296	481	132	83	69	85	68	72	-0.005	7.16	0.01	
480	80.445	84.468	0.17	0.18	2.28	79	-1.74	1.82	78	-1.8	79	0.070	100	100	1.6	-0.1	299	275	284	301	303	292	478	130	83	69	85	68	72	-0.004	6.97	0.01	
490	82.127	86.237	0.17	0.18	2.27	79	-1.41	1.81	78	-1.6	78	0.070	100	100	1.6	-0.1	294	271	278	298	298	288	472	129	82	69	84	68	72	-0.004	6.87	0.01	
500	83.807	88.006	0.17	0.18	2.27	79	-1.66	1.82	77	-1.6	78	0.070	100	100	1.5	-0.1	291	269	272	294	293	284	462	129	82	69	84	68	71	-0.004	6.92	0.02	
510	85.489	89.775	0.17	0.18	2.27	79	-1.7	1.81	77	-1.8	78	0.070	100	100	1.4	-0.1	289	265	268	290	289	280	461	127	82	69	84	68	71	-0.004	6.88	0.02	
520	87.169	91.542	0.17	0.18	2.27	79	-1.78	1.82	77	-1.8	78	0.070	100	100	1.3	-0.1	285	264	264	286	285	277	456	127	83	69	84	68	71	-0.004	6.54	0.02	
530	88.849	93.310	0.17	0.18	2.27	79	-1.53	1.82	77	-1.6	77	0.070	100	100	1.2	-0.1	280	262	260	282	281	273	459	126	83	69	84	68	71	-0.004	6.36	0.02	
540	90.530	95.077	0.17	0.18	2.27	79	-1.7	1.82	77	-1.8	77	0.070	100	100	1.2	-0.1	275	260	256	278	277	269	434	125	82	69	83	68	70	-0.004	6.08	0.02	
550	92.210	96.844	0.17	0.18	2.27	79	-1.82	1.82	77	-1.6	76	0.070	100	100	1.1	-0.1	270	258	254	274	272	266	427	123	82	69	83	68	70	-0.004	5.98	0.02	
560	93.890	98.613	0.17	0.18	2.26	78	-1.6	1.83	77	-1.8	76	0.070	100	100	1.0	-0.1	265	257	252	270	268	262	420	122	82	69	82	68	70	-0.004	5.77	0.02	
570	95.571	100.381	0.17	0.18	2.27	78	-1.41	1.82	77	-1.7	76	0.070	100	100	1.0	0.0	261	255	251	266	264	259	415	121	82	69	82	68	70	-0.003	5.62	0.02	
580	97.252	102.149	0.17	0.18	2.25	78	-1.42	1.82	77	-1.8	76	0.070	100	100	0.9	-0.1	257	254	251	262	259	257	411	121	85	69	82	68	70	-0.003	5.6	0.02	
590	98.930	103.917	0.17	0.18	2.27	78	-1.43	1.82	76	-1.7	75	0.070	100	100	0.9	-0.1	253	253	250	258	255	254	407	119	87	70	84	68	69	-0.003	5.7	0.02	
600	100.609	105.683	0.17	0.18	2.28	78	-1.82	1.82	76	-1.8	75	0.070	100	100	0.8	-0.1	253	252	251	254	252	252	407	119	87	70	84	68	69	-0.003	5.8	0.02	
610	102.289	107.450	0.17	0.18	2.26	78	-1.41	1.81	76	-1.6	75	0.070	100	100	0.7	-0.1	251	252	250	250	249	250	405	119	85	69	85	68	69	-0.003	5.5	0.02	
620	103.968	109.216	0.17	0.18	2.27	78	-1.61	1.81	76	-1.8	74	0.070	100	100	0.6	-0.1	248	249	250	247	246	248	403	118	84	70	85	68	69	-0.003	5.52	0.02	
630	105.648	110.982	0.17	0.18	2.28	78	-1.64	1.81	76	-1.6	74	0.070	100	100	0.6	-0.1	244	247	249	244	243	245	395	118	83	70	85	68	68	-0.003	5.29	0.02	
640	107.329	112.749	0.17	0.18	2.26	77	-1.7	1.81	76	-1.8	74	0.070	100	100	0.6	0.0	242	245	247	241	241	243	393	117	83	69	84	68	68	-0.002	5.53	0.02	
650	109.009	114.516	0.17	0.18	2.28	77	-1.46	1.82	76	-1.8	74	0.070	100	100	0.5	-0.1	241	243	247	238	239	242	406	117	83	69	84	68	68	-0.002	5.85	0.02	
660	110.689	116.282	0.17	0.18	2.28	77	-1.83	1.82	75	-1.8	74	0.070	100	100	0.4	-0.1	246	241	247	237	235	238	410	118	83	69	84	68	68	-0.002	6.22	0.03	
670	112.370	118.048	0.17	0.18	2.28	77	-1.74	1.83	75	-1.6	74	0.070	100	100	0.3	-0.1	252	240	248	233	238	242	430	119	83	69	84	68	68	-0.003	6.5	0.03	

Wood Heater Test Data  
High Burn Emissions Data

Run: 2

Manufacturer: Kuma Stoves

Model: K180 Series

Tracking No.: 2407

Project No.: 0123W/N011E REV 002

Test Date: 11-Jun-20

Beginning Clock Time: 16:08

Meter Box Y Factor: 0.994 (1) 0.998 (2) 1.016 (Amb)

Barometric Pressure: Begin Middle End Average

28.38 28.41 28.39 0

OMNI Equipment Numbers:

Total Sampling Time: 700 min

Recording Interval: 10 min

Background Sample Volume: 178.944 cubic feet

PM Control Modules: 371, 372

Dilution Tunnel MW(dry): 29.00 lb/b-mole

Dilution Tunnel MW(wet): 28.75 lb/b-mole

Dilution Tunnel H<sub>2</sub>O: 2.00 percent

Dilution Tunnel Static: -0.108 "H<sub>2</sub>O

Tunnel Area: 0.19035 ft<sup>2</sup>

Pilot Tube Cp: 0.99

Avg. Tunnel Velocity: 17.77 ft/sec

Initial Tunnel Flow: 188.5 scfm


Average Tunnel Flow: 188.5 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: 20.00 Dry Basis %

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	0.070	0.066	0.070	0.072	0.066	0.060	0.072
Temp	94	94	94	94	94	94	94	94	94
V <sub>stave</sub>	18.16 ft/sec			V <sub>scant</sub> 18.71 ft/sec			F <sub>p</sub> 0.971		

Technician Signature 

Elapsed Time (min)	Particulate Sampling Data												Fuel Weight (lb)		Temperature Data (°F)												Stack Gas Data					
	Gas Meter 1 (ft <sup>3</sup> )	Gas Meter 2 (ft <sup>3</sup> )	Sample Rate 1 (cfm)	Sample Rate 2 (cfm)	Orifice d1 (H <sub>2</sub> O)	Meter 1 Temp (°F)	Meter 1 Vacuum (°Hg)	Orifice d2 (H <sub>2</sub> O)	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 <sub>2</sub> O)	CO <sub>2</sub> (%)	CO (%)
680	114.049	118.814	0.17	0.18	2.27	77	-1.4	1.82	75	-1.8	74	0.070	100	100	0.2	-0.1	259	239	250	237	237	244	443	121	83	69	84	68	67	-0.003	8.64	0.03
690	115.729	121.579	0.17	0.18	2.28	77	-1.4	1.82	75	-1.8	74	0.070	100	100	0.1	-0.1	262	239	251	244	237	247	442	121	84	69	84	68	68	-0.004	8.59	0.03
700	117.409	123.344	0.17	0.18	2.28	77	-1.48	1.82	75	-1.6	73	0.070	100	100	0.0	-0.1	261	238	253	253	236	248	440	121	83	69	84	68	68	-0.004	8.36	0.03
Avg Tot	117.409	123.344	0.17	0.18	2.28	80		1.80	79		85	0.070	100	100								138.2			71	84	70	73	-0.014			

## Wood Heater Lab Data

Manufacturer: Kuma Stoves      Equipment Numbers: \_\_\_\_\_  
 Model: K180 Series      \_\_\_\_\_  
 Tracking No.: 2407      \_\_\_\_\_  
 Project No.: 0123WN011E.REV 002      \_\_\_\_\_  
 Run #: 2      \_\_\_\_\_  
 Date: 6/11/20      \_\_\_\_\_

### TRAIN 1 (First Hour emissions)

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
B. Front filter catch	Filter	T277S	91.8	90.4	1.4
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:      1.4

### 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	T286AP	194.9	194.1	0.8
C. Rear filter catch	Filter				0.0
D. Probe catch*	Probe	9	115696.8	115696.1	0.7
E. Filter seals catch*	Seals	S023	4125.8	4124.5	1.3

**Sub-Total**      Total Particulate, mg:      2.8

**Train 1 Aggregate**      Total Particulate, mg:      4.2

### TRAIN 2

Sample Component	Reagent	Filter, Probe or Dish #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	T286BP	194.8	195.2	-0.4
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe	11	114188.8	114188.0	0.8
D. Filter seals catch*	Seals	S024	3334.5	3331.3	3.2

Total Particulate, mg:      3.6

### AMBIENT

Sample Component	Reagent	Filter # or Probe #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch*	Filter	E053	120.2	120.1	0.1

Total Particulate, mg:      0.1

\*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: K180 Series  
 Project No.: 0123WN011E.REV 002  
 Tracking No.: 2407  
 Run: 2  
 Test Date: 06/11/20

Burn Rate	<b>0.64 kg/hr dry</b>
Average Tunnel Temperature	85 degrees Fahrenheit
Average Gas Velocity in Dilution Tunnel - vs	17.77 feet/second
Average Gas Flow Rate in Dilution Tunnel - Qsd	11312.9 dscf/hour
Average Delta p	0.070 inches H2O
Total Time of Test	700 minutes

	AMBIENT	SAMPLE TRAIN 1	SAMPLE TRAIN 2	FIRST HOUR FILTER (TRAIN 1)
Total Sample Volume - Vm	176.944 cubic feet	117.409 cubic feet	123.344 cubic feet	10.028 cubic feet
Average Gas Meter Temperature	73 degrees Fahrenheit	80 degrees Fahrenheit	79 degrees Fahrenheit	81 degrees Fahrenheit
Total Sample Volume (Standard Conditions) - Vmstd	169.005 dscf	108.761 dscf	114.954 dscf	9.281 dscf
Total Particulates - m <sub>n</sub>	0.1 mg	4.2 mg	3.6 mg	1.4 mg
Particulate Concentration (dry-standard) - C <sub>p</sub> /C <sub>s</sub>	0.000001 grams/dscf	0.00004 grams/dscf	0.00003 grams/dscf	0.00015 grams/dscf
Total Particulate Emissions - E <sub>T</sub>	0.08 grams	5.02 grams	4.06 grams	1.71 grams
Particulate Emission Rate	0.01 grams/hour	0.43 grams/hour	0.35 grams/hour	1.71 grams/hour
Emissions Factor		0.67 g/kg	0.54 g/kg	1.12 g/kg
Difference from Average Total Particulate Emissions		0.48 grams	0.48 grams	

Dual Train Comparison Results Are Acceptable

FINAL AVERAGE RESULTS	
<b>Complete Test Run</b>	
Total Particulate Emissions - E <sub>T</sub>	4.54 grams
Particulate Emission Rate	<b>0.39 grams/hour</b>
Emissions Factor	0.61 grams/kg
<b>First Hour Emissions</b>	
Total Particulate Emissions - E <sub>T</sub>	1.71 grams
Particulate Emission Rate	1.71 grams/hour
Emissions Factor	1.12 grams/kg
7.5% of Average Total Particulate Emissions	0.34 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

Technician Signature: \_\_\_\_\_



# Wood Heater Efficiency Results - CSA B415.1

**Manufacturer:** Kuma Stoves  
**Model:** K180 Series  
**Date:** 06/11/20  
**Run:** 2  
**Control #:** 3WN011E.REV 002  
**Test Duration:** 700  
**Output Category:** I

**Technician Signature:**



## Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	83.6%	90.4%
Combustion Efficiency	99.0%	99.0%
Heat Transfer Efficiency	84%	91.2%

Output Rate (kJ/h)	10,628	10,082	(Btu/h)
Burn Rate (kg/h)	0.64	1.41	(lb/h)
Input (kJ/h)	12,713	12,059	(Btu/h)

Test Load Weight (dry kg)	7.49	16.50	dry lb
MC wet (%)	17.08126036		
MC dry (%)	20.60		
Particulate (g )	0.39		
CO (g)	131		
Test Duration (h)	11.67		

Emissions	Particulate	CO
g/MJ Output	0.00	1.06
g/kg Dry Fuel	0.05	17.49
g/h	0.03	11.22
lb/MM Btu Output	0.01	2.45

Air/Fuel Ratio (A/F)	12.62
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VERSION:

2.2

12/14/2009

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

Cordwood Fuel Load Calculators - 12 lb/ft<sup>3</sup> 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<sup>3</sup> - Low and Medium Fire**

Nominal Required Load Density (wet basis)	12	lb/ft <sup>3</sup>		
Usable Firebox Volume	1.73	ft <sup>3</sup>		
Total Nom. Load Wt. Target	20.76	lb		
Total Load Wt. Allowable Range	19.72	to 21.80	lb	
Core Target Wt. Allowable Range	9.342	to 13.49	lb	
Remainder Load Wt. Allowable Range	7.27	to 11.42	lb	
				Mid-Point
Core Load Fuel Pc. Wt. Allowable Range	3.11	to 5.19	lb	4.15
Remainder Load Pc. Wt. Allowable Range	2.08	to 6.23	lb	4.15
	Pc. #			
Core Load Piece Wt. Actual	1	3.84	lb	In Range
	2	4.81	lb	In Range
	3	3.77	lb	In Range
Core Load Total. Wt. Actual		12.42	lb	In Range
	Pc. #			
Remainder Load Piece Wt.	1	2.20	lb	In Range
(2 or 3 Pcs.)	2	5.24	lb	In Range
	3		lb	NA
Remainder Load Piece Weight Ratio - Small/Large		42%		In Range ≤ 67%
Remainder Load Tot. Wt. Act		7.44	lb	In Range
Total Load Wt. Actual		19.86	lb	In Range
Core % of Total Wt.		63%		In Range 45-65%
Remainder % of Total Wt.		37%		In Range 35-55%
Actual Load % of Nominal Target		96%		In Range 95-105%
Actual Fuel Load Density		11.5	lb/ft <sup>3</sup>	
Allowable Charcoal Bed Wt. Range (lb)	2.0	to 3.9		Mid-Point
Actual Charcoal Bed Wt.		2.5	lb	In Range
Actual Fuel Load Ending Wt.		0.0	lb	Valid Test ≥ 90%
Total Wt. of Fuel Burned During Test Run lb.		19.9	lb	

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Fuel Piece Moisture Reading (%-dry basis)								
1	2	3	Ave.		Pc. Wt. Dry Basis			
21.8	18.9	15.2	18.6	In Range	3.24	lb	1.47	kg
20	20.5	22.1	20.9	In Range	3.98	lb	1.81	kg
22.5	22.2	23.7	22.8	In Range	3.07	lb	1.39	kg
20.1	21.2	20.5	20.6	In Range	1.82	lb	0.83	kg
20.7	19.2	21.2	20.4	In Range	4.35	lb	1.97	kg
			NA	NA	NA	lb	NA	kg
Total Load Ave. MC % (dry basis)			20.6	In Range				
Total Load Ave. MC % (wet basis)			17.1					
Total Test Load Weight (dry basis)					16.47	lb	7.47	kg
Total Fuel Weight Burned During Test Run (dry basis)					16.5	lb	7.47	kg

**Wood Heater Run Sheets**Client: Kuma StovesProject Number: 0123WM011E.REV002 Run Number: 2Model: K-180Tracking Number: 2407Date: 9/15/20Test Crew: B. Davis

OMNI Equipment ID numbers: \_\_\_\_\_

**Wood Heater Run Notes****Air Control Settings**

Primary:

Fully closed

Secondary:

fixed

Tertiary/Pilot:

n/a

Fan:

on low**Preburn Notes**

Time	Notes

**Test Notes**

Sketch test fuel configuration:

See photo

Start up procedures &amp; Timeline:

Bypass:

closed by 2:00

Fuel loaded by:

1:55

Door closed at:

2:00

Primary air:

fully open until 15 min  
then closed

Notes:

FAN on low @ 30 min

Time	Notes
<u>60</u>	<u>Changed front filter in tra. A.</u>

Technician Signature: B. Davis

Date:

9/29/20

**Wood Heater Run Sheets**Client: Kuma StovesProject Number: 0123WM011E.REV002 Run Number: 2Model: K-180Tracking Number: 2407Date: 9/15/20Test Crew: B Davis

OMNI Equipment ID numbers: \_\_\_\_\_

**Wood Heater Supplemental Data**Start Time: 1608

Booth #: \_\_\_\_\_

Stop Time: 0350**Stack Gas Leak Check:**Initial: See Rn Final: good**Sample Train Leak Check:**A: 0.0 @ 6 "HgB: 0.0 @ 8 "HgCalibrations: Span Gas CO<sub>2</sub>: 12.4 CO: 2.48

	Pre Test		Post Test	
	Zero	Span	Zero	Span
Time	<u>1556</u>	<u>1556</u>	<u>0400</u>	<u>0400</u>
CO <sub>2</sub>	<u>0.00</u>	<u>12.41</u>	<u>0.00</u>	<u>12.35</u>
CO	<u>0.00</u>	<u>2.48</u>	<u>0.00</u>	<u>2.47</u>

Air Velocity (ft/min): Initial: 250Final: 250Scale Audit (lbs): Initial: 10.0Final: 10.0Pitot Tube Leak Test: Initial: goodFinal: goodStack Diameter (in): 6"Induced Draft: 0.0% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in Series:

Date: 9/14/20 Initials: BL

	Initial	Middle	Ending
P <sub>b</sub> (in/Hg)	<u>28.36</u>		<u>28.41</u>
RH (%)	<u>47</u>		<u>42</u>
Ambient (°F)	<u>74</u>		<u>68</u>

Tunnel Traverse		
Microtector Reading	dP (in H <sub>2</sub> O)	T(°F)
	<u>.065</u>	<u>94</u>
	<u>.070</u>	<u>94</u>
	<u>.070</u>	<u>94</u>
	<u>.066</u>	<u>94</u>
	<u>.070</u>	<u>94</u>
	<u>.072</u>	<u>94</u>
	<u>.066</u>	<u>94</u>
	<u>.060</u>	<u>94</u>
Center:		
	<u>.072</u>	<u>94</u>

Background Filter Volume: 176.944

Tunnel Static Pressure (in H <sub>2</sub> O):	
Beginning of Test	End of Test
<u>-1.108</u>	<u>-1.108</u>

Technician Signature: B DavisDate: 9/29/20



## **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-180 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.

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

# **Sample Analysis**

## **Analysis Worksheets**

### **Tared Filter, Probe, and O-Ring Data**

## Wood Heater Run Sheets

Client: Kuma Stoves

Project Number: 0123WM011E.REV002 Run Number: 1

Model: K-180

Tracking Number: 2407

Date: 9/15/20

Test Crew: D Davis

OMNI Equipment ID numbers: 637, 592, 251A

## ASTM E2515 Lab Sheet

Assembled By:

D Davis

Date/Time in Dessicator:

9/15/20 2015

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: 9/15/20 09:20	Date/Time: 9/15/20 09:20	Date/Time: 9/15/20 09:10	Date/Time: 9/15/20 09:40	Date/Time:
R/H %: 16.1	R/H %: 14.4	R/H %: 9.8	R/H %: 10.2	R/H %:
Temp: 74.6	Temp: 75.5	Temp: 74.8	Temp: 74.6	Temp:
200 mg Audit: 200.0	200 mg Audit: 200.1	200 mg Audit: 200.1	200 mg Audit: 200.1	200 mg Audit:
2 g Audit: 2000.4	2 g Audit: 2000.3	2 g Audit: 2000.4	2 g Audit: 2000.4	2 g Audit:
100 g Audit: 9999.0	100 g Audit: 9999.8	100 g Audit: 9999.8	100 g Audit: 9999.8	100 g Audit:
Initials: DL	Initials: TT	Initials: BL	Initials: DL	Initials:

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	T273S	97.1	99.5	99.3			
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	T275AP	191.6	194.0	194.1			
	Rear Filter	T274S	98.3	100.4	100.3			
	Probe	T275S	90.9	90.8	91.0			
	Probe	7	114981.6	114982.9	114983.2	114982.9	114982.9	
B	O-Ring Set	S021	4104.9	4105.6	4105.5			
	Front Filter	T285AP	190.9	195.3	195.5			
	Rear Filter	T276S	91.0	92.7	92.7			
	Probe	8	115597.5	115598.3	115598.7	115598.3	115598.3	
BG	O-Ring Set	S022	3352.9	3353.7	3353.4	3353.1	3352.9	
	Filter	F052	119.5	119.7	119.6			

Technician Signature: D Davis

Date: 9/29/20



## Wood Heater Run Sheets

Client: Kuma Stoves

Project Number: 0123WM011E.REV002 Run Number: 2

Model: K-180

Tracking Number: 2407

Date: 9/15/20

Test Crew: B Davis

OMNI Equipment ID numbers: 637, 592, 283A

## ASTM E2515 Lab Sheet

Assembled By:

B Davis

Date/Time in Dessicator:

9/16/20 2015

Weighing #1	Weighing #2	Weighing #3	Weighing #4	Weighing #5
Date/Time: 9/21/20 0830	Date/Time: 09/23/20 08:10	Date/Time: 9/24/20 0910	Date/Time: 9/28/20 0940	Date/Time: 9/29/20 0840
R/H %: 16.1	R/H %: 14.4	R/H %: 9.8	R/H %: 10.2	R/H %: 15.6
Temp: 74.6	Temp: 75.5	Temp: 74.8	Temp: 74.6	Temp: 74.6
200 mg Audit: 200.0	200 mg Audit: 200.1	200 mg Audit: 200.1	200 mg Audit: 200.1	200 mg Audit: 200.1
2 g Audit: 2000.4	2 g Audit: 2000.3	2 g Audit: 2000.4	2 g Audit: 2000.4	2 g Audit: 2000.3
100 g Audit: 9999.0	100 g Audit: 9999.0	100 g Audit: 9999.2	100 g Audit: 9999.7	100 g Audit: 9999.7
Initials: DL	Initials: TT	Initials: DL	Initials: DL	Initials: DL

Train	Element	ID #	Tare (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)	Weight (mg)
A (First Hour)	Front Filter	T277S	90.4	91.6	91.8			
	Rear Filter							
	Probe							
	O-Ring Set							
A (Remainder)	Front Filter	T286AP	194.1	194.9	194.9			
	Rear Filter							
	Probe	9	115696.1	115696.8	115696.8			
	O-Ring Set	5023	4124.5	4125.6	4126.0	4425.8		
B	Front Filter	T286AP	195.2	194.9	194.8			
	Rear Filter							
	Probe	11	114188.0	114188.8	114188.8			
	O-Ring Set	5024	3331.3	3335.3	3335.0	3334.7	3334.3	3334.5
BG	Filter	E053	120.1	120.2	120.2			

Technician Signature: [Signature]

Date: 9/29/20

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: <u>04/29/2020</u> Time: <u>8:15</u> RH %: <u>19.6</u> T (°F): <u>72.5</u> Audit: <u>199.8</u>	Date: <u>04/30/2020</u> Time: <u>9:00</u> RH %: <u>18.6</u> T (°F): <u>71.9</u> Audit: <u>199.8</u>	Date: <u>05/04/2020</u> Time: <u>8:00</u> RH %: <u>24.7</u> T (°F): <u>67.4</u> Audit: <u>199.8</u>	Date: _____ Time: _____ RH %: _____ T (°F): _____ Audit: _____	Date Used	Project Number	Run No.
ID #							
T263S	100.8	100.7 ✓					
T264S	97.2	97.3 ✓					
T265S	97.9	97.6 ✓	97.5 ✓				
T266S	96.3	96.3 ✓					
T267S	98.0	97.9 ✓					
T268S	98.5	98.4 ✓					
T269S	96.9	97.0 ✓					
T270S	96.5	96.5 ✓					
T271S	96.6	96.6 ✓					
T272S	97.1	96.9 ✓					
T273S	97.1	97.1 ✓			9-15-20	0123456789	1
T274S	98.4	98.3 ✓					
T275S	90.8	90.9 ✓					
T276S	90.9	91.0 ✓					
T277S	90.6	90.4 ✓			9-15-20		2
T278S	91.1	90.9 ✓					
T279S	90.8	91.0 ✓					
T280S	97.3	97.2 ✓					
T281S	96.9	96.8 ✓					
T282S	98.5	98.4 ✓					
Initials: TT	Initials: TT	Initials: TT	Initials:				

Final Technician Signature:

Tony Tong

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

Date: 05/04/2020

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Evaluator signature: [Signature] 2/15/2020



Tare Sheet: (check one)

Probes

47mm Filters

100mm Filters

O-Ring Pair

Prepared By: Tomy TongBalance ID #: 00637Thermohyrometer ID #: 00592Audit Weight ID #/Mass: 00283 A 1200 mg

Placed in Dessicator:	Date: <u>10/21/2020</u> Time: <u>16:30</u> RH %: <u>10.8</u> T (°F): <u>81.1</u> Audit: <u>200.1</u>	Date: <u>7/22/2020</u> Time: <u>14:00</u> RH %: <u>15.9</u> T (°F): <u>79.7</u> Audit: <u>200.1</u>	Date: _____ Time: _____ RH %: _____ T (°F): _____ Audit: _____	Date: _____ Time: _____ RH %: _____ T (°F): _____ Audit: _____	Date Used	Project Number	Run No.
T283AP	195.4	195.4					
T283BP	186.9	186.9					
T284AP	181.0	181.1					
T284BP	191.3	191.2					
T285AP	191.6	191.6			9/15/20	0123456789	1
T285BP	190.8	190.9			↓	↓	↓
T286AP	194.1	194.1					2
T286BP	195.1	195.2			↓	↓	↓
T287AP	194.8	194.9					
T287BP	191.0	191.1					
T288AP	192.2	192.1					
T288BP	193.8	193.4					
T289AP	190.1	189.9					
T289BP	190.0	190.1					
T290AP	186.8	186.7					
T290BP	182.3	182.2					
T291AP	182.1	182.2					
T291BP	178.5	178.3					
T292AP	179.3	179.4					
T292BP	179.3	179.4					
Initials: <u>TT</u>	Initials: <u>TT</u>	Initials: _____	Initials: _____				

Final Technician Signature: Tomy Tong

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

Date: 7/22/2020

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Evaluator signature: BCD

Tare Sheet: (check one) Probes \_\_\_\_\_ 47mm Filters ☒ 100mm Filters \_\_\_\_\_ O-Ring Pair \_\_\_\_\_  
 Prepared By: Tomy Tong Balance ID #: OMNI-00637 Thermohyrometer ID #: OMNI-00592 Audit Weight ID #: OMNI-002834 200 mg

Placed in Dessicator:		Date: <u>08/25/2020</u>	Date: <u>08/31/2020</u>	Date: <u>09/01/2020</u>	Date: _____	Date Used	Project Number	Run No.
Date: <u>08/24/2020</u>	Time: <u>13:20</u>	Time: <u>13:40</u>	Time: <u>7:45</u>	Time: <u>7:30</u>	Time: _____			
	RH %: <u>17.3</u>	RH %: <u>10.1</u>	RH %: <u>9.4</u>	RH %: _____	RH %: _____			
	T (°F): <u>76.1</u>	T (°F): <u>76.1</u>	T (°F): <u>75.9</u>	T (°F): _____	T (°F): _____			
ID #	Audit: <u>200.0</u>	Audit: <u>200.1</u>	Audit: <u>200.0</u>	Audit: _____	Audit: _____			
E041	119.7	119.7	-					
E042	120.2	120.1	-					
E043	120.1	119.9	-					
E044	120.0	119.9	-					
E045	120.2	120.1	-					
E046	119.7	119.7	-					
E047	121.2	120.9	121.1	-				
E048	120.4	120.2	-					
E049	120.6	120.6	-					
E050	119.5	119.3	-					
E051	119.8	119.6	-					
E052	119.6	119.5	-					
E053	120.2	120.1	-			7-15-20	0123Wm311E RFU002	1
E054	120.0	120.1	-			↓	↓	2
E055	120.5	120.3	-					
E056	120.3	120.1	-					
E057	120.8	120.8	-					
E058	120.7	120.7	-					
E059	119.8	119.9	-					
E060	120.7	120.7	-					
Initials: <u>TT</u>	Initials: <u>TT</u>	Initials: <u>TT</u>	Initials: _____	Initials: _____	Initials: _____			

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

Date: 09/01/2020  
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Evaluator signature: WZ 9/29/20



Tare Sheet: (check one)

Probes ☒47mm Filters ☐100mm Filters ☐O-Ring Pair ☐

Prepared By:

Balance ID #: 0MNI-00637

Thermohyrometer ID #: 0MNI-00592

Audit Weight ID #/Mass: 0MNI-00283A1 100g

Placed in Dessicator:	Date: 08/24/2020	Date: 08/25/2020	Date: 08/31/2020	Date: 09/01/2020	Date Used	Project Number	Run No.
Date: 08/05/2020	Time: 9:15	Time: 10:30	Time: 7:30	Time: 7:40			
Time: 14:00	RH %: 20.7	RH %: 21.0	RH %: 10.1	RH %: 7.8			
	T (°F): 75.5	T (°F): 75.3	T (°F): 76.1	T (°F): 75.9			
ID #	Audit: 99997.9	Audit: 99998.0	Audit: 99998.0	Audit: 99998.0			
2	115015.9	115016.1					
3	116011.6	116011.8					
0ES3	114768.8	114768.8					
4	114857.6	114858.1	114857.8	114857.7			
7	114981.4	114981.6			9-15-20	0123456789. REV002	1
8	115597.4	115597.5					↓
9	115696.0	115696.1					2
11	11487.7	114188.1	114188.0				↓
6	115347.8	115347.6					
0ES6	113709.8	113709.8					
12	114284.8	114285.0					
13	114322.1	114322.3					
14	114548.1	114548.3					
15	114341.3	114341.7	114341.2	114341.1			
16	114266.4	114266.8	114266.5	114266.4			
17	114562.0	114562.2					
18	114402.0	114402.1					
20	114254.2	114254.1					
21	114392.2	114392.5	114392.2	114392.0			
22	114342.2	114342.2					
	Initials: TT	Initials: TT	Initials: TT	Initials: TT			

Final Technician Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Evaluator signature: \_\_\_\_\_

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

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Tare Sheet: (check one) Probes \_\_\_\_\_ 47mm Filters \_\_\_\_\_ 100mm Filters \_\_\_\_\_ O-Ring Pair ☒  
 Prepared By: Tony Tong Balance ID #: 0MM1-00637 Thermohygrometer ID #: 0MM1-00592 Audit Weight ID #/Mass: 0MM1-00283A 5g

Placed in Dessicator: Date: <u>08/31/2020</u> Time: <u>9:00</u>	Date: <u>09/03/2020</u> Time: <u>9:15</u> RH %: <u>17.0</u> T (°F): <u>77.7</u> Audit: <u>5000.2</u>	Date: <u>09/08/2020</u> Time: <u>7:30</u> RH %: <u>11.4</u> T (°F): <u>76.4</u> Audit: <u>5000.0</u>	Date: <u>09/09/2020</u> Time: <u>7:30</u> RH %: <u>12.8</u> T (°F): <u>76.2</u> Audit: <u>5000.1</u>	Date: <u>09/10/2020</u> Time: <u>7:30</u> RH %: <u>7.2</u> T (°F): <u>77.3</u> Audit: <u>5000.1</u>	Date Used	Project Number	Run No.
ID #							
S017	4079.6	4078.9	4079.0				
S018	3299.0	3298.3	3298.1				
S019	3303.3	3302.3	3302.2				
S020	3272.7	3271.9	3271.8				
S021	4105.5	4104.6	4104.9	4104.9	7-15-20	013MM011E.REV002	1
S022	3353.8	3352.5	3352.8	3352.9			↓
S023	4125.2	4124.3	4124.5				2
S024	3332.3	3331.3	3331.3				↓
S025	3391.5	3390.2	3390.5	3390.5			
S026	3349.0	3347.9	3348.1				
S027	3578.1	3577.1	3577.2				
S028	3374.4	3373.3	3373.5				
S029	3286.3	3285.3	3285.3				
S030	4148.5	4147.5	4147.6				
S031	3353.8	3353.0	3352.9				
S032	3371.5	3370.3	3370.5				
S033	4157.8	4156.8	4157.2	4157.4			
S034	3327.3	3326.6	3326.7				
S035	4069.0	4068.7	4068.7				
S036	4059.8	4059.3	4059.2				
Initials: <u>TT</u>	Initials: <u>TT</u>	Initials: <u>TT</u>	Initials: <u>TT</u>				

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

Date: 09/10/2020  
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Evaluator signature: [Signature] - 9/29/20

# 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: <u>MYREN</u>	Date: <u>9/1/17</u>
Work Order Number: <u>49320</u>	PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. <u>PANTHER</u>	<u>4466459</u>	<u>1000 x .1</u>	<u>Ø</u>		
	Pass...Fail		<u>50</u>		
Notes: <u>DOA</u> <u>will be new Scale deck</u>			<u>100</u>		
			<u>300</u>		
			<u>500</u>		
			<u>Ø</u>		

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. <u>PANTHER</u>	<u>001555564</u>	<u>5K x 1</u>	<u>Ø</u>		
	Pass...Fail		<u>50</u>		
Notes: <u>DNF</u> <u>SPARE Readout</u>			<u>100</u>		
			<u>300</u>		
			<u>500</u>		
			<u>Ø</u>		

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3. <u>PANTHER</u>	<u>00025736A5</u>	<u>1000 x .1</u>	<u>Ø</u>	<u>Ø</u>	<u>Ø</u>
	Pass...Fail		<u>50</u>	<u>50</u>	<u>50</u>
Notes: <u>SCALE CALIBRATED w/ CERT. WEIGHTS.</u> <u>900TH Scale</u>			<u>100</u>	<u>99.9</u>	<u>100</u>
			<u>300</u>	<u>299.6</u>	<u>300</u>
			<u>500</u>	<u>498.8</u>	<u>500</u>
			<u>Ø</u>	<u>Ø</u>	<u>Ø</u>

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
4. <u>PANTHER</u>	<u>00926516KL</u>	<u>1000 x .1</u>	<u>Ø</u>	<u>Ø</u>	
	Pass...Fail		<u>50</u>	<u>50</u>	
Notes: <u>SCALE CALIBS (GOOD)</u> <u>Center Scale</u>			<u>100</u>	<u>100</u>	
			<u>300</u>	<u>300</u>	
			<u>500</u>	<u>500</u>	
			<u>Ø</u>	<u>Ø</u>	

Additional Comments:

Last Checked: <u>11/16</u>	Next Check Due: <u>—</u>
Weights Certified: <u>10/16</u>	Technician: <u>BB</u>

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

# SCALE CALIBRATION RECORD

Customer: MYREN Date: 9/11/17  
Work Order Number: 49320 PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. SARTORIUS	25359106	15K x .5	$\phi$	0	0
CTSL1-4	Pass...Fail		50	50	50
Notes: STRAIN TEST w/ 4026 lbs CALIBRATED w/ 3926 lbs SCALE CHECKS GOOD			500	499	500
			1000	998	1000
			<del>2000</del> 3926	<del>3926</del>	3926
			$\phi$	$\phi$	$\phi$

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. OHAUS	2350003	24 x .002	$\phi$	0	$\phi$
RANGER	Pass...Fail		.5	.5	.5
Notes: LEVELED SCALE, SCALE CHECKS GOOD,			4	4	4
			20	20.002	20
			24	24.002	24
			$\phi$	$\phi$	$\phi$

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3.					
	Pass...Fail				
Notes:					

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

Additional Comments:

Last Checked: 11/16 Next Check Due: -  
Weights Certified: 10/16 Technician: BB B. B. B.





Red Ball Technical Gas Service  
555 Craig Kennedy Way  
Shreveport, LA 71107  
800-551-8150  
PGVP Vendor ID # G12018

## EPA PROTOCOL GAS CERTIFICATE OF ANALYSIS

Cylinder Number: EB0004096  
Product ID Number: 126512  
Cylinder Pressure: 1900 PSIG  
COA #: EB0004096.20180618-0  
Customer PO. NO.:  
Customer:

Certification Date: 07/03/2018  
Expiration Date: 07/01/2026  
MFG Facility: - Shreveport - LA  
Lot Number: EB0004096.20180618  
Tracking Number: 6043326  
Previous Certification Dates:

This calibration standard has been certified per the May 2012 EPA Traceability Protocol, Document EPA-600/R-12/531, using procedure G2.

Do Not Use This Cylinder Below 100 psig (0.7 Megapascal).

### Certified Concentration(s)

Component	Concentration	Uncertainty	Analytical Principle	Assayed On
Carbon Monoxide	2.48 %	±0.02 %	FTIR	07/03/2018
Carbon Dioxide	12.40 %	±0.08 %	NDIR	06/27/2018
Nitrogen	Balance			

Analytical Measurement Data Available Online.

### Reference Standard(s)

Serial Number	Lot	Expiration	Type	Balance	Component	Concentration	Uncertainty(%)	NIST Reference
CC219495	CC219495.20151013g	01/11/2024	GMIS	N2	CO	2.488 %	0.584	2642a
EB0016197	EB0016197.20180205	05/13/2026	GMIS	N2	CO2	15 %	0.76	101001
EB0097755	EB0097755.20171018-0	12/26/2025	GMIS	N2	CO2	24.86 %	0.212	C1309410.01

### Analytical Instrumentation

Component	Principle	Make	Model	Serial	MPC Date
CO2	NDIR	Thermo	410i	1162980025	06/08/2018
CO	FTIR	MKS	MKS 2031DJG2EKVS13T	017146467	07/03/2018

### SMART-CERT



This is to certify the gases referenced have been calibrated/tested, and verified to meet the defined specifications. This calibration/test was performed using Gases or Scales that are traceable through National Institute of Standards and Technology (NIST) to the International System of Units (SI). The basis of compliance stated is a comparison of the measurement parameters to the specified or required calibration/testing process. The expanded uncertainties use a coverage factor of k=2 to approximate the 95% confidence level of the measurement, unless otherwise noted. This calibration certificate applies only to the item described and shall not be reproduced other than in full, without written approval from Red Ball Technical Gas Services. If not included, the uncertainty of calibrations are available upon request and were taken into account when determining pass or fail.

Brandon Theus  
Analytical Chemist  
Assay Laboratory: Red Ball TGS  
Version 02-1, Revised on 2017-09-07

# 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

PO: **200299**

Order Date: **05/28/2020**

Authorized By: **N/A**



0723.01

Calibration

Property #: **OMNI-00650**

User: **N/A**

Department: **N/A**

Make: **Control Company**

Model: **6530**

Serial #: **181062211**

Description: **Thermohygrometer / Barometer**

Procedure: **403406**

Accuracy:  **$\pm 3\% \text{RH}$ ,  $\pm 4^\circ\text{C}$  ( $0.8^\circ\text{F}$ ),  $\pm 4 \text{mbar}$  ( $0.12 \text{inHg}$ )**

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

## Parameter

## Measurement Data

Measurement Description	Range Unit	Reference	Min	Max	Error	UUT	Uncertainty
<b>Before/After Humidity</b>							Accredited = ✓
	%	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 ✓
<b>Temperature</b>							
	°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/NCCL 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

PO: **180188**

Order Date: **10/09/2018**

Authorized By: **N/A**

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**



0723.01

Calibration

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**

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

## Parameter

## Measurement Data

Measurement Description	Range Unit	Reference	Min	Max	*Error	UUT	Uncertainty
<b>Before/After</b>							Accredited = ✓
<b>Mass</b>							
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: 702003  
 OMNI Tracking No.: OMNI-00371  
 Calibrated Orifice: ☐ Yes

**Average Gas Meter y Factor**  
**0.994**

**Orifice Meter dH@**  
**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 °F  
 Standard Press.: 29.92 "Hg  
 Barometric Press., Pb: 29.99 "Hg  
 Signature/Date:  6/29/2020

### Previous Calibration Comparison

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

Reference Standard *		
Standard	Model	Standard Test Meter
Calibrator	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
<b>Gas Meter y Factor =</b>	<b>1.000</b>	<b>0.993</b>	<b>0.989</b>
<b>Gas Meter y Factor Deviation (from avg.)</b>	0.006	0.001	0.005
<b>Orifice dH@</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
<b>Orifice dH@ Deviation (from avg.)</b>	N/A	N/A	N/A

where:

1. Deviation = |Average value for all runs - current run value|
- \*\* 2.  $y = [V_r \times (y \text{ factor (ref)}) \times (P_b + (P_r / 13.6)) \times (T_d + 460)] / [V_d \times (P_d + (P_r / 13.6)) \times (T_r + 460)]$
- \*\* 3.  $dH@ = 0.0317 \times P_d / (P_b (T_d + 460)) \times [(T_r + 460) \times \text{time}] / V_r ]^2$

\* 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  $\pm 0.14 \text{ ft}^3/\text{min}$ . 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<sub>2</sub>O

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  $\pm 0.4$ " 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: 

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					FB Interior
			Meter B	Filter A	Filter B	Tunnel	
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: 702004  
 OMNI Tracking No.: OMNI-00372  
 Calibrated Orifice: ☐ Yes

**Average Gas Meter y Factor**  
**0.998**

**Orifice Meter dH@**  
**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 °F  
 Standard Press.: 29.92 "Hg  
 Barometric Press., Pb: 29.94 "Hg  
 Signature/Date:  6/29/2020

### Previous Calibration Comparison

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

Reference Standard *		
Standard	Model	Standard Test Meter
Calibrator	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
<b>Gas Meter y Factor =</b>	<b>1.003</b>	<b>0.998</b>	<b>0.992</b>
<b>Gas Meter y Factor Deviation (from avg.)</b>	0.005	0.000	0.005
<b>Orifice dH@</b>	N/A	N/A	N/A
<b>Orifice dH@ Deviation (from avg.)</b>	N/A	N/A	N/A

where:

1. Deviation = |Average value for all runs - current run value|
- \*\* 2.  $y = [V_r \times (y \text{ factor (ref)}) \times (P_b + (P_r / 13.6)) \times (T_d + 460)] / [V_d \times (P_b + (P_d / 13.6)) \times (T_r + 460)]$
- \*\* 3.  $dH@ = 0.0317 \times P_d / (P_b (T_d + 460)) \times [(T_r + 460) \times \text{time}] / V_r ]^2$

\* 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  $\pm 0.14 \text{ ft}^3/\text{min}$ . 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<sub>2</sub>O

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  $\pm 0.4$ " 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: 

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



# Certificate of Calibration

Certificate Number: **712014**

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



**JJ Calibrations, Inc.**

7724 SE Aspen Summit Drive  
Portland, OR 97266-9217  
Phone 503.786.3005  
FAX 503.786.2994



0723.01  
Calibration

PO: **190268**

Order Date: **10/29/2019**

Authorized By: **N/A**

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**

Property #: **OMNI-00410**

User: **N/A**

Department: **N/A**

Make: **Dwyer**

Model: **1430**

Serial #: **OMNI-00410**

Description: **Microtector**

Procedure: **500364**

Accuracy: **±0.00025" WC**

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

## Parameter

## Measurement Data

Measurement Description	Range Unit	Reference	Min	Max	*Error	UUT	Uncertainty
<b>Before/After</b>							Accredited = ✓
<b>Length</b>	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/NCCL 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 11/08/2019

Rev # 15

  
Inspector



## Vaneometer Air Velocity Meter OMNI-00559

85 of 138

## VWR Temperature Hygrometer Calibration Procedure and Data Sheet

Frequency: Every Two Years

Step 1: Locate NIST traceable standard.

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

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

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

### Verification Data:

Date: 1/29/19  
1/29/19 Technician: B. Davis

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.

# ZRE

# NDIR/O<sub>2</sub>



# USER'S

# MANUAL



1312 West Grove Avenue  
Orange, CA 92865-4134  
Phone: 714-974-5560 Fax: 714-921-2531  
[www.gasanalyzers.com](http://www.gasanalyzers.com)

# Certificate of Calibration

Certificate Number: **728321**

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



**JJ Calibrations, Inc.**

7724 SE Aspen Summit Drive  
Portland, OR 97266-9217  
Phone 503.786.3005  
FAX 503.786.2994

OnSite

PO: **200302**

Order Date: **07/09/2020**

Authorized By: **N/A**

Calibrated on: **07/09/2020**

\*Recommended Due: **01/09/2021**

Environment: **20 °C 42 % RH**

\* As Received: **Within Tolerance**

\* As Returned: **Within Tolerance**

Action Taken: **Calibrated**

Technician: **111**



0723.01  
Calibration

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**

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
503A	Rice Lake	1mg-200g (Class 0)	Mass Set,	08/08/2020	702709

Parameter

## Measurement Data

Measurement Description	Range Unit	Reference	Min	Max	*Error	UUT	Uncertainty
Before/After Force							Accredited = ✓
	g	10.00000	9.9995	10.0005	0.0001	9.9999 g	9.7E-05 ✓
	g	30.00000	29.9995	30.0005	0.0000	30.0000 g	1.3E-04 ✓
	g	60.00000	59.9995	60.0005	0.0000	60.0000 g	2E-04 ✓
	g	90.00000	89.9995	90.0005	0.0002	90.0002 g	2.4E-04 ✓
	g	120.00000	119.9995	120.0005	0.0001	120.0001 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 07/15/2020 Rev # 15

Inspector

## **Example Calculations**

## Equations and Sample Calculations

Manufacturer: Kuma Stoves  
Model: K180 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,

$\theta$  = Total length of test run, min

Sample Calculation:

$$M_{Bdb} = 7.47 \quad \text{kg}$$

$$\theta = 700 \quad \text{min}$$

$$BR = \frac{60 \times 7.47}{700}$$

$$BR = \mathbf{0.64} \quad \text{kg/hr}$$

**V<sub>s</sub> – Average gas velocity in the dilution tunnel, ft/sec**

ASTM E2515 equations (9)

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

Where:

- $F_p$  = Adjustment factor for center of tunnel pitot tube placement,  $F_p = \frac{V_{strav}}{V_{scent}}$ , ASTM E2515 Equation (1)
- $V_{scent}$  = Dilution tunnel velocity calculated after the multi-point pitot traverse at the center, ft/sec
- $V_{strav}$  = Dilution tunnel velocity calculated after the multi-point pitot traverse, ft/sec
- $k_p$  = Pitot tube constant, 85.49
- $C_p$  = Pitot tube coefficient: 0.99, unitless
- $\Delta P^*$  = Velocity pressure in the dilution tunnel, in H<sub>2</sub>O
- $T_s$  = 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<sub>2</sub>O; (in Hg = in H<sub>2</sub>O/13.6)
- $M_s$  = \*\*The dilution tunnel wet molecular weight;  $M_s = 28.78$  assuming a dry weight of 29 lb/lb-mole

Sample calculation:

$$F_p = \frac{18.16}{18.71} = 0.971$$

$$V_s = 0.971 \times 85.49 \times 0.99 \times 0.265 \times \left( \frac{85.0 + 460}{\left( \frac{28.39}{28.39} + \frac{-0.11}{13.6} \right) \times 28.78} \right)^{1/2}$$

$$V_s = 17.77 \text{ ft/s}$$

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

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



**Q<sub>sd</sub> – 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<sub>ws</sub> = Water vapor in gas stream, proportion by volume; assume 2%
- A = Cross sectional area of dilution tunnel, ft<sup>2</sup>
- T<sub>std</sub> = Standard absolute temperature, 528 °R
- P<sub>s</sub> = Absolute average gas static pressure in dilution tunnel, = P<sub>bar</sub> + P<sub>g</sub>, in Hg
- T<sub>s(avg)</sub> = Absolute average gas temperature in the dilution tunnel, °R; (°R = °F + 460)
- P<sub>std</sub> = Standard absolute pressure, 29.92 in Hg

Sample calculation:

$$Q_{sd} = 3600 \times (1 - 0.02) \times 17.77 \times 0.196 \times \frac{528}{85.0 + 460} \times \frac{28.4 + \frac{-0.11}{13.6}}{29.92}$$

$$Q_{sd} = 11312.9 \text{ dscf/hr}$$

**$V_{m(std)}$  – 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
- $\Delta H$  = Average pressure differential across the orifice meter, in. H<sub>2</sub>O
- $T_m$  = Absolute average dry gas meter temperature, °R

Sample Calculation:

Using equation for Train 1:

$$V_{m(std)} = 17.64 \times 117.409 \times 0.994 \times \frac{\left( 28.39 + \frac{2.26}{13.6} \right)}{\left( 80.4 + 460 \right)}$$

$$V_{m(std)} = \mathbf{108.761} \text{ dscf}$$

Using equation for Train 2:

$$V_{m(std)} = 17.64 \times 123.344 \times 0.998 \times \frac{\left( 28.39 + \frac{1.80}{13.6} \right)}{\left( 78.7 + 460 \right)}$$

$$V_{m(std)} = \mathbf{114.954} \text{ dscf}$$

Using equation for ambient train:

$$V_{m(std)} = 17.64 \times 176.94 \times 1.016 \times \frac{\left( 28.39 + \frac{0.00}{13.6} \right)}{\left( 72.6 + 460 \right)}$$

$$V_{m(std)} = \mathbf{169.005} \text{ dscf}$$

**$m_n$  – Total Particulate Matter Collected, mg**

ASTM E2515 Equation (12)

$$m_n = m_p + m_f + m_g$$

Where:

$m_p$  = mass of particulate matter from probe, mg

$m_f$  = mass of particulate matter from filters, mg

$m_g$  = mass of particulate matter from filter seals, mg

Sample Calculation:

Using equation for Train 1 (first hour):

$$m_n = 0.0 + 1.4 + 0.0$$

$$m_n = 1.4 \text{ mg}$$

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

$$m_n = 0.7 + 0.8 + 1.3$$

$$m_n = 2.8 \text{ mg}$$

Train 1 aggregate:

$$m_n = 1.4 + 2.8$$

$$m_n = 4.2 \text{ mg}$$

Using equation for Train 2:

$$m_n = 0.8 + -0.4 + 3.2$$

$$m_n = 3.6 \text{ mg}$$

**C<sub>s</sub> - 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<sub>2</sub> = Constant, 0.001 g/mg

m<sub>n</sub> = Total mass of particulate matter collected in the sampling train, mg

V<sub>m(std)</sub> = Volume of gas sampled corrected to dry standard conditions, dscf

Sample calculation:

For Train 1:

$$C_s = 0.001 \times \frac{4.2}{108.76}$$

$$C_s = \mathbf{0.00004} \text{ g/dscf}$$

For Train 2

$$C_s = 0.001 \times \frac{3.6}{114.95}$$

$$C_s = \mathbf{0.00003} \text{ g/dscf}$$

For Ambient Train

$$C_r = 0.001 \times \frac{0.1}{169.01}$$

$$C_r = \mathbf{0.000001} \text{ g/dscf}$$

**E<sub>T</sub> – Total Particulate Emissions, g**

ASTM E2515 equation (15)

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

Where:

C <sub>s</sub>	=	Concentration of particulate matter in tunnel gas, g/dscf
C <sub>r</sub>	=	Concentration particulate matter room air, g/dscf
Q <sub>std</sub>	=	Average dilution tunnel gas flow rate, dscf/hr
θ	=	Total time of test run, minutes

Sample calculation:

For Train 1

$$E_T = ( \underline{0.000039} - 0.000001 ) \times \underline{11312.9} \times \underline{700} / 60$$
$$E_T = \underline{5.02} \text{ g}$$

For Train 2

$$E_T = ( \underline{0.000031} - 0.000001 ) \times \underline{11312.9} \times \underline{700} / 60$$
$$E_T = \underline{4.06} \text{ g}$$

Average

$$E = \underline{4.54} \text{ g}$$

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

$$7.5\% \text{ of the average} = \underline{0.34}$$

$$\text{Train 1 difference} = \underline{0.48}$$

$$\text{Train 2 difference} = \underline{0.48}$$

**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:

$\theta$  = Total sampling time, min

$\theta_i$  = Length of recording interval, min

$V_{mi}$  = Volume of gas sample measured by the dry gas meter during the "ith" time interval, dcf

$V_m$  = Volume of gas sample as measured by dry gas meter, dcf

$V_{si}$  = Average gas velocity in the dilution tunnel during the "ith" time interval, ft/sec

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

$T_{mi}$  = Absolute average dry gas meter temperature during the "ith" time interval, °R

$T_m$  = Absolute average dry gas meter temperature, °R

$T_{si}$  = Absolute average gas temperature in the dilution tunnel during the "ith" time interval, °R

$T_s$  = Absolute average gas temperature in the dilution tunnel, °R

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

$$PR = \left( \frac{700 \times 1.67 \times 17.77 \times (107.0 + 460) \times (80.4 + 460)}{10 \times 117.4 \times 18.11 \times (85.0 + 460) \times (80.0 + 460)} \right) \times 100$$

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

**PM<sub>R</sub> – Particulate emissions for test run, g/hr**

ASTM E2780 equation (6)

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

Where,

E<sub>T</sub> = Total particulate emissions, grams

θ = Total length of full integrated test run, min

Sample Calculation:

$$E_T (\text{Dual train average}) = 4.54 \text{ g}$$

$$\theta = 700 \text{ min}$$

$$PM_R = 60 \times ( 4.54 / 700 )$$

$$PM_R = 0.39 \text{ g/hr}$$



**PM<sub>F</sub>** – Particulate emission factor for test run, g/dry kg of fuel burned  
ASTM E2780 equation (7)

$$PM_F = E_T / M_{FTAdb}$$

Sample Calculation:

$$E_T (\text{Dual train average}) = 4.54 \text{ g}$$

$$M_{Bdb} = 7.47 \text{ kg}$$

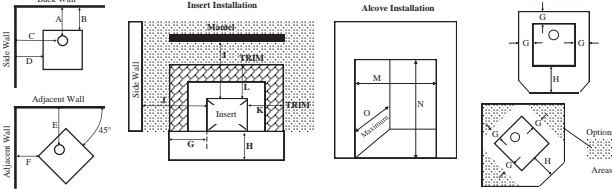
$$PM_F = 4.54 / 7.47$$

$$PM_F = \mathbf{0.61} \text{ g/kg}$$

# **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															




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 SERVING ANOTHER APPLIANCE. DO NOT USE GRATE OR ELEVATE FIRE - BUILD WOOD FIRE DIRECTLY ON FIREBRICK. REPLACE GLASS ONLY WITH *Santa* 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 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 BLUED 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.  
58145 N OLD HWY 95  
RATHDRUM ID 83858



MODEL NAME:  
K-180

Serial Number

Emissions Test Report #: 0123WM011E Safety Test Report # TBD



**CAUTION:** HOT WHILE IN OPERATION - DO NOT TOUCH - TACT 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. 0.72 Grams per hour. Tested to ASTM 3053-2017.



Model # K-180:

**Aspen LE, Tamarack LE, Aberdeen LE, Alpine LE,**



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

Emissions tested to: ASTM 3053-2017  
Report# 0123WM011E

Safety tested to UL 1482  
Report # TBD

**INSTALLATION AND OPERATING INSTRUCTIONS**  
**SAVE THESE INSTRUCTIONS**

This manual describes the installation and operation of the Kuma Model K-180 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 10,614 to 32,121 Btu/hr. and an efficiency of 81.0% (High Heating Value). Please visit <https://www.kumastoves.com/content/page/EPA> for a detailed explanation of stove efficiencies. Particulate emissions are 0.72 grams per hour and average CO emissions are 0.10 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

### SECTION 2 - SPECIFICATIONS

### SECTION 3 - INSTALLATION INSTRUCTIONS

### SECTION 4 - OPERATING INSTRUCTIONS

### SECTION 5 - CATALYST INFORMATION

### SECTION 6 - MAINTENANCE

### SECTION 7 - TROUBLESHOOTING

### SECTION 8 - WARRANTY

## 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, naphtha 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.**

Listing Tag:



**CAUTION:** HOT WHILE IN OPERATION - DO NOT TOUCH  
 KEEP CHILDREN AND CLOTHING AWAY - CON-  
 TACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS.  
 KEEP FURNISHINGS AND OTHER COMBUSTIBLE MATERIALS AT A CONSID-  
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 SSED BUILDUP MAY OCCUR RAPIDLY. DO NOT PASS CONNECTOR PIPE THROUGH  
 COMBUSTIBLE WALLS OR CEILINGS. DO NOT OBSTRUCT BENEATH THE HEATER.



**MODEL NAME:**  
 K-180

☐ 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. 0.72 Grams per hour. Tested to ASTM 3083-2017.





## 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 component 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

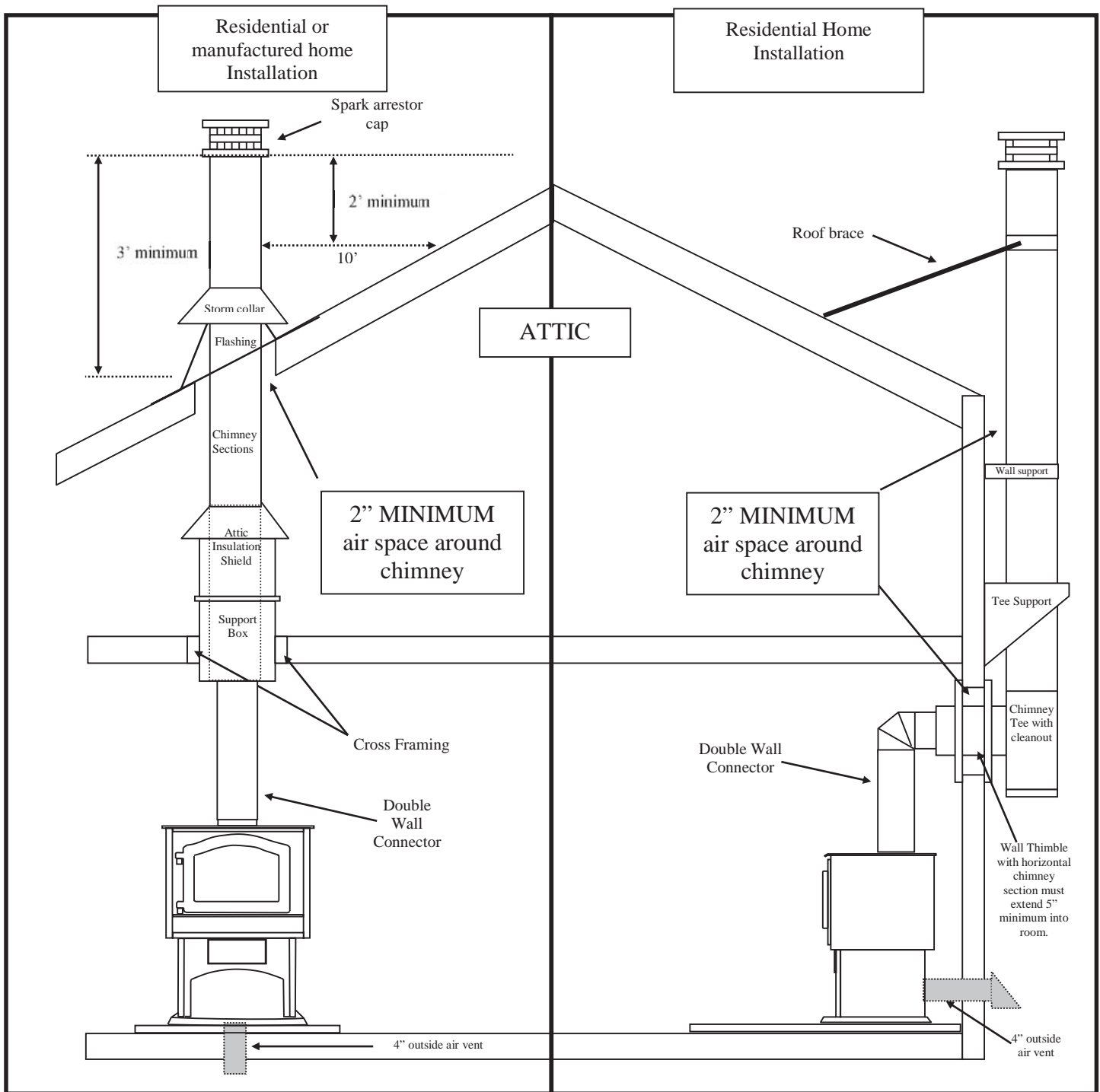
- 🔥 For chimney installation instructions, carefully follow the installation manual that came with your all fuel chimney system.
- 🔥 Your chimney must meet the UL-103HT standard. Do not mix different brands of chimney parts.
- 🔥 Do not use connector pipe to pass through an attic, closet, wall, floor 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 structural 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.

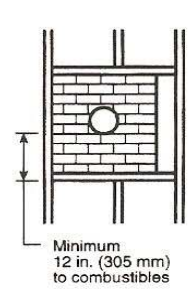
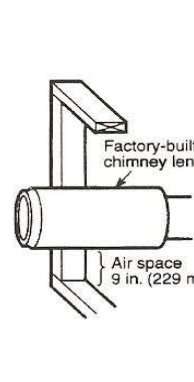
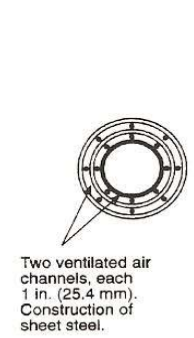
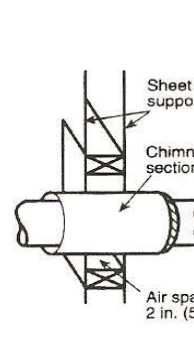
## WHEN CONNECTING TO A MASONRY CHIMNEY

### 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](http://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)
 <p>Minimum chimney clearance to brick and combustibles 2 in. (51 mm)</p> <p>Minimum 12 in. (305 mm) to combustibles</p> <p>Masonry chimney constructed to NFPA 211</p>	<p><b>A</b> 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, <i>Standard Specification for Clay Fire Linings</i>, or equivalent), minimum 3/8-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.</p>	12/305
 <p>Minimum chimney clearance from masonry to sheet steel supports and combustibles 2 in. (51 mm)</p> <p>Minimum clearance 9 in. (229 mm) of brick</p> <p>Chimney flue</p> <p>Chimney connector</p> <p>Fireclay liner</p> <p>Masonry chimney constructed to NFPA 211</p> <p>Factory-built chimney length</p> <p>Chimney length flush with inside of flue</p> <p>Air space 9 in. (229 mm) min.</p> <p>Non-soluble refractory cement</p> <p>Use chimney mfrs. parts to attach connector securely</p> <p>Solid-insulated, listed factory-built chimney length</p> <p>Sheet steel supports</p>	<p><b>B</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.</p> <p>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.</p> <p>Fasteners between supports and the chimney length shall not penetrate the chimney liner.</p>	9/229
 <p>Minimum chimney clearance to sheet steel supports and combustibles 2 in. (51 mm)</p> <p>Minimum clearance 9 in. (229 mm)</p> <p>Chimney flue</p> <p>Chimney connector</p> <p>Masonry chimney constructed to NFPA 211</p> <p>Sheet steel supports</p> <p>Two ventilated air channels, each 1 in. (25.4 mm). Construction of sheet steel.</p> <p>Two air channels each 1 in. (25.4 mm)</p> <p>Minimum 6 in. (152 mm) glass fiber insulation</p>	<p><b>C</b> 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.</p> <p>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.</p>	6/152
 <p>Minimum chimney clearance to sheet steel supports and combustibles 2 in. (51 mm)</p> <p>Minimum clearance 2 in. (51 mm)</p> <p>Chimney flue</p> <p>Chimney connector</p> <p>Masonry chimney constructed to NFPA 211</p> <p>Sheet steel supports</p> <p>Chimney section</p> <p>Chimney connector</p> <p>Air space 2 in. (51 mm)</p> <p>1-in. (25.4-mm) air space to chimney length</p>	<p><b>D</b> 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.</p> <p>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.</p> <p>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.</p>	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<sup>2</sup>-°F (4.88 kg-cal/hr-m<sup>2</sup>-°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.

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## 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

-  **NEVER USE FLAMMABLE LIQUIDS TO START OR FRESHEN UP A FIRE**
-  **CAUTION:** Do not use any fuels that are not seasoned natural wood.
-  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 16". 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.

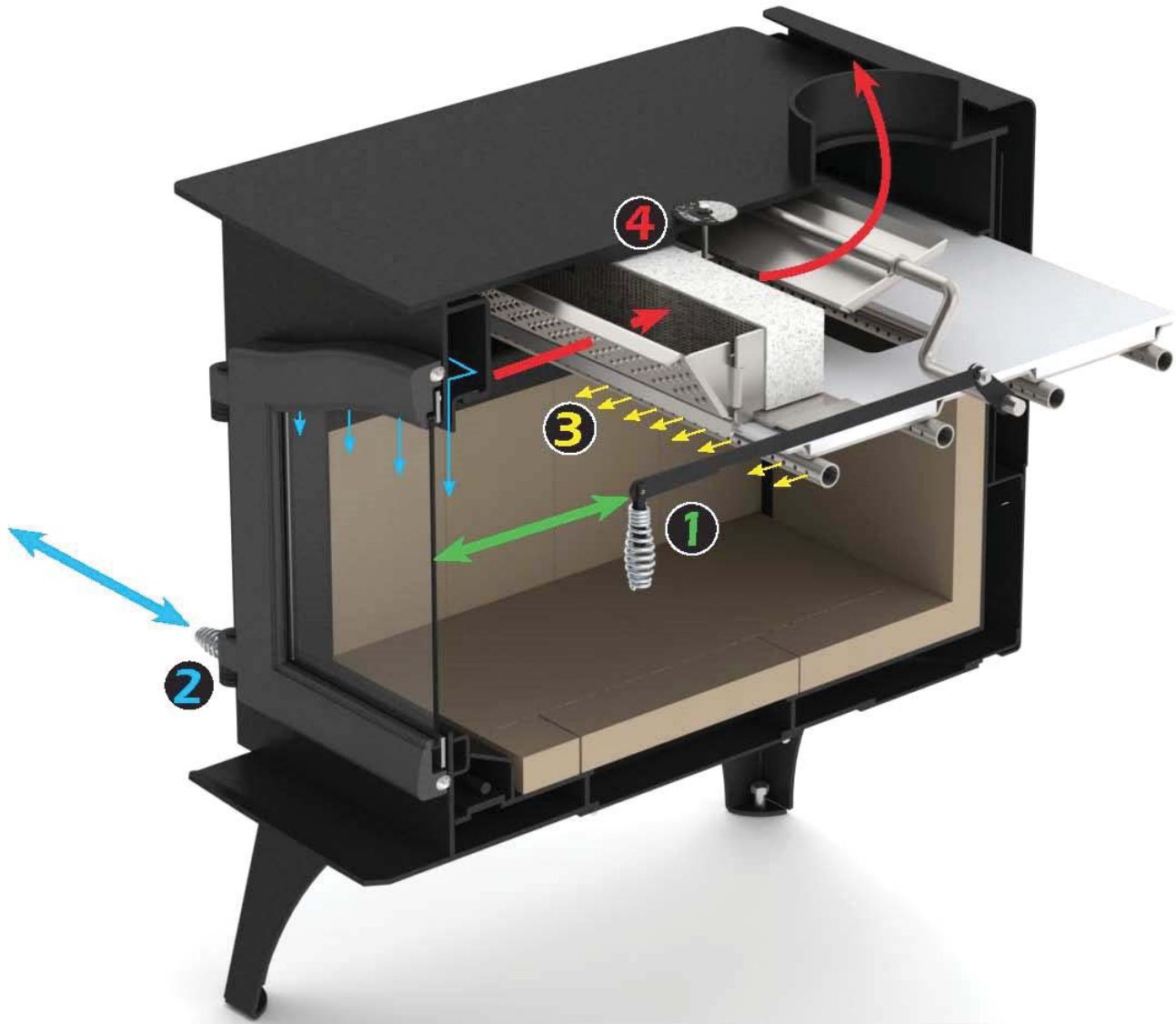
Inadequate draft may cause back puffing into the room and creosote formation in the chimney. Inadequate draft will cause the appliance to leak smoke and carbon monoxide into the room through appliance and chimney connector joints.

## 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 too hot.
  - c. Use the Primary Air Control to change the temperature of the stove.
  - d. 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 plate and open the wood loading door
3. Place wood pieces directly on the firebox bottom: using a grate will allow too much air to the coal bed and will result in incomplete combustion of the wood. 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 1<sup>st</sup> reaches the active range, close the bypass control to engage the combustor.
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	13 hours
Medium Burn	About 1/2" Open	11 hours
High Burn and Start Up	Fully Open	5 hours

## ADDING MORE WOOD TO THE FIRE

1. Start by sliding the air control to fully open and wait 1 minute to allow the coals to become active.
2. Pull open the bypass plate and wait 1 minute to allow the smoke to draft up the chimney
3. Slowly open the wood loading door and rake the coals breaking up any larger pieces
4. Add wood then shut the door but leave the air control and the bypass control in the open position.
5. As soon as the catalytic thermometer is in the active range, close the bypass control
6. Leave the air control open for 10-20 minutes so that the fire becomes well established then begin to adjust you 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](http://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](http://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

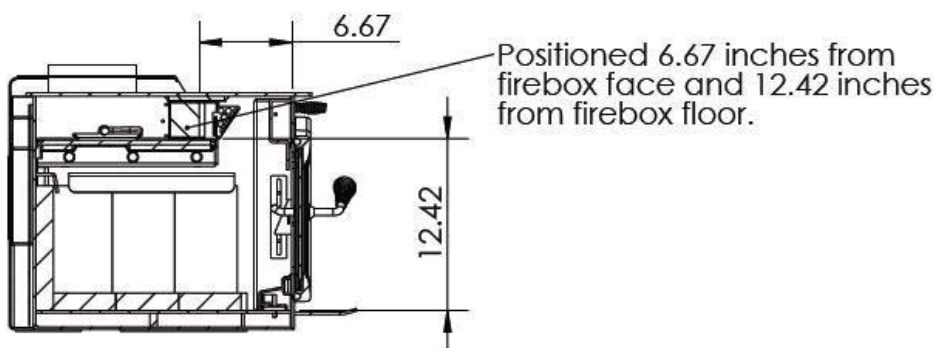
## SECONDARY BURN TUBE REPLACEMENT

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 at least once a year and replaced if necessary. 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:  $\frac{1}{4}$  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:  $\frac{1}{4}$  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.	Burn a hot fire with the bypass rod partially open to burn off the creosote buildup.
	Burning improper material such as cardboard, coal or wrapping paper.	Burn only dry seasoned natural wood.
Lower Efficiency	Flames contacting the catalyst from excessive draft.	Use less wood or lower the air to the stove. Install a damper to reduce draft.
	Poisoning	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.	Make sure you achieve catalyst light off (see section 4)
	Burning material that produces fly ash and char. See section 4 for a list of improper materials	Burn only dry, seasoned natural wood. Vacuum or brush off the catalyst.





## 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](http://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](http://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 28 2018

Mr. Justin White  
Hearthstone QHPP, Inc.  
#17 Stafford Ave.  
Morrisville, VT 05661

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:

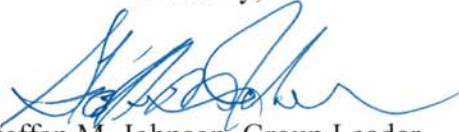
1. The filter temperature must be maintained between 80 and 90 degrees F during testing.
2. Filters must be weighed in pairs to reduce weighing error propagation; see ASTM 2515-11, Section 10.2.1 Analytical Procedure.
3. Sample filters must be Pall TX-40 or equivalent Teflon-coated glass fiber, and of 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](mailto:toney.mike@epa.gov).

Sincerely,

A handwritten signature in blue ink, appearing to read 'Steffan M. Johnson', with a stylized flourish at the end.

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  $\leq$  (original catalyst category 1 + 0.5g/hr)

AND

Replacement catalyst category 4  $\leq$  (original catalyst category 4 + 0.5g/hr)

As noted in Section 60.533(k)(4)<sup>1</sup>, 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](mailto: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.<sup>2</sup>

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](mailto:sanchez.rafael@epa.gov).

Sincerely,



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

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<sup>1</sup> 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.

<sup>2</sup> 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 Aspen LE

0123WM011E

BDAMS

Fire box Volume

2/25/19

H	W	D
9.5	18.25	17.25

$$V_1 = 9.5 \times 18.25 \times 17.25 = 1.731$$

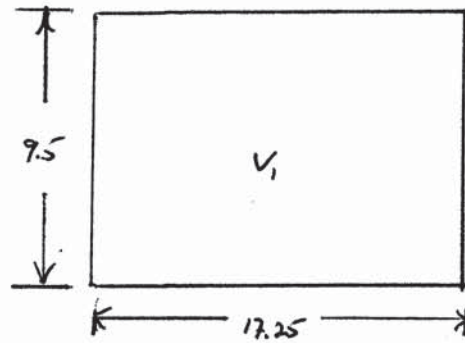
1.731 ft<sup>3</sup>

This rough drawing was done to confirm a more in depth drawing done by Myren Consulting that calculated a 1.736 ft<sup>3</sup> box.

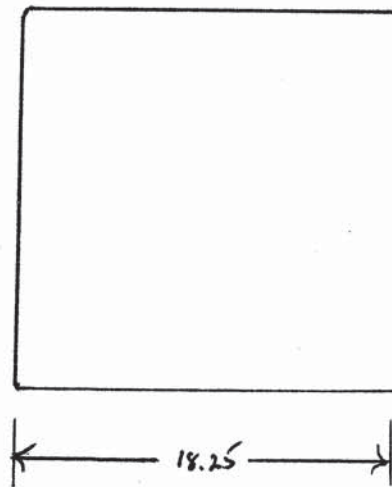
1.736 was used for all fuel calculations

BD

Side view



Front view



## **Appendix D**

### **Revision History**

Date	Project No.	Tech. & Evaluator	Report Sect.	Summary of Changes
9/29/20	0123WM011E.REV001	Bruce Davis	All	Original report generated
10/13/20	0123WM011E.REV001 Edition 001	Bruce Davis	All	General grammar/spelling updates on first edition.
10/19/20	0123WM011E.REV001 Edition 002	Bruce Davis	All	Incorrect reference to Catalyst part number was edited.
10/26/20	0123WM011E.REV001 Edition 003	Bruce Davis	Cover	Updated incorrect heading on cover
7/15/21	0123WM011E.REV001 Edition 004	Bruce Davis	Preface	Cover updated for new edition, signatories updated, table of content updated to show revision history.
			1	Table 8 added to show train precision. Negative filter weights in run 2 explained in individual run summary
			3	Added "Operated for 50 hours at a medium burn rate" to conditioning data on page 24
			5	Manual page updated to show corrected log length on page 114.