
Hearth & Home Technologies

Project # 24-281

Branding: Vermont Castings

Model: Aspen C3

Type: Single Burn Rate Wood-Fired Room
Heater

April 19, 2024

**ASTM E2780 Standard Test Method for
Determining Particulate Matter Emissions
from Wood Heaters**

**EPA Test Method 28R for Certification
and Auditing of Wood Heaters**

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Revision Summary

Date: 4/19/2024– Original Issue

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Affidavit

PFS-TECO was contracted by Hearth & Home Technologies (HHT) to provide testing services for the Aspen C3 Single Burn Rate Wood-Fired Room Heater per EPA Method 28R, *Certification and Auditing of Wood Heaters*. All testing and associated procedures were conducted at PFS-TECO's Portland Laboratory beginning on 3/26/2024 and ending on 3/27/2024. PFS-TECO's Portland Laboratory is located at 11785 SE Highway 212 – Suite 305, Clackamas, Oregon 97015. Testing procedures followed EPA Method 28R and ASTM E2780, *Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters*. Particulate sampling was performed per ASTM E2515, *Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel*.

PFS-TECO is accredited by the U.S. Environmental Protection Agency for the certification and auditing of wood heaters pursuant to subpart AAA of 40 CFR Part 60, New Source Performance Standards for Residential Wood Heaters and subpart QQQQ of 40 CFR Part 60, Standards of Performance for New Hydronic Heaters and Forced Air Furnaces, Methods 28R, 28WHH, 28 WHH-PTS, and all methods listed in Sections 60.534 and 60.5476. PFS-TECO holds EPA Accreditation Certificate Numbers 4 and 4M (mobile). PFS-TECO is accredited by IAS to ISO 17020:2012 "Criteria for Bodies Performing Inspections", and ISO 17025:2017 "Requirements for Testing Laboratories." PFS-TECO is also accredited by Standards Council of Canada to ISO 17065:2012 "Requirements for Bodies Operating Product Certification Systems."

The following people were associated with the testing, analysis and report writing associated with this project.



Aaron Kravitz, Testing Supervisor

Introduction

HHT contracted with PFS-TECO to perform EPA certification testing on the Aspen C3 Single Burn Rate Wood-Fired Room Heater. All testing was performed at PFS-TECO's Portland Laboratory. All testing was performed by Aaron Kravitz.

Notes

- Prior to start of testing, 50 hours of conditioning was performed by the manufacturer at a medium burn setting in accordance with ASTM E2780.
- Prior to start of testing, the dilution tunnel was cleaned with a steel brush.
- A separate, independent, third filter train was utilized to determine 1st hour emissions for all test runs.
- All filters and O-rings were weighed in pairs.
- A total of 2 test runs were completed on this single burn rate appliance. The burn rate from each test agrees within 10% of the average, meeting the requirements of a single burn rate appliance. All runs have been found to be appropriate, no anomalies occurred. See the Run Narrative section for further detail on each run.
- The test fuel configuration was altered due to loading difficulties. The firebox's nominal width is 10.25", which proved too constrictive to fit two 5" wide test fuel pieces side by side. Therefore, an alternate loading configuration, placing three of the four pieces on edge in accordance with ASTM E2780 §9.5.5.2, was utilized. See fuel photos in Appendix A for details.

Wood Heater Identification and Testing

- Appliance Tested: **Aspen C3**
- PFS Tracking Number: **186**
- Manufacturer: **Hearth And Home Technologies**
- Catalyst: **No**
- Heat exchange blower: **None**
- Type: **Wood Stove**
- Style: **Freestanding Single Burn Rate Wood Stove**
- Date Received: **Friday, March 15, 2024**
- Testing Period – Start: **Tuesday, March 26, 2024**
Finish: **Wednesday, March 27, 2024**
- Test Location: **PFS TECO**
11785 SE Hwy 212
Clackamas, OR 97015
- Elevation: **~131 Feet above sea level**
- Test Technician(s): **Aaron Kravitz**
- Observers: **Douglas Fongeallaz of HHT**

Test Procedures and Equipment

All Sampling and analytical procedures were performed by Aaron Kravitz. All procedures used are directly from ASTM E2780 and ASTM E2515. See the list below for equipment used. See Appendix C submitted with this report for calibration data.

Equipment List:

Equipment ID#	Equipment Description
50	Digiweigh DWP12i Platform Scale
53	APEX XC-60-ED Digital Emissions Sampling Box A
54	APEX XC-60-ED Digital Emissions Sampling Box B
203	APEX XC-50-DIR Digital Emissions Sampling Box C
55	Apex Ambient Air Sample Box
57	California Analytical ZRE CO2/CO/O2 IR ANALYZER
94	Moisture meter calibration block
95	Anemometer
97	10 lb audit weight
107	Sartorius Analytical Balance
109A/B	Troemner 100mg/200mg Audit Weights
111	Dwyer 1430 Microtector
115	Delmhorst Wood Moisture Meter
189	Mettler 3'x3' floor scale w/digital weight indicator
207	Dewalt Tape Measure
208	Digital Calipers
215	Temperature Logger
CC505834	Gas Analyzer Calibration Span Gas
SG9199309	Gas Analyzer Calibration Mid Gas

Barometric Pressure data was taken from a local National Weather Service station, corrected for altitude differences in accordance with ASTM E2515 6.1.2.

Results

A total of 2 test runs were performed on the Aspen C3. The average emissions rate for the 2 run test series was measured to be **1.8 g/hr** with a Higher Heating Value efficiency of **71%**. The average CO emission rate for the 2 tests was **1.6 g/min**. The HHT Aspen C3 meets the 2020 cribwood PM emission standard of ≤ 2.0 g/hr per CFR 40 part 60, §60.532 (b).

Detailed individual run data can be found in Appendix A submitted with this report.

Summary Table

Date	3/26/2024	3/27/2024
Run Number	1	2
Emission Rate (g/hr)	1.67	1.85
Burn Rate (kg/hr)	1.94	1.73
Heat Output (Btu/hr)	25,549	22,960
Overall Efficiency (% HHV)	71%	72%
CO Emissions (g/MJ Output)	3.88	3.43
CO Emissions (g/kg Dry Fuel)	54.44	48.66
CO Emissions (g/min)	1.74	1.38
Emissions – 1 st hr (g/hr)	2.84	3.66
Particulate emission average of 2 test runs: 1.8 grams per hour.		
Average HHV efficiency of 2 test runs: 71%.		
Average CO Emissions Rate: 1.6 g/min		

Test Run Narrative

Run 1

Run 1 was performed on 3/26/2024 as a single burn rate appliance, per EPA Method 28R. The total test time was 111 minutes. The particulate emissions rate for the test was 1.67 g/hr, the burn rate was 1.94 kg/hr with an HHV efficiency of 70.9%. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

Run 2

Run 2 was performed on 3/27/2024 as a single burn rate appliance, per EPA Method 28R. The total test time was 126 minutes. The particulate emissions rate for the test was 1.85 g/hr, the burn rate was 1.73 kg/hr with an HHV efficiency of 71.6%. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

Test Conditions Summary

Testing conditions for all runs fell within allowable specifications of the ASTM 2780 and ASTM E2515. A summary of facility conditions, fuel burned, and run times is listed below.

Run	Ambient (°F)		Relative Humidity (%)		Average Barometric Pressure (In. Hg.)	Preburn Fuel Weight (lbs)	Test Fuel Weight (lbs)	Test Fuel Moisture (%DB)	Test Run Time (Min)
	Pre	Post	Pre	Post					
1	66.3	67.5	39.8	35.6	29.94	9.5	9.41	20.3	111
2	66.2	66.5	44.0	40.6	29.61	11.0	9.55	20.9	126

Appliance Operation and Test Settings

The appliance was operated according to procedures as described in the Operations Manual, found in Appendix B submitted with this report. Detailed run information can be found in Appendix A submitted with this report.

Settings & Run Notes

	Pre-Burn Air Setting	Test Run Air and Fan Settings
Run 1	N/A – Single burn rate appliance has no air control	N/A – Single burn rate appliance has no air control
Run 2	N/A – Single burn rate appliance has no air control	N/A – Single burn rate appliance has no air control

Appliance Description

Model(s): Aspen C3

Appliance Type: Single Burn Rate Wood-Fired Room Heater

Total/Usable Firebox Volume: 1.25 ft³, the total firebox volume and usable firebox volume are the same for this appliance.

Additional Models: None

Air Introduction System: Combustion air enters the appliance through a round opening in the firebox back. Air is channeled to secondary air ports located at the rear of the baffle system, and to air ports directed at the glass for an air wash system.

Combustion Control System: Primary air is controlled by a Bi-metallic spring thermostat located at the rear of the stove inside the outside air collar. As the appliance heats it causes the spring to expand and lower a plate over the combustion air opening. The spring assembly is not accessible to tampering, no user controls are offered that could alter the burn rate.

Baffles: A C-Cast baffle is located at the top of the fire chamber, it is located so flames must travel to the front of the fire chamber around the front edge of the baffle.

Catalytic Combustor: N/A

Refractory Insulation: The firebox is lined with 1.25" thick high-density firebrick.

Flue Outlet: 6-inch exhaust outlet located on the top of the appliance.

Fan: None

Appliance design drawings can be found in Appendix D submitted with the CBI copy of this report.

Firebox Volume Dimension

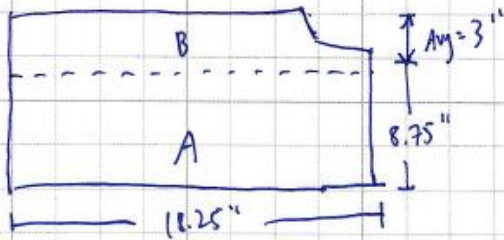
Total Firebox Volume = Usable Firebox Volume

PROJECT: 24-281

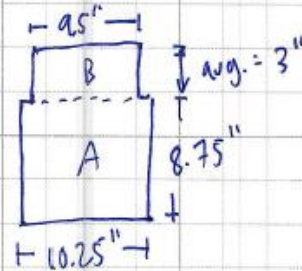
DATE: 4/8/24

FB Volume

Side View:



Front View:



$$A = 18.25 \times 8.75 \times 10.25 = 0.95 \text{ ft}^3$$

$$B = 9.5 \times 3 \times 18.25 = \underline{0.30 \text{ ft}^3}$$

$$\text{total} = 1.25 \text{ ft}^3$$

Appliance Front



Appliance Left



Appliance Right



Appliance Rear



Test Fuel Properties

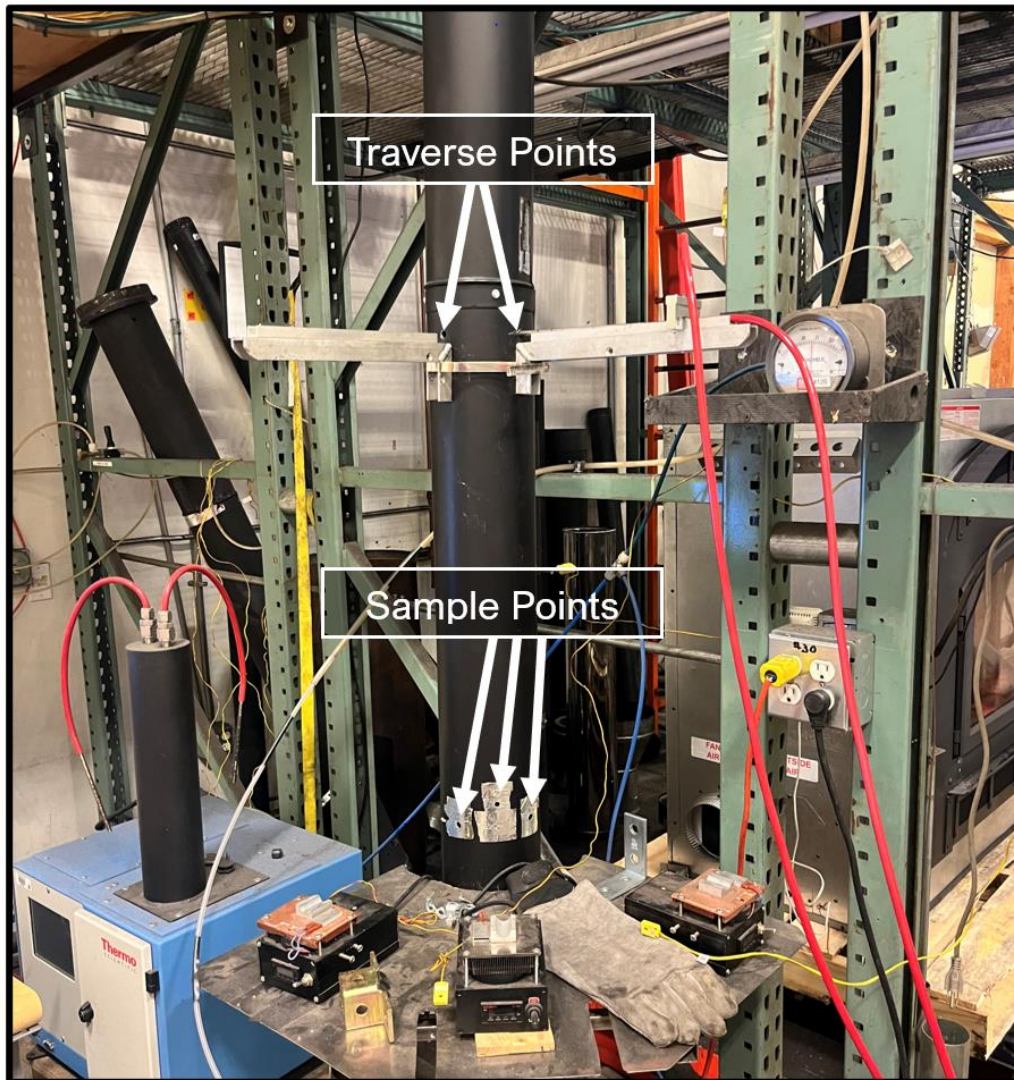
Test fuel used was Douglas Fir dimensional lumber, air-dried to the specified moisture content range. A typical fuel load is pictured below:

Typical Fuel Load



Sampling Locations and Descriptions

Sample ports are located 14 feet downstream from any disturbances and 2 feet upstream from any disturbances. Flow rate traverse data was collected 12 feet downstream from any disturbances and 4 feet upstream from any disturbances. (See below).



Sampling Methods

ASTM E2515 was used in collecting particulate samples. The dilution tunnel is 6 inches in diameter. All sampling conditions per ASTM E2515 were followed. No alternate procedures were used.

Analytical Methods Description

All sample recovery and analysis procedures followed ASTM E2515 procedures. At the end of each test run, filters, O-Rings and probes were removed from their housings, desiccated for a minimum of 24 hours, and then weighed at 6 hour intervals to a constant weight per ASTM E2515-11 Section 10. .

Calibration, Quality Control and Assurances

Calibration procedures and results were conducted per EPA Method 28R and ASTM E2515-11. Test method quality control procedures (leak checks, volume meter checks, stratification checks, proportionality results) followed the procedures outlined. All leak check data can be found on the Quality systems check page for each run performed in Appendix A of the report.

Appliance Sealing and Storage

Upon completion of testing, the appliance was secured with metal strapping and the seal below was applied, the appliance was then returned to the manufacturer's location at: 1915 West Saunders Street Mt Pleasant IA, 52641, for archival.

Sealing Label

ATTENTION:

THIS SEAL IS NOT TO BE BROKEN WITHOUT PRIOR AUTHORIZATION FROM THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.

THIS APPLIANCE HAS BEEN SEALED IN ACCORDANCE WITH REQUIREMENTS OF 40CFR
PART 60 SUBPART AAA §60.535 (a)(2)(vii)

REPORT # _____

DATE SEALED _____

MANUFACTURER _____

MODEL # _____

Sealed Unit



List of Appendices

The following appendices have been submitted electronically in conjunction with this report:

Appendix A – Test Run Data, Technician Notes, and Sample Analysis

Appendix B – Labels and Manuals

Appendix C – Equipment Calibration Records

Appendix D – Design Drawings (CBI Report Only)

Appendix E – Manufacturer QAP (CBI Report Only)

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 1 Data Summary

Client:	HHT
Model:	Aspen C3
Job #:	24-281
Tracking #:	186
Test Date:	3/26/2024



Technician Signature

4/19/2024

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 1

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/26/2024

Burn Rate (kg/hr):	1.94
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	9.090	20.139	19.375	8.473
Average Gas Velocity in Dilution Tunnel (ft/sec)	18.9			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	12387.5			
Average Gas Meter Temperature (°F)	67.6	80.0	81.8	80.9
Total Sample Volume (dscf)	9.216	19.937	19.122	8.325
Average Tunnel Temperature (°F)	99.5			
Total Time of Test (min)	111			
Total Particulate Catch (mg)	0.1	3.0	2.7	2.0
Particulate Concentration, dry-standard (g/dscf)	0.0000109	0.0001505	0.0001412	0.0002402
Total PM Emissions (g)	0.25	3.20	2.99	2.84
Particulate Emission Rate (g/hr)	0.13	1.73	1.61	2.84
Emissions Factor (g/kg)	-	0.89	0.83	-
Difference from Average Total Particulate Emissions (g)	-	0.11	0.11	-
Difference from Average Total Particulate Emissions (%)	-	3.4%	3.4%	-
Difference from Average Emissions Factor (g/kg)	-	0.03	0.03	-

Final Average Results	
Total Particulate Emissions (g)	3.09
Particulate Emission Rate (g/hr)	1.67
Emissions Factor (g/kg)	0.86
HHV Efficiency (%)	70.9%
LHV Efficiency (%)	76.6%
CO Emissions (g/min)	1.74

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	79.8	OK
Face Velocity	< 30 ft/min	10.1	OK
Leakage Rate	Less than 4% of average sample rate	0 cfm	OK
Ambient Temp	55-90 °F	Min:66.3/Max:68.4	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	26.8	OK

B415.1 Efficiency Results

Manufacturer: HHT
Model: Aspen C3
Date: 03/26/24
Run: 1
Control #: 24-281
Test Duration: 111
Output Category: 4

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	70.9%	76.6%
Combustion Efficiency	96.1%	96.1%
Heat Transfer Efficiency	73.7%	79.7%

Output Rate (kJ/h)	26,933	25,549	(Btu/h)
Burn Rate (kg/h)	1.92	4.23	(lb/h)
Input (kJ/h)	37,993	36,041	(Btu/h)

Test Load Weight (dry kg)	3.55	7.82	dry lb
MC wet (%)	16.90		
MC dry (%)	20.33		
Particulate (g)	3.09		
CO (g)	193		
Test Duration (h)	1.85		

Emissions	Particulate	CO
g/MJ Output	0.06	3.88
g/kg Dry Fuel	0.87	54.44
g/h	1.67	104.42
g/min	0.03	1.74
lb/MM Btu Output	0.14	9.01

Air/Fuel Ratio (A/F)	10.51
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VERSION:

2.4

4/15/2010

WOODSTOVE FUEL DATA - ASTM E2780

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	19.4				
2x4	16.00	19.9				
2x4	16.00	20.0				
2x4	16.00	20.8				
2x4	16.00	19.1				
2x4	16.00	20.4				
Total Fuel Weight (lbs):		9.52	Average Moisture (%DB):		19.9	

Firebox Volume (ft³): 1.25
 Total 2x4 Crib Weight, with spacers (lbs): 9.41
 Total 4x4 Crib Weight, with spacers (lbs): 0.00
 Total Wet Fuel Weight, with spacers (lbs): 9.41

Coal Bed Range (20-25%):

Min (lbs): 1.88
 Max (lbs): 2.35

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	16.75	1.85	20.2	23.4	21.9	1.52
2x4	16.75	1.87	19.1	22.6	20.4	1.55
2x4	16.75	1.98	19.1	19.4	19.4	1.66
2x4	16.75	2.07	19.5	19.9	19.1	1.73
Total Dry Weight, no spacers (lbs):						6.46
Total Dry Weight, with spacers (lbs):						7.92

Spacer Moisture Readings (%DB)							
12.4	13.8						
14.0	14.2						
10.9	12.0						
11.3	13.3						
10.4	10.6						
10.1	13.2						
13.3	14.3						
14.2	10.9						

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	31.7	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	7.53	OK
2x4 Fuel Mix	35 - 65 % of total weight	N/A	N/A

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: HHT
 Model: Aspen C3
 Run #: 1
 Test Start Time: 10:32

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Total Sampling Time (min): 111
 Recording Interval (min): 1

Meter Box γ Factor: 1.004 (A)
 Meter Box γ Factor: 1.005 (B)
 Meter Box γ Factor: 1.004 (C)
 Meter Box γ Factor: 1.013 (Ambient)

Induced Draft Check (in. H₂O): 0
 Smoke Capture Check (%): 100%
 Date Flue Pipe Last Cleaned: 3/25/2024
 Test Fuel Scale Audit (lbs): 10.00
 Platform Scale Audit (lbs): 10.0

	Pre-Test	Post Test	Avg.
Barometric Pressure (in. Hg)	29.93	29.94	29.94
Relative Humidity (%)	39.8	35.6	
Room Air Velocity (ft/min)	<50	<50	
Pitot Tube Leak Check	0	0	
Ambient Sample Volume:		9.090	ft ³

Sample Train Leak Checks

	Pre-test	Post-test		
(A)	0.000	0.000	cfm @	-6 in. Hg
(B)	0.000	0.000	cfm @	-7 in. Hg
(C)	0.000	0.000	cfm @	-6 in. Hg
(Ambient)	0.000	0.000	cfm @	-12 in. Hg

DILUTION TUNNEL FLOW

Traverse Data

Point	dP (in H ₂ O)	Temp (°F)
1	0.054	69
2	0.082	69
3	0.088	69
4	0.076	69
5	0.064	69
6	0.084	69
7	0.088	69
8	0.070	69
Center	0.088	69

Dilution Tunnel H₂O: 2.00 percent

Tunnel Diameter: 6 inches

Pitot Tube Cp: 0.99 [unitless]

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

Dilution Tunnel MW(wet): 28.78 lb/lb-mole

Tunnel Area: 0.1963 ft²

V_{strav}: 18.20 ft/sec

V_{scent}: 19.68 ft/sec

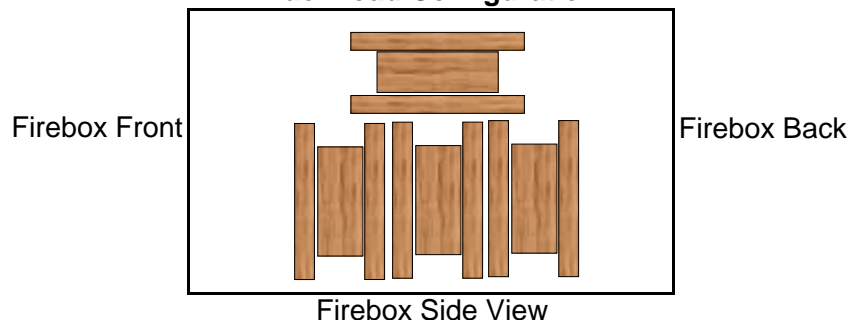
F_p: 0.925 [ratio]

Initial Tunnel Flow: 209.8 scf/min

Static Pressure: -0.140 in. H₂O

TEST FUEL PROPERTIES

Fuel Load Configuration



Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	20.3

WOODSTOVE PREBURN DATA - ASTM E2780

Client: HHT

Model: Aspen C3

Run #: 1

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/26/2024

Recording Interval (min): 1
Run Time (min): 89

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	9.21	-0.096	231	248	135	783	98	299.1	535	65
1	9.09	-0.095	235	257	135	745	100	294.1	505	65
2	8.99	-0.092	238	265	134	710	102	289.8	477	65
3	8.89	-0.088	241	272	133	672	105	284.5	442	65
4	8.80	-0.085	244	277	132	637	107	279.4	423	65
5	8.71	-0.085	247	282	131	607	109	275.1	410	65
6	8.61	-0.085	250	286	129	586	111	272.4	410	65
7	8.51	-0.089	252	289	128	575	113	271.4	422	65
8	8.42	-0.089	253	292	127	579	115	273.2	442	65
9	8.31	-0.093	255	294	126	592	117	276.8	465	65
10	8.21	-0.096	257	295	125	615	119	281.9	489	65
11	8.08	-0.098	258	296	124	641	120	287.7	514	65
12	7.96	-0.099	260	296	123	657	122	291.6	526	65
13	7.85	-0.099	261	296	122	670	124	294.7	528	65
14	7.73	-0.098	263	297	122	677	125	296.7	529	65
15	7.62	-0.098	264	297	121	688	126	299.4	534	65
16	7.50	-0.100	266	297	121	700	128	302.4	536	65
17	7.37	-0.099	268	298	120	712	129	305.5	545	65
18	7.23	-0.100	270	299	120	732	130	310.1	550	65
19	7.10	-0.101	272	300	120	748	132	314.1	553	65
20	6.97	-0.101	274	301	120	762	133	317.9	564	65
21	6.83	-0.104	276	302	121	789	134	324.2	583	65
22	6.70	-0.101	279	304	121	808	135	329.3	581	66
23	6.57	-0.102	282	305	122	820	136	333.0	579	66
24	6.44	-0.102	285	307	123	827	137	335.9	571	66
25	6.30	-0.102	287	310	124	829	138	337.7	566	66
26	6.18	-0.099	291	312	125	828	139	338.9	563	66
27	6.07	-0.099	294	314	127	820	140	338.7	553	66
28	5.96	-0.097	297	316	128	814	141	339.1	549	66
29	5.85	-0.100	300	319	130	811	142	340.2	546	66
30	5.75	-0.098	303	322	132	805	143	340.8	535	66
31	5.65	-0.096	306	324	134	795	144	340.4	525	66
32	5.57	-0.093	308	326	136	782	144	339.3	512	66
33	5.48	-0.094	312	328	138	762	145	337.1	499	66
34	5.40	-0.091	314	331	140	746	146	335.3	488	66
35	5.33	-0.091	317	333	142	731	146	333.7	482	66
36	5.25	-0.090	319	335	144	717	147	332.3	475	66
37	5.17	-0.090	322	336	146	702	147	330.8	467	66
38	5.11	-0.088	324	338	148	688	148	329.3	460	66
39	5.03	-0.087	327	340	149	677	149	328.2	454	66
40	4.97	-0.087	329	341	151	667	149	327.4	450	66
41	4.89	-0.087	331	343	152	658	150	326.9	443	66
42	4.82	-0.087	333	344	154	650	151	326.3	441	66
43	4.75	-0.085	335	346	155	645	151	326.4	436	66
44	4.68	-0.086	337	348	157	639	152	326.3	436	66

WOODSTOVE PREBURN DATA - ASTM E2780

Client: HHT

Model: Aspen C3

Run #: 1

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/26/2024

Recording Interval (min): 1
Run Time (min): 89

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
45	4.61	-0.086	340	349	158	634	153	326.8	432	66
46	4.55	-0.085	341	351	159	632	153	327.3	433	66
47	4.48	-0.086	343	353	161	631	154	328.3	435	66
48	4.42	-0.084	345	355	162	629	155	329.2	435	66
49	4.33	-0.087	347	356	164	626	156	329.7	428	66
50	4.28	-0.082	349	358	166	621	157	330.0	422	66
51	4.23	-0.081	350	360	167	614	157	329.6	415	66
52	4.17	-0.081	352	361	168	606	158	329.0	409	66
53	4.11	-0.082	353	362	170	600	160	329.0	407	66
54	4.04	-0.083	354	363	172	600	161	329.7	416	66
55	3.97	-0.082	355	364	173	602	162	331.1	423	67
56	3.91	-0.081	356	366	174	603	163	332.3	419	67
57	3.83	-0.084	356	366	175	603	164	332.9	415	66
58	3.77	-0.083	357	367	177	602	165	333.6	414	66
59	3.70	-0.081	357	369	178	602	166	334.4	414	66
60	3.64	-0.083	358	370	179	601	168	335.1	414	66
61	3.57	-0.082	359	371	181	601	169	336.1	416	66
62	3.52	-0.082	359	373	182	599	170	336.6	413	66
63	3.45	-0.082	360	373	184	595	172	336.6	407	67
64	3.38	-0.079	360	375	185	589	173	336.5	402	66
65	3.33	-0.080	361	376	186	587	175	336.8	399	66
66	3.28	-0.079	361	377	187	583	177	337.1	397	66
67	3.21	-0.080	362	379	188	580	178	337.5	397	67
68	3.14	-0.082	362	379	190	579	180	337.9	399	67
69	3.08	-0.081	363	381	191	580	182	339.3	399	66
70	3.04	-0.078	363	382	192	579	184	340.0	396	67
71	2.99	-0.074	364	383	193	574	186	339.9	383	66
72	2.94	-0.076	364	384	195	566	187	339.2	379	66
73	2.89	-0.076	365	385	196	560	189	338.8	373	66
74	2.84	-0.077	365	386	197	554	191	338.6	372	66
75	2.80	-0.073	365	386	198	549	193	338.3	371	66
76	2.74	-0.077	365	386	200	547	195	338.7	372	67
77	2.71	-0.073	365	386	201	544	197	338.7	368	67
78	2.66	-0.074	366	386	203	539	199	338.4	363	67
79	2.61	-0.070	366	386	205	533	201	337.9	355	66
80	2.57	-0.072	366	385	207	525	202	336.9	350	66
81	2.54	-0.071	366	385	208	519	204	336.4	347	66
82	2.50	-0.071	366	385	210	513	206	335.8	341	66
83	2.44	-0.069	366	384	212	508	207	335.4	342	66
84	2.41	-0.072	366	383	213	506	209	335.5	343	66
85	2.36	-0.072	366	383	215	503	211	335.6	344	66
86	2.32	-0.071	367	382	217	502	212	336.0	345	66
87	2.27	-0.070	367	382	219	502	214	336.7	346	67
88	2.23	-0.074	367	381	221	502	216	337.3	347	66
89	2.19	-0.071	368	382	223	502	217	338.1	348	67

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.088	2.90	69	1.1		9.41		99	336	70	66
1	0.117	0.117	0.088	2.90	69	1.1	-	9.24	-0.17	104	343	71	66
2	0.282	0.165	0.088	2.96	69	1.1	-	9.09	-0.15	105	437	72	67
3	0.450	0.168	0.090	3.01	69	1.1	-	8.97	-0.12	110	499	72	66
4	0.621	0.171	0.089	3.04	69	1.1	-	8.77	-0.20	116	627	74	67
5	0.794	0.173	0.089	3.06	69	1.1	-	8.57	-0.20	124	637	74	67
6	0.964	0.170	0.091	3.09	69	1.1	-	8.41	-0.16	113	556	74	67
7	1.139	0.175	0.093	3.13	69	1.1	-	8.26	-0.15	108	555	74	67
8	1.312	0.173	0.090	3.14	70	1.1	-	8.10	-0.16	105	563	74	67
9	1.482	0.170	0.094	3.16	70	1.1	-	7.93	-0.17	104	575	74	67
10	1.656	0.174	0.090	3.19	70	1.1	94	7.75	-0.18	104	588	75	67
11	1.833	0.177	0.089	3.21	70	1.2	-	7.59	-0.16	105	599	75	67
12	2.007	0.174	0.090	3.22	70	1.1	-	7.41	-0.18	105	607	75	67
13	2.180	0.173	0.091	3.24	71	1.2	-	7.24	-0.17	107	615	76	67
14	2.356	0.176	0.091	3.24	71	1.1	-	7.05	-0.19	108	629	76	67
15	2.538	0.182	0.091	3.27	71	1.2	-	6.85	-0.20	108	639	76	67
16	2.711	0.173	0.093	3.26	71	1.2	-	6.66	-0.19	109	645	76	67
17	2.886	0.175	0.091	3.28	72	1.1	-	6.49	-0.17	109	649	77	67
18	3.062	0.176	0.088	3.29	72	1.2	-	6.29	-0.20	110	650	77	67
19	3.240	0.178	0.089	3.29	72	1.2	-	6.10	-0.19	111	652	77	67
20	3.419	0.179	0.090	3.29	72	1.1	100	5.91	-0.19	112	654	77	67
21	3.595	0.176	0.092	3.30	73	1.2	-	5.72	-0.19	112	657	77	68
22	3.771	0.176	0.092	3.31	73	1.2	-	5.53	-0.19	113	655	78	68
23	3.952	0.181	0.091	3.32	73	1.2	-	5.33	-0.20	113	664	78	68
24	4.132	0.180	0.091	3.32	73	1.2	-	5.15	-0.18	113	650	78	68
25	4.312	0.180	0.092	3.33	74	1.2	-	4.99	-0.16	112	636	78	68
26	4.487	0.175	0.093	3.33	74	1.2	-	4.82	-0.17	111	629	78	68
27	4.666	0.179	0.093	3.34	74	1.2	-	4.66	-0.16	111	623	78	68
28	4.847	0.181	0.090	3.35	75	1.2	-	4.50	-0.16	111	626	79	68
29	5.029	0.182	0.092	3.36	75	1.2	-	4.35	-0.15	111	626	79	68
30	5.209	0.180	0.092	3.36	75	1.2	100	4.20	-0.15	111	628	79	68
31	5.386	0.177	0.091	3.37	76	1.2	-	4.05	-0.15	112	629	79	68

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
32	5.565	0.179	0.091	3.37	76	1.2	-	3.89	-0.16	111	632	79	68
33	5.747	0.182	0.093	3.38	76	1.2	-	3.75	-0.14	111	630	79	68
34	5.930	0.183	0.092	3.39	76	1.2	-	3.61	-0.14	110	623	79	68
35	6.111	0.181	0.092	3.39	77	1.2	-	3.46	-0.15	110	612	79	68
36	6.288	0.177	0.093	3.37	77	1.2	-	3.33	-0.13	110	605	79	68
37	6.467	0.179	0.094	3.39	77	1.2	-	3.21	-0.12	109	597	79	68
38	6.651	0.184	0.093	3.40	78	1.2	-	3.09	-0.12	109	589	79	68
39	6.834	0.183	0.093	3.41	78	1.2	-	2.97	-0.12	109	583	79	68
40	7.015	0.181	0.091	3.40	78	1.2	100	2.85	-0.12	108	576	79	68
41	7.195	0.180	0.093	3.41	78	1.2	-	2.74	-0.11	108	568	79	68
42	7.376	0.181	0.091	3.42	79	1.2	-	2.64	-0.10	108	559	79	68
43	7.560	0.184	0.090	3.42	79	1.2	-	2.54	-0.10	107	549	79	68
44	7.741	0.181	0.090	3.42	79	1.2	-	2.44	-0.10	106	539	79	68
45	7.924	0.183	0.090	3.42	79	1.2	-	2.34	-0.10	106	531	79	68
46	8.106	0.182	0.091	3.43	80	1.2	-	2.25	-0.09	105	522	79	68
47	8.286	0.180	0.094	3.43	80	1.2	-	2.17	-0.08	105	513	79	68
48	8.467	0.181	0.092	3.42	80	1.2	-	2.08	-0.09	104	508	79	68
49	8.652	0.185	0.090	3.45	80	1.2	-	2.00	-0.08	104	501	79	68
50	8.835	0.183	0.093	3.45	81	1.2	100	1.93	-0.07	104	495	79	68
51	9.018	0.183	0.094	3.45	81	1.2	-	1.86	-0.07	103	486	79	68
52	9.202	0.184	0.093	3.45	81	1.2	-	1.80	-0.06	103	476	79	68
53	9.382	0.180	0.093	3.46	81	1.2	-	1.74	-0.06	102	463	79	68
54	9.564	0.182	0.091	3.45	81	1.2	-	1.67	-0.07	101	452	79	68
55	9.750	0.186	0.093	3.46	82	1.2	-	1.62	-0.05	100	440	79	68
56	9.934	0.184	0.092	3.47	82	1.2	-	1.58	-0.04	99	430	78	68
57	10.118	0.184	0.089	3.46	82	1.2	-	1.53	-0.05	99	421	78	68
58	10.302	0.184	0.090	3.47	82	1.2	-	1.48	-0.05	98	415	78	68
59	10.483	0.181	0.089	3.46	82	1.2	-	1.43	-0.05	98	409	78	68
60	10.666	0.183	0.090	3.46	83	1.2	100	1.38	-0.05	97	402	78	68
61	10.852	0.186	0.091	3.48	83	1.2	-	1.35	-0.03	97	397	78	68
62	11.037	0.185	0.091	3.47	83	1.2	-	1.30	-0.05	96	392	78	68
63	11.222	0.185	0.091	3.47	83	1.2	-	1.27	-0.03	95	387	78	68

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
64	11.407	0.185	0.090	3.48	83	1.2	-	1.23	-0.04	95	382	78	68
65	11.588	0.181	0.090	3.49	83	1.2	-	1.18	-0.05	95	380	77	68
66	11.773	0.185	0.090	3.49	84	1.2	-	1.15	-0.03	95	375	77	68
67	11.960	0.187	0.089	3.48	84	1.2	-	1.12	-0.03	94	369	77	68
68	12.142	0.182	0.091	3.48	84	1.3	-	1.07	-0.05	94	365	77	68
69	12.330	0.188	0.089	3.49	84	1.2	-	1.05	-0.02	93	361	77	68
70	12.514	0.184	0.091	3.49	84	1.2	101	1.02	-0.03	93	357	77	68
71	12.699	0.185	0.090	3.50	84	1.2	-	1.00	-0.02	92	354	77	68
72	12.881	0.182	0.091	3.50	84	1.2	-	0.97	-0.03	92	350	77	68
73	13.065	0.184	0.088	3.50	85	1.2	-	0.93	-0.04	92	346	77	68
74	13.253	0.188	0.088	3.50	85	1.2	-	0.91	-0.02	92	343	77	68
75	13.438	0.185	0.088	3.49	85	1.2	-	0.88	-0.03	91	342	76	68
76	13.625	0.187	0.089	3.50	85	1.2	-	0.86	-0.02	91	342	76	68
77	13.810	0.185	0.088	3.50	85	1.2	-	0.82	-0.04	91	339	76	68
78	13.995	0.185	0.089	3.49	85	1.3	-	0.79	-0.03	91	341	76	68
79	14.179	0.184	0.090	3.52	85	1.2	-	0.77	-0.02	91	339	76	68
80	14.363	0.184	0.088	3.49	85	1.2	101	0.74	-0.03	90	338	76	68
81	14.550	0.187	0.088	3.50	86	1.2	-	0.71	-0.03	90	337	76	68
82	14.736	0.186	0.089	3.51	86	1.2	-	0.68	-0.03	90	333	76	68
83	14.924	0.188	0.090	3.50	86	1.2	-	0.66	-0.02	90	333	76	67
84	15.108	0.184	0.089	3.50	86	1.2	-	0.63	-0.03	90	332	76	68
85	15.294	0.186	0.086	3.50	86	1.2	-	0.60	-0.03	90	330	76	68
86	15.478	0.184	0.087	3.51	86	1.2	-	0.58	-0.02	90	329	76	67
87	15.662	0.184	0.090	3.51	86	1.2	-	0.55	-0.03	89	328	76	68
88	15.851	0.189	0.089	3.51	86	1.2	-	0.52	-0.03	89	327	76	68
89	16.036	0.185	0.090	3.51	86	1.2	-	0.51	-0.01	89	326	76	68
90	16.225	0.189	0.088	3.50	86	1.2	102	0.47	-0.04	89	324	76	68
91	16.410	0.185	0.088	3.52	86	1.2	-	0.45	-0.02	89	324	76	68
92	16.597	0.187	0.088	3.51	87	1.2	-	0.42	-0.03	89	323	76	68
93	16.780	0.183	0.089	3.52	87	1.2	-	0.40	-0.02	89	321	75	68
94	16.966	0.186	0.089	3.52	87	1.2	-	0.36	-0.04	89	318	75	68
95	17.153	0.187	0.089	3.52	87	1.2	-	0.34	-0.02	88	317	75	68

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHTJob #: 24-281Model: Aspen C3Tracking #: 186Run #: 1Technician: AKDate: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
96	17.340	0.187	0.091	3.52	87	1.2	-	0.33	-0.01	88	316	75	68
97	17.528	0.188	0.090	3.52	87	1.2	-	0.29	-0.04	88	313	75	68
98	17.714	0.186	0.090	3.51	87	1.2	-	0.29	0.00	88	312	75	68
99	17.902	0.188	0.089	3.53	87	1.2	-	0.26	-0.03	88	312	75	68
100	18.085	0.183	0.089	3.52	87	1.3	101	0.23	-0.03	88	310	75	68
101	18.272	0.187	0.089	3.52	87	1.2	-	0.21	-0.02	87	310	75	68
102	18.457	0.185	0.088	3.52	87	1.2	-	0.20	-0.01	87	309	75	68
103	18.645	0.188	0.088	3.52	87	1.2	-	0.17	-0.03	87	307	75	67
104	18.832	0.187	0.088	3.54	87	1.2	-	0.15	-0.02	87	306	75	67
105	19.021	0.189	0.087	3.53	87	1.2	-	0.12	-0.03	87	305	75	68
106	19.206	0.185	0.089	3.53	87	1.2	-	0.10	-0.02	87	304	75	67
107	19.393	0.187	0.087	3.53	87	1.2	-	0.07	-0.03	87	304	75	68
108	19.577	0.184	0.088	3.53	88	1.2	-	0.06	-0.01	87	302	75	67
109	19.764	0.187	0.088	3.52	88	1.2	-	0.04	-0.02	87	302	75	68
110	19.951	0.187	0.088	3.53	88	1.2	101	0.01	-0.03	87	300	75	68
111	20.139	0.188	0.087	3.53	88	1.2	102	0.00	-0.01	87	300	75	68
Avg/Tot	20.139	0.181	0.090	3.40	80.0	1.2	100			99.5	457.2	76.6	67.6

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.000		0.04	70	0.9		71	-0.079	7.02	0.047
1	0.159	0.159	3.08	70	1.4	-	71	-0.079	4.08	0.265
2	0.327	0.168	3.09	70	2.1	-	71	-0.091	3.77	0.790
3	0.498	0.171	3.09	70	1.5	-	71	-0.097	4.72	0.550
4	0.669	0.171	3.09	70	1.7	-	71	-0.115	8.03	0.524
5	0.837	0.168	3.09	70	2.0	-	74	-0.101	9.23	0.243
6	1.006	0.169	3.08	70	2.1	-	74	-0.099	13.26	0.720
7	1.177	0.171	3.09	70	1.7	-	74	-0.102	13.61	0.544
8	1.348	0.171	3.09	70	2.0	-	75	-0.103	14.46	0.596
9	1.517	0.169	3.09	70	1.7	-	75	-0.103	14.73	0.575
10	1.685	0.168	3.08	70	1.6	100	75	-0.106	15.30	0.595
11	1.857	0.172	3.09	70	2.0	-	75	-0.105	15.42	0.657
12	2.028	0.171	3.08	70	1.9	-	76	-0.106	15.45	0.509
13	2.197	0.169	3.10	70	1.8	-	76	-0.107	15.80	0.653
14	2.369	0.172	3.10	70	2.1	-	76	-0.110	16.14	0.925
15	2.544	0.175	3.10	71	2.2	-	77	-0.109	16.30	1.091
16	2.711	0.167	3.10	71	1.7	-	77	-0.109	16.29	1.209
17	2.879	0.168	3.10	71	1.7	-	77	-0.109	16.07	1.032
18	3.051	0.172	3.10	71	2.2	-	77	-0.107	16.18	0.983
19	3.223	0.172	3.10	72	1.7	-	78	-0.108	16.26	1.026
20	3.392	0.169	3.10	72	1.7	101	78	-0.109	16.34	1.034
21	3.564	0.172	3.10	72	1.7	-	78	-0.109	16.47	1.162
22	3.736	0.172	3.10	73	1.8	-	78	-0.109	16.56	1.198
23	3.909	0.173	3.11	73	1.7	-	78	-0.111	16.65	1.832
24	4.078	0.169	3.12	73	1.9	-	78	-0.109	16.30	0.955
25	4.251	0.173	3.12	73	1.7	-	79	-0.108	15.68	0.575
26	4.424	0.173	3.11	74	1.9	-	79	-0.106	15.32	0.433
27	4.595	0.171	3.12	74	1.9	-	79	-0.105	15.36	0.420
28	4.766	0.171	3.12	75	2.3	-	79	-0.106	15.57	0.446
29	4.939	0.173	3.13	75	1.9	-	79	-0.107	15.78	0.481
30	5.113	0.174	3.13	75	2.2	101	79	-0.107	15.83	0.524
31	5.284	0.171	3.13	75	1.7	-	79	-0.106	15.88	0.557

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
32	5.455	0.171	3.13	76	2.2	-	79	-0.106	15.94	0.563
33	5.629	0.174	3.13	76	1.7	-	79	-0.105	16.04	0.502
34	5.803	0.174	3.13	76	1.7	-	79	-0.104	15.82	0.407
35	5.973	0.170	3.13	77	1.7	-	80	-0.104	15.31	0.313
36	6.146	0.173	3.12	77	2.2	-	80	-0.104	14.93	0.292
37	6.320	0.174	3.12	78	1.7	-	80	-0.103	14.85	0.287
38	6.495	0.175	3.13	78	1.7	-	80	-0.102	14.55	0.257
39	6.666	0.171	3.12	78	2.2	-	80	-0.102	14.29	0.227
40	6.839	0.173	3.13	79	1.8	100	80	-0.100	14.15	0.215
41	7.014	0.175	3.13	79	2.0	-	80	-0.099	13.94	0.190
42	7.189	0.175	3.14	79	1.8	-	80	-0.099	13.63	0.186
43	7.365	0.176	3.14	80	2.2	-	80	-0.095	13.30	0.166
44	7.535	0.170	3.13	80	2.2	-	80	-0.096	13.04	0.159
45	7.710	0.175	3.14	80	1.7	-	80	-0.095	12.79	0.175
46	7.886	0.176	3.14	80	2.1	-	80	-0.094	12.53	0.171
47	8.059	0.173	3.15	81	2.1	-	80	-0.097	12.33	0.148
48	8.232	0.173	3.15	81	1.7	-	80	-0.093	12.23	0.153
49	8.408	0.176	3.16	81	1.9	-	80	-0.092	12.06	0.140
50	8.584	0.176	3.16	82	2.1	100	80	-0.091	11.93	0.119
51	8.757	0.173	3.16	82	2.1	-	80	-0.090	11.51	0.135
52	8.931	0.174	3.16	82	2.1	-	80	-0.089	10.99	0.156
53	9.107	0.176	3.15	83	1.7	-	79	-0.088	10.51	0.187
54	9.284	0.177	3.16	83	1.7	-	79	-0.085	10.09	0.242
55	9.459	0.175	3.17	83	1.7	-	79	-0.085	9.71	0.297
56	9.631	0.172	3.17	83	2.2	-	79	-0.084	9.36	0.377
57	9.807	0.176	3.16	84	2.0	-	79	-0.083	9.19	0.420
58	9.984	0.177	3.17	84	1.7	-	79	-0.081	9.19	0.383
59	10.160	0.176	3.17	84	1.9	-	79	-0.080	9.11	0.432
60	10.333	0.173	3.16	84	1.8	99	79	-0.079	9.03	0.441
61	10.509	0.176	3.17	85	2.2	-	79	-0.079	8.99	0.469
62	10.686	0.177	3.17	85	1.8	-	79	-0.078	8.95	0.494
63	10.863	0.177	3.18	85	2.1	-	79	-0.078	8.87	0.517

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
64	11.038	0.175	3.18	86	2.3	-	78	-0.077	8.79	0.521
65	11.213	0.175	3.18	86	2.2	-	78	-0.077	8.77	0.497
66	11.390	0.177	3.18	86	2.0	-	78	-0.076	8.70	0.507
67	11.569	0.179	3.18	86	2.2	-	78	-0.075	8.43	0.561
68	11.743	0.174	3.18	86	1.7	-	78	-0.073	8.26	0.617
69	11.918	0.175	3.19	87	1.7	-	78	-0.073	8.24	0.619
70	12.093	0.175	3.18	87	1.9	100	78	-0.073	8.14	0.641
71	12.272	0.179	3.19	87	2.2	-	78	-0.072	8.11	0.640
72	12.450	0.178	3.19	87	1.9	-	78	-0.070	8.15	0.639
73	12.625	0.175	3.19	87	2.0	-	78	-0.070	8.17	0.664
74	12.801	0.176	3.19	88	2.0	-	78	-0.071	8.24	0.646
75	12.978	0.177	3.20	88	1.7	-	78	-0.070	8.30	0.623
76	13.156	0.178	3.19	88	1.7	-	77	-0.070	8.26	0.634
77	13.333	0.177	3.20	88	2.0	-	77	-0.068	8.23	0.651
78	13.508	0.175	3.19	88	1.8	-	77	-0.070	8.43	0.597
79	13.685	0.177	3.19	89	1.7	-	77	-0.070	8.85	0.514
80	13.863	0.178	3.20	89	2.2	100	77	-0.067	8.81	0.530
81	14.042	0.179	3.20	89	1.9	-	77	-0.066	8.82	0.553
82	14.218	0.176	3.20	89	1.8	-	77	-0.068	8.85	0.551
83	14.393	0.175	3.20	89	1.8	-	77	-0.068	8.83	0.564
84	14.570	0.177	3.20	89	1.7	-	77	-0.066	8.82	0.567
85	14.749	0.179	3.20	89	1.7	-	77	-0.068	8.88	0.559
86	14.927	0.178	3.20	90	1.9	-	77	-0.067	8.91	0.549
87	15.104	0.177	3.20	90	2.0	-	77	-0.066	8.92	0.526
88	15.281	0.177	3.20	90	1.7	-	77	-0.067	8.90	0.546
89	15.458	0.177	3.20	90	1.8	-	77	-0.067	8.80	0.530
90	15.636	0.178	3.21	90	2.0	101	77	-0.065	8.81	0.555
91	15.814	0.178	3.20	90	1.9	-	77	-0.067	8.70	0.589
92	15.991	0.177	3.20	90	2.0	-	77	-0.065	8.74	0.593
93	16.168	0.177	3.20	91	2.2	-	77	-0.066	8.67	0.610
94	16.347	0.179	3.21	91	1.7	-	77	-0.065	8.24	0.678
95	16.525	0.178	3.21	91	1.8	-	77	-0.063	8.21	0.695

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
96	16.703	0.178	3.21	91	1.8	-	77	-0.065	8.20	0.706
97	16.879	0.176	3.21	91	2.2	-	77	-0.065	8.14	0.731
98	17.058	0.179	3.21	91	1.7	-	76	-0.065	8.14	0.736
99	17.237	0.179	3.21	91	2.2	-	76	-0.065	8.16	0.737
100	17.416	0.179	3.22	91	2.0	100	76	-0.065	8.17	0.742
101	17.593	0.177	3.22	91	1.7	-	76	-0.065	8.18	0.752
102	17.769	0.176	3.21	91	1.7	-	76	-0.063	8.17	0.772
103	17.948	0.179	3.21	92	2.1	-	76	-0.064	8.22	0.770
104	18.127	0.179	3.21	92	1.8	-	76	-0.062	8.20	0.777
105	18.307	0.180	3.22	92	1.7	-	76	-0.061	8.23	0.790
106	18.484	0.177	3.21	92	2.2	-	76	-0.061	8.23	0.800
107	18.660	0.176	3.21	92	1.7	-	76	-0.063	8.22	0.797
108	18.839	0.179	3.21	92	1.8	-	76	-0.062	8.18	0.796
109	19.018	0.179	3.22	92	1.8	-	76	-0.060	7.91	0.911
110	19.198	0.180	3.22	92	1.7	100	76	-0.061	7.86	0.952
111	19.375	0.177	3.21	92	2.2	100	76	-0.063	7.95	0.951
Avg/Tot	19.375	0.175	3.13	81.8	1.9	100	77.4	-0.085	11.05	0.570

BOX C TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 1

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data						
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)
0	0.000		0.90	74	1.1		70
1	0.112	0.112	0.92	74	1.6	-	70
2	0.248	0.136	0.93	74	1.7	-	71
3	0.385	0.137	0.92	74	1.6	-	71
4	0.521	0.136	0.93	74	1.7	-	71
5	0.657	0.136	0.93	74	1.6	-	72
6	0.794	0.137	0.94	74	1.7	-	72
7	0.931	0.137	0.94	75	1.7	-	72
8	1.068	0.137	0.95	75	1.5	-	72
9	1.206	0.138	0.94	75	1.6	-	72
10	1.344	0.138	0.95	76	1.6	97	73
11	1.483	0.139	0.96	76	1.6	-	73
12	1.621	0.138	0.95	76	1.7	-	73
13	1.761	0.140	0.96	76	1.8	-	73
14	1.900	0.139	0.96	77	1.7	-	74
15	2.041	0.141	0.96	77	1.8	-	74
16	2.179	0.138	0.96	77	1.6	-	74
17	2.317	0.138	0.95	77	1.6	-	74
18	2.458	0.141	0.97	77	1.6	-	74
19	2.597	0.139	0.96	78	1.8	-	75
20	2.735	0.138	0.96	78	1.8	100	75
21	2.876	0.141	0.97	78	1.8	-	75
22	3.015	0.139	0.96	79	1.8	-	75
23	3.155	0.140	0.97	79	1.6	-	75
24	3.296	0.141	0.97	79	1.8	-	75
25	3.435	0.139	0.96	80	1.7	-	76
26	3.577	0.142	0.98	80	1.6	-	76
27	3.717	0.140	0.97	80	1.8	-	76
28	3.857	0.140	0.97	81	1.7	-	76
29	3.999	0.142	0.98	81	1.8	-	76
30	4.140	0.141	0.98	81	1.7	100	76
31	4.281	0.141	0.97	81	1.8	-	76

BOX C TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 1

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/26/2024

Elapsed Time (min)	Particulate Sampling Data						
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)
32	4.423	0.142	0.99	82	1.6	-	76
33	4.566	0.143	0.99	82	1.8	-	77
34	4.708	0.142	0.98	82	1.7	-	77
35	4.850	0.142	0.98	82	1.6	-	77
36	4.993	0.143	1.00	83	1.6	-	77
37	5.136	0.143	1.00	83	1.8	-	77
38	5.279	0.143	0.99	84	1.7	-	77
39	5.422	0.143	0.99	84	1.8	-	77
40	5.566	0.144	1.01	84	1.7	101	77
41	5.710	0.144	1.01	84	1.7	-	77
42	5.854	0.144	1.00	84	1.6	-	77
43	6.001	0.147	1.00	85	1.8	-	77
44	6.142	0.141	1.00	85	1.7	-	77
45	6.287	0.145	1.01	85	1.6	-	77
46	6.433	0.146	1.02	85	1.8	-	77
47	6.577	0.144	1.01	86	1.6	-	77
48	6.722	0.145	1.01	86	1.6	-	77
49	6.867	0.145	1.01	86	1.8	-	77
50	7.012	0.145	1.01	86	1.8	101	77
51	7.157	0.145	1.02	86	1.6	-	77
52	7.304	0.147	1.02	87	1.8	-	77
53	7.450	0.146	1.02	87	1.8	-	77
54	7.596	0.146	1.02	87	1.8	-	77
55	7.741	0.145	1.02	87	1.7	-	77
56	7.887	0.146	1.02	88	1.6	-	77
57	8.033	0.146	1.02	88	1.6	-	77
58	8.180	0.147	1.02	88	1.6	-	77
59	8.326	0.146	1.03	88	1.7	-	77
60	8.473	0.147	1.03	88	1.7	102	77
Avg/Tot	8.473	0.141	0.98	80.9	1.7	100	75.2

WOODSTOVE SURFACE TEMPERATURE DATA

Client: HHT

Job #: 24-281

Model: Aspen C3

Tracking #: 186

Run #: 1

Technician: AK

Date: 3/26/2024

Stove ΔT: 27

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	368	382	223	502	217	338.1	N/A
1	368	384	236	479	222	337.8	N/A
2	369	385	235	473	225	337.3	N/A
3	370	385	231	487	227	339.9	N/A
4	370	386	226	529	229	347.6	N/A
5	369	385	221	603	231	361.5	N/A
6	368	384	214	652	233	369.9	N/A
7	366	382	207	696	234	377.2	N/A
8	365	381	201	735	236	383.7	N/A
9	364	379	196	772	237	389.6	N/A
10	362	378	191	806	238	394.9	N/A
11	361	376	187	834	239	399.3	N/A
12	360	374	183	856	241	402.6	N/A
13	361	372	180	873	241	405.3	N/A
14	359	371	177	892	242	408.3	N/A
15	359	370	174	910	243	411.1	N/A
16	359	369	172	920	243	412.7	N/A
17	359	368	170	928	244	413.9	N/A
18	360	367	168	934	245	414.6	N/A
19	360	366	167	940	246	415.8	N/A
20	361	367	165	946	246	417.1	N/A
21	362	367	164	954	246	418.8	N/A
22	364	368	163	961	247	420.4	N/A
23	365	369	162	967	247	422.2	N/A
24	366	370	163	963	248	421.9	N/A
25	368	370	163	955	248	420.9	N/A
26	369	372	165	947	249	420.2	N/A
27	370	373	166	943	249	420.2	N/A
28	372	374	168	943	250	421.2	N/A
29	372	376	169	945	250	422.4	N/A
30	373	377	171	948	251	423.8	N/A
31	375	378	172	951	250	425.2	N/A
32	376	379	174	954	251	426.6	N/A
33	377	381	175	957	251	428.2	N/A
34	379	383	177	957	251	429.4	N/A
35	380	384	178	951	252	429.0	N/A
36	382	385	180	942	252	428.2	N/A
37	383	386	182	932	252	427.0	N/A
38	384	388	184	922	252	425.9	N/A
39	385	389	186	911	252	424.7	N/A
40	387	390	188	903	252	424.0	N/A
41	388	392	190	893	252	423.0	N/A
42	389	394	192	882	252	421.7	N/A
43	390	395	194	868	252	419.9	N/A
44	391	396	197	854	253	418.1	N/A
45	392	398	199	838	253	416.0	N/A
46	394	400	201	823	253	414.1	N/A
47	395	401	203	811	253	412.8	N/A

WOODSTOVE SURFACE TEMPERATURE DATA

Client: HHT

Job #: 24-281

Model: Aspen C3

Tracking #: 186

Run #: 1

Technician: AK

Date: 3/26/2024

Stove ΔT: 27

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
48	397	403	206	800	253	411.6	N/A
49	398	404	208	790	252	410.5	N/A
50	400	406	210	781	252	409.8	N/A
51	401	406	213	771	252	408.5	N/A
52	402	409	215	758	252	407.2	N/A
53	404	410	217	741	253	404.9	N/A
54	405	411	219	726	253	402.7	N/A
55	406	412	221	709	253	400.3	N/A
56	407	413	223	692	253	397.6	N/A
57	408	414	225	677	253	395.4	N/A
58	409	414	226	663	254	393.1	N/A
59	409	415	228	651	254	391.2	N/A
60	411	415	229	639	254	389.6	N/A
61	411	416	231	629	254	388.2	N/A
62	411	416	232	619	255	386.6	N/A
63	413	416	234	611	255	385.6	N/A
64	413	416	235	603	256	384.5	N/A
65	414	416	236	595	256	383.5	N/A
66	414	416	238	589	257	382.5	N/A
67	414	416	238	581	257	381.3	N/A
68	414	415	239	573	258	379.8	N/A
69	414	414	241	566	258	378.6	N/A
70	415	414	242	559	259	377.7	N/A
71	415	413	242	553	259	376.6	N/A
72	415	412	243	547	260	375.4	N/A
73	415	412	244	541	261	374.4	N/A
74	415	411	245	535	261	373.3	N/A
75	415	409	245	531	262	372.4	N/A
76	415	408	246	527	263	371.8	N/A
77	415	408	246	523	264	371.0	N/A
78	415	406	247	520	265	370.7	N/A
79	415	406	247	518	266	370.4	N/A
80	416	404	248	515	266	370.0	N/A
81	415	404	249	513	267	369.6	N/A
82	416	403	250	511	268	369.6	N/A
83	417	402	251	509	269	369.6	N/A
84	416	402	251	507	270	369.3	N/A
85	417	402	252	505	271	369.4	N/A
86	417	401	253	502	272	369.1	N/A
87	416	401	254	500	273	368.8	N/A
88	417	400	255	498	274	369.0	N/A
89	417	400	256	497	275	368.9	N/A
90	417	400	257	496	276	369.1	N/A
91	418	399	258	494	277	369.1	N/A
92	418	400	259	493	278	369.3	N/A
93	418	399	260	491	279	369.2	N/A
94	418	399	260	489	280	369.0	N/A
95	418	399	261	487	281	369.0	N/A

WOODSTOVE SURFACE TEMPERATURE DATA

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

Stove ΔT: 27

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
96	418	398	262	484	282	368.8	N/A
97	417	398	263	482	283	368.6	N/A
98	417	398	264	480	283	368.6	N/A
99	417	398	264	478	284	368.3	N/A
100	416	397	265	477	285	368.0	N/A
101	417	397	265	475	286	368.0	N/A
102	416	396	265	474	287	367.5	N/A
103	415	396	265	471	288	367.2	N/A
104	414	396	265	470	289	367.0	N/A
105	413	396	265	469	290	366.5	N/A
106	413	396	265	467	291	366.2	N/A
107	412	395	265	466	291	365.9	N/A
108	412	394	265	465	292	365.6	N/A
109	411	394	266	464	292	365.4	N/A
110	411	394	266	462	293	365.2	N/A
111	410	393	266	461	294	364.9	N/A
Average	395.4	394.3	220.2	681.3	258.2	389.9	N/A

LAB SAMPLE DATA - ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 1

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/26/2024

		Sample ID	Tare, mg	Final, mg	Catch, mg
Filters	A	G00981	241.5	243.4	1.9
	B	G00982	240.6	242.4	1.8
	C - 1st Hour	G00983	240.6	241.7	1.1
	Amb	G00984	241.9	242.0	0.1
Probes	A	4A	116022.6	116023.1	0.5
	B	4B	116181.8	116182.0	0.2
	C - 1st Hour	4C	116997.3	116997.5	0.2
O-rings	A	4A	3377.0	3377.6	0.6
	B	4B	3580.6	3581.3	0.7
	C - 1st Hour	4C	3373.0	3373.7	0.7

Placed in Dessicator on: 3/26/2024

Balance Audit (mg):

		200.0		200.0					
		Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time
Filters	A	243.5	3/29 10:00	243.4	4/1 8:30				
	B	242.6	3/29 10:00	242.4	4/1 8:30				
	C - 1st Hour	241.9	3/29 10:00	241.7	4/1 8:30				
	Amb	242.0	3/29 10:00	242.0	4/1 8:30				
Probes	A	116023.0	3/29 10:00	116023.1	4/1 8:30				
	B	116182.1	3/29 10:00	116182.0	4/1 8:30				
	C - 1st Hour	116997.5	3/29 10:00	116997.5	4/1 8:30				
O-Rings	A	3377.6	3/29 10:00	3377.6	4/1 8:30				
	B	3581.2	3/29 10:00	3581.3	4/1 8:30				
	C - 1st Hour	3373.6	3/29 10:00	3373.7	4/1 8:30				

Train A Aggregate, mg:	3.0
Train B Aggregate, mg:	2.7
Train C Aggregate, mg:	2.0
Ambient, mg:	0.1

ASTM E2780 Wood Heater Run Sheets

Client: HHT Job Number: 24-281 Tracking #: 186
Model: Aspen C3 Run Number: 1 Test Date: 3/26/24

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): N/A – Single Burn Rate
Targeted Burn Category: N/A – Single Burn Rate

Preburn Notes

Time	Notes
	-None-

Test Notes

Test Burn Start Time: 10:31 Test Fuel Loaded by: 55 seconds
Door Closed: 110 seconds Air Control Set at: N/A seconds
Other Loading Notes: Initial fuel config resulted in loading difficulties, used alternate config – see photos

Time	Notes
	-None-

Test Burn End Time: 12:22

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.98 CO (%): 4.300
Mid Gas CO₂ (%): 10.06 CO (%): 2.538

Calibration Results:

	Pre Test			Post Test		
	Zero	Span	Mid	Zero	Span	Mid
Time	09:03	09:04	09:05	13:31	13:32	13:33
CO ₂	0.00	16.97	10.10	0.01	17.04	10.08
CO	0.000	4.300	2.531	-0.020	4.264	2.481

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Technician Signature: 

Date: 4/8/2024

ASTM E2780 Wood Heater Run Sheets

Client: HHT
Model: Aspen C3

Job Number: 24-281
Run Number: 1

Tracking #: 186
Test Date: 3/26/24



Test Fuel Front/Side View



Test Fuel Iso View




Test Fuel Loaded in Stove

N/A – Single Burn Rate

Air Setting

Technician Signature: _____



Date: 4/8/2024

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 2 Data Summary

Client:	HHT
Model:	Aspen C3
Job #:	24-281
Tracking #:	186
Test Date:	3/27/2024



Technician Signature

4/19/2024

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

Burn Rate (kg/hr):	1.73
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	10.297	23.000	22.074	8.494
Average Gas Velocity in Dilution Tunnel (ft/sec)	19.3			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	12547.9			
Average Gas Meter Temperature (°F)	67.0	81.1	84.1	78.8
Total Sample Volume (dscf)	10.339	22.476	21.462	8.287
Average Tunnel Temperature (°F)	96.8			
Total Time of Test (min)	126			
Total Particulate Catch (mg)	0.1	3.4	3.5	2.5
Particulate Concentration, dry-standard (g/dscf)	0.0000097	0.0001513	0.0001631	0.0003017
Total PM Emissions (g)	0.25	3.73	4.04	3.66
Particulate Emission Rate (g/hr)	0.12	1.78	1.92	3.66
Emissions Factor (g/kg)	-	1.03	1.11	-
Difference from Average Total Particulate Emissions (g)	-	0.16	0.16	-
Difference from Average Total Particulate Emissions (%)	-	4.0%	4.0%	-
Difference from Average Emissions Factor (g/kg)	-	0.04	0.04	-

Final Average Results	
Total Particulate Emissions (g)	3.89
Particulate Emission Rate (g/hr)	1.85
Emissions Factor (g/kg)	1.07
HHV Efficiency (%)	71.6%
LHV Efficiency (%)	77.4%
CO Emissions (g/min)	1.38

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	79.4	OK
Face Velocity	< 30 ft/min	10.2	OK
Leakage Rate	Less than 4% of average sample rate	0 cfm	OK
Ambient Temp	55-90 °F	Min:66.2/Max:67.5	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	33.3	OK

B415.1 Efficiency Results

Manufacturer: HHT
Model: Aspen C3
Date: 03/27/24
Run: 2
Control #: 24-281
Test Duration: 126
Output Category: 3

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	71.6%	77.4%
Combustion Efficiency	96.6%	96.6%
Heat Transfer Efficiency	74.1%	80.1%

Output Rate (kJ/h)	24,204	22,960	(Btu/h)
Burn Rate (kg/h)	1.71	3.76	(lb/h)
Input (kJ/h)	33,821	32,082	(Btu/h)

Test Load Weight (dry kg)	3.59	7.90	dry lb
MC wet (%)	17.26		
MC dry (%)	20.86		
Particulate (g)	3.89		
CO (g)	174		
Test Duration (h)	2.10		

Emissions	Particulate	CO
g/MJ Output	0.08	3.43
g/kg Dry Fuel	1.08	48.66
g/h	1.85	83.07
g/min	0.03	1.38
lb/MM Btu Output	0.18	7.98

Air/Fuel Ratio (A/F)	10.99
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VERSION:

2.4

4/15/2010

WOODSTOVE FUEL DATA - ASTM E2780

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	22.3				
2x4	16.00	20.2				
2x4	16.00	22.9				
2x4	16.00	24.1				
2x4	16.00	19.7				
2x4	16.00	19.5				
Total Fuel Weight (lbs):		11	Average Moisture (%DB):		21.5	

Firebox Volume (ft³): 1.25
 Total 2x4 Crib Weight, with spacers (lbs): 9.55
 Total 4x4 Crib Weight, with spacers (lbs): 0.00
 Total Wet Fuel Weight, with spacers (lbs): 9.55

Coal Bed Range (20-25%):

Min (lbs): 1.91
 Max (lbs): 2.39

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	16.75	1.92	19.8	19.2	20.6	1.60
2x4	16.75	2.12	20.9	19.3	19.1	1.77
2x4	16.75	1.94	20.9	22.6	23.3	1.59
2x4	16.75	1.96	19.9	21.3	23.4	1.61
Total Dry Weight, no spacers (lbs):						6.57
Total Dry Weight, with spacers (lbs):						8.02

Spacer Moisture Readings (%DB)							
12.1	12.9						
11.3	11.6						
12.8	12.4						
12.5	9.9						
10.3	11.2						
11.9	11.0						
13.3	10.0						
8.5	11.6						

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	32.3	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	7.64	OK
2x4 Fuel Mix	35 - 65 % of total weight	N/A	N/A

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: **HHT**
 Model: **Aspen C3**
 Run #: **2**
 Test Start Time: **11:16**

Job #: **24-281**
 Tracking #: **186**
 Technician: **AK**
 Date: **3/27/2024**

Total Sampling Time (min): **126**
 Recording Interval (min): **1**

Meter Box γ Factor: **1.004 (A)**
 Meter Box γ Factor: **1.005 (B)**
 Meter Box γ Factor: **1.004 (C)**
 Meter Box γ Factor: **1.013 (Ambient)**

	Pre-Test	Post Test	Avg.
Barometric Pressure (in. Hg)	29.57	29.65	29.61
Relative Humidity (%)	44.0	40.6	
Room Air Velocity (ft/min)	<50	<50	
Pitot Tube Leak Check	0	0	
Ambient Sample Volume:		10.297	ft ³

Sample Train Leak Checks

	Pre-test	Post-test		
Induced Draft Check (in. H ₂ O):	0	(A) 0.000	cfm @	-6 in. Hg
Smoke Capture Check (%):	100%	(B) 0.000	cfm @	-6 in. Hg
Date Flue Pipe Last Cleaned:	3/25/2024	(C) 0.000	cfm @	-6 in. Hg
Test Fuel Scale Audit (lbs)	10.00	(Ambient) 0.000	cfm @	-13 in. Hg
Platform Scale Audit (lbs)	10.0			

DILUTION TUNNEL FLOW

Traverse Data

Point	dP (in H ₂ O)	Temp (°F)
1	0.060	68
2	0.088	68
3	0.090	68
4	0.072	68
5	0.060	68
6	0.090	68
7	0.094	68
8	0.074	68
Center	0.082	68

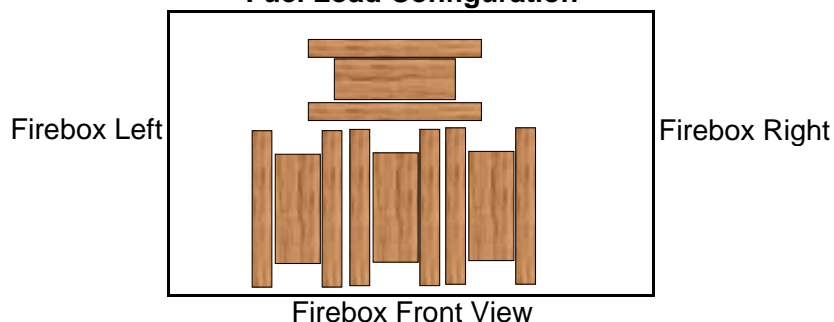
Dilution Tunnel H₂O: **2.00** percent
 Tunnel Diameter: **6** inches
 Pitot Tube Cp: **0.99** [unitless]
 Dilution Tunnel MW(dry): **29.00** lb/lb-mole
 Dilution Tunnel MW(wet): **28.78** lb/lb-mole
 Tunnel Area: **0.1963** ft²

 V_{strav} : **18.62** ft/sec
 V_{scent} : **19.09** ft/sec
 F_p : **0.975** [ratio]
 Initial Tunnel Flow: **212.5** scf/min

Static Pressure: **-0.140** in. H₂O

TEST FUEL PROPERTIES

Fuel Load Configuration



Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	20.9

WOODSTOVE PREBURN DATA - ASTM E2780

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

Recording Interval (min): 1
Run Time (min): 90

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	9.10	-0.098	270	320	129	763	150	326.1	527	66
1	8.99	-0.095	272	325	129	734	151	322.2	503	66
2	8.87	-0.094	275	330	130	709	153	319.2	489	66
3	8.76	-0.096	277	334	130	690	154	317.0	483	66
4	8.65	-0.093	280	337	130	677	156	315.8	482	66
5	8.54	-0.094	283	339	130	671	157	316.1	484	66
6	8.42	-0.095	285	341	130	669	159	316.8	487	66
7	8.30	-0.094	287	343	130	672	160	318.5	493	66
8	8.20	-0.095	289	344	130	679	162	320.8	494	66
9	8.07	-0.096	291	345	130	682	163	322.4	500	66
10	7.96	-0.095	294	346	131	692	165	325.3	502	66
11	7.83	-0.096	296	346	131	699	166	327.6	505	66
12	7.72	-0.095	298	347	132	710	168	330.6	512	66
13	7.59	-0.098	300	347	132	724	169	334.5	525	66
14	7.47	-0.098	302	348	133	744	170	339.2	537	66
15	7.34	-0.098	304	348	134	758	172	342.9	537	66
16	7.22	-0.099	306	348	135	769	173	346.1	539	66
17	7.10	-0.098	308	349	136	777	174	348.8	538	66
18	6.98	-0.099	311	349	137	780	175	350.4	534	66
19	6.87	-0.095	314	350	138	778	176	351.1	529	66
20	6.76	-0.097	316	351	140	776	177	351.8	525	66
21	6.65	-0.097	319	351	141	776	177	352.7	523	66
22	6.54	-0.097	322	352	142	774	178	353.7	523	66
23	6.44	-0.096	325	353	144	770	179	354.1	517	66
24	6.34	-0.095	328	354	146	768	179	355.0	517	66
25	6.23	-0.095	331	355	147	765	180	355.6	512	66
26	6.14	-0.094	334	357	149	762	180	356.4	509	66
27	6.04	-0.093	337	358	150	758	181	356.9	506	66
28	5.94	-0.094	341	360	152	752	181	357.0	501	66
29	5.86	-0.092	344	362	154	748	182	357.9	499	66
30	5.75	-0.092	347	363	155	742	182	358.0	492	66
31	5.67	-0.091	351	365	157	735	182	358.0	484	66
32	5.58	-0.092	354	367	158	728	183	357.8	480	66
33	5.49	-0.090	357	368	160	722	183	358.1	478	66
34	5.41	-0.091	361	370	162	717	184	358.6	475	66
35	5.32	-0.090	364	371	163	713	184	359.1	472	66
36	5.24	-0.088	367	374	165	706	185	359.2	466	66
37	5.17	-0.088	370	375	167	700	185	359.3	462	66
38	5.08	-0.089	373	377	168	695	186	359.8	458	66
39	5.01	-0.088	375	379	170	689	186	359.8	455	66
40	4.93	-0.087	378	381	172	683	187	360.3	450	66
41	4.86	-0.086	381	383	174	677	188	360.4	444	67
42	4.79	-0.086	383	384	176	669	188	360.1	441	67
43	4.72	-0.085	386	386	177	662	189	360.0	434	66
44	4.64	-0.084	388	387	179	656	190	360.0	432	66

WOODSTOVE PREBURN DATA - ASTM E2780

Client: HHT
Model: Aspen C3
Run #: 2

Job #: 24-281
Tracking #: 186
Technician: AK
Date: 3/27/2024

Recording Interval (min): 1
Run Time (min): 90

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
45	4.58	-0.085	390	389	181	649	191	359.9	429	66
46	4.51	-0.083	393	390	182	643	192	360.0	424	66
47	4.44	-0.083	395	392	184	637	193	360.0	420	66
48	4.38	-0.081	396	393	186	631	194	359.9	417	66
49	4.31	-0.082	398	395	187	625	195	360.1	414	66
50	4.24	-0.084	400	396	189	621	197	360.6	413	66
51	4.18	-0.081	401	398	191	618	198	361.2	412	66
52	4.11	-0.082	403	400	193	617	199	362.3	412	66
53	4.05	-0.082	404	401	195	615	200	363.1	412	66
54	3.97	-0.082	406	403	197	615	202	364.5	412	66
55	3.91	-0.082	407	405	199	614	203	365.6	411	66
56	3.84	-0.081	409	407	201	614	204	367.0	410	66
57	3.79	-0.080	411	409	203	614	206	368.4	410	66
58	3.72	-0.081	413	410	205	614	207	369.7	410	66
59	3.65	-0.081	413	412	206	614	209	370.8	410	66
60	3.58	-0.082	415	413	208	614	210	371.9	411	66
61	3.52	-0.081	416	414	210	616	211	373.5	412	66
62	3.46	-0.080	419	415	212	617	213	375.1	411	66
63	3.39	-0.082	420	417	214	619	214	376.7	411	66
64	3.33	-0.080	421	417	215	622	216	377.9	414	66
65	3.27	-0.081	421	418	217	626	217	379.8	416	66
66	3.21	-0.080	423	419	218	628	219	381.3	412	66
67	3.15	-0.080	423	420	220	627	221	382.2	407	67
68	3.09	-0.079	423	420	222	622	222	381.7	403	67
69	3.05	-0.077	425	421	224	616	224	381.7	397	67
70	2.99	-0.076	425	421	227	607	225	381.1	389	67
71	2.95	-0.077	425	422	230	599	227	380.5	383	67
72	2.90	-0.075	425	422	233	592	229	380.0	380	67
73	2.86	-0.074	425	422	235	584	231	379.4	375	66
74	2.81	-0.074	425	423	238	577	233	379.1	370	67
75	2.76	-0.073	425	423	241	570	234	378.8	368	66
76	2.72	-0.071	425	424	244	564	236	378.6	364	66
77	2.68	-0.074	425	424	247	559	238	378.4	362	66
78	2.62	-0.072	425	425	249	554	240	378.5	359	66
79	2.60	-0.071	424	425	252	549	242	378.4	357	66
80	2.56	-0.071	424	425	254	545	244	378.4	355	66
81	2.51	-0.072	424	425	256	541	246	378.4	353	66
82	2.47	-0.072	423	425	259	538	248	378.5	351	66
83	2.44	-0.072	423	425	260	535	250	378.7	350	66
84	2.40	-0.071	422	426	262	533	252	378.9	350	66
85	2.36	-0.070	422	425	264	531	254	379.0	349	66
86	2.33	-0.070	421	425	265	529	256	379.2	349	66
87	2.28	-0.070	421	424	266	527	258	379.4	348	66
88	2.24	-0.071	420	424	267	525	260	379.4	345	66
89	2.21	-0.070	420	424	269	522	262	379.5	345	66

WOODSTOVE PREBURN DATA - ASTM E2780

Client: HHT
Model: Aspen C3
Run #: 2

Job #: 24-281
Tracking #: 186
Technician: AK
Date: 3/27/2024

Recording Interval (min): 1
Run Time (min): 90

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
90	2.18	-0.070	420	424	271	519	265	379.7	341	66

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.082	2.88	69	1.1		9.55		97	348	71	66
1	0.161	0.161	0.082	2.88	69	1.1	-	9.44	-0.11	103	374	71	66
2	0.325	0.164	0.084	2.92	69	1.1	-	9.27	-0.17	113	491	72	66
3	0.493	0.168	0.082	2.97	69	1.2	-	9.07	-0.20	117	602	73	67
4	0.665	0.172	0.083	2.99	69	1.1	-	8.88	-0.19	121	661	74	67
5	0.834	0.169	0.083	3.02	69	1.2	-	8.72	-0.16	114	554	73	67
6	1.002	0.168	0.082	3.05	70	1.2	-	8.59	-0.13	106	510	74	67
7	1.176	0.174	0.082	3.09	70	1.1	-	8.44	-0.15	104	520	74	67
8	1.349	0.173	0.082	3.10	70	1.2	-	8.29	-0.15	103	538	74	67
9	1.519	0.170	0.085	3.12	70	1.1	-	8.12	-0.17	102	560	74	67
10	1.693	0.174	0.086	3.14	70	1.1	95	7.95	-0.17	103	565	74	67
11	1.869	0.176	0.086	3.16	70	1.1	-	7.79	-0.16	103	580	74	67
12	2.044	0.175	0.086	3.18	71	1.2	-	7.60	-0.19	104	590	74	67
13	2.216	0.172	0.086	3.19	71	1.1	-	7.43	-0.17	104	587	74	67
14	2.391	0.175	0.085	3.21	71	1.1	-	7.26	-0.17	104	589	74	67
15	2.569	0.178	0.084	3.22	71	1.1	-	7.10	-0.16	104	593	75	67
16	2.745	0.176	0.086	3.23	72	1.2	-	6.92	-0.18	106	593	75	67
17	2.919	0.174	0.085	3.23	72	1.2	-	6.75	-0.17	106	595	75	67
18	3.095	0.176	0.085	3.25	72	1.2	-	6.57	-0.18	107	599	75	67
19	3.274	0.179	0.086	3.25	72	1.2	-	6.40	-0.17	107	592	75	67
20	3.453	0.179	0.084	3.25	73	1.2	98	6.23	-0.17	107	593	75	67
21	3.630	0.177	0.084	3.27	73	1.2	-	6.07	-0.16	107	592	76	67
22	3.807	0.177	0.086	3.29	73	1.2	-	5.91	-0.16	107	592	76	67
23	3.987	0.180	0.086	3.29	73	1.2	-	5.75	-0.16	107	591	76	67
24	4.168	0.181	0.086	3.30	74	1.2	-	5.58	-0.17	107	591	76	67
25	4.346	0.178	0.085	3.30	74	1.2	-	5.43	-0.15	107	591	76	67
26	4.523	0.177	0.084	3.31	74	1.2	-	5.27	-0.16	107	591	76	67
27	4.701	0.178	0.085	3.32	75	1.2	-	5.12	-0.15	107	590	76	67
28	4.883	0.182	0.086	3.33	75	1.2	-	4.96	-0.16	107	589	76	67
29	5.065	0.182	0.089	3.34	75	1.2	-	4.82	-0.14	107	587	76	67
30	5.245	0.180	0.086	3.34	76	1.2	100	4.67	-0.15	107	588	76	67
31	5.423	0.178	0.086	3.34	76	1.2	-	4.53	-0.14	107	587	76	67

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
32	5.602	0.179	0.086	3.34	76	1.2	-	4.38	-0.15	107	585	76	67
33	5.784	0.182	0.086	3.34	76	1.2	-	4.26	-0.12	107	583	77	67
34	5.967	0.183	0.085	3.36	77	1.2	-	4.12	-0.14	108	578	77	67
35	6.148	0.181	0.085	3.36	77	1.2	-	3.99	-0.13	108	575	77	67
36	6.327	0.179	0.084	3.36	77	1.2	-	3.86	-0.13	107	575	77	67
37	6.508	0.181	0.086	3.37	78	1.2	-	3.73	-0.13	106	575	77	67
38	6.690	0.182	0.087	3.38	78	1.2	-	3.61	-0.12	106	573	77	67
39	6.872	0.182	0.084	3.38	78	1.2	-	3.49	-0.12	106	571	77	67
40	7.056	0.184	0.084	3.39	78	1.2	100	3.37	-0.12	106	567	77	67
41	7.238	0.182	0.087	3.39	79	1.2	-	3.26	-0.11	106	559	77	68
42	7.417	0.179	0.085	3.37	79	1.2	-	3.15	-0.11	105	554	77	67
43	7.598	0.181	0.085	3.38	79	1.2	-	3.04	-0.11	105	551	77	67
44	7.782	0.184	0.085	3.40	79	1.2	-	2.93	-0.11	105	545	77	67
45	7.966	0.184	0.085	3.41	80	1.2	-	2.83	-0.10	105	541	77	67
46	8.149	0.183	0.087	3.41	80	1.2	-	2.74	-0.09	105	538	77	67
47	8.332	0.183	0.085	3.41	80	1.2	-	2.64	-0.10	105	532	77	67
48	8.513	0.181	0.084	3.42	80	1.2	-	2.55	-0.09	104	530	77	67
49	8.694	0.181	0.086	3.41	81	1.2	-	2.46	-0.09	104	528	77	67
50	8.879	0.185	0.086	3.42	81	1.2	100	2.36	-0.10	103	523	77	68
51	9.064	0.185	0.085	3.43	81	1.2	-	2.27	-0.09	103	519	77	68
52	9.247	0.183	0.085	3.43	81	1.2	-	2.19	-0.08	103	513	77	68
53	9.430	0.183	0.084	3.43	81	1.2	-	2.12	-0.07	102	505	77	67
54	9.612	0.182	0.085	3.44	82	1.2	-	2.05	-0.07	102	494	77	68
55	9.794	0.182	0.084	3.43	82	1.2	-	1.98	-0.07	102	484	77	68
56	9.980	0.186	0.085	3.43	82	1.2	-	1.91	-0.07	101	472	77	67
57	10.165	0.185	0.085	3.44	82	1.2	-	1.85	-0.06	100	461	77	67
58	10.349	0.184	0.085	3.44	82	1.2	-	1.79	-0.06	99	452	77	67
59	10.533	0.184	0.084	3.43	83	1.2	-	1.73	-0.06	99	445	76	67
60	10.714	0.181	0.085	3.44	83	1.2	100	1.68	-0.05	98	438	77	67
61	10.898	0.184	0.084	3.45	83	1.2	-	1.63	-0.05	98	432	76	67
62	11.084	0.186	0.083	3.46	83	1.2	-	1.57	-0.06	97	425	76	67
63	11.269	0.185	0.085	3.47	83	1.2	-	1.53	-0.04	97	420	76	67

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
64	11.455	0.186	0.084	3.46	83	1.2	-	1.48	-0.05	96	413	76	67
65	11.639	0.184	0.083	3.47	84	1.2	-	1.43	-0.05	96	408	76	67
66	11.822	0.183	0.085	3.46	84	1.2	-	1.40	-0.03	96	403	76	67
67	12.006	0.184	0.084	3.46	84	1.2	-	1.35	-0.05	95	396	76	67
68	12.190	0.184	0.084	3.47	84	1.2	-	1.31	-0.04	94	390	76	67
69	12.377	0.187	0.086	3.46	84	1.2	-	1.28	-0.03	94	383	76	67
70	12.563	0.186	0.085	3.46	84	1.2	100	1.24	-0.04	94	378	76	67
71	12.748	0.185	0.084	3.46	84	1.2	-	1.21	-0.03	94	373	76	67
72	12.934	0.186	0.083	3.46	85	1.2	-	1.18	-0.03	93	369	76	67
73	13.117	0.183	0.083	3.49	85	1.2	-	1.15	-0.03	93	365	76	67
74	13.302	0.185	0.083	3.47	85	1.2	-	1.12	-0.03	92	362	75	67
75	13.486	0.184	0.083	3.46	85	1.2	-	1.10	-0.02	92	359	75	67
76	13.673	0.187	0.083	3.46	85	1.2	-	1.06	-0.04	92	356	75	67
77	13.861	0.188	0.083	3.48	85	1.2	-	1.04	-0.02	92	354	75	67
78	14.045	0.184	0.083	3.47	85	1.2	-	1.01	-0.03	92	351	75	67
79	14.231	0.186	0.083	3.46	85	1.2	-	0.99	-0.02	91	350	75	67
80	14.415	0.184	0.082	3.48	86	1.2	101	0.96	-0.03	91	345	75	67
81	14.600	0.185	0.084	3.47	86	1.2	-	0.93	-0.03	91	342	75	67
82	14.785	0.185	0.084	3.48	86	1.2	-	0.91	-0.02	91	340	75	67
83	14.972	0.187	0.083	3.49	86	1.2	-	0.89	-0.02	90	336	75	67
84	15.160	0.188	0.084	3.49	86	1.2	-	0.86	-0.03	90	334	75	67
85	15.345	0.185	0.082	3.48	86	1.2	-	0.83	-0.03	90	333	75	67
86	15.532	0.187	0.083	3.48	86	1.2	-	0.81	-0.02	89	331	75	67
87	15.715	0.183	0.085	3.49	86	1.2	-	0.79	-0.02	89	328	75	67
88	15.901	0.186	0.084	3.49	86	1.2	-	0.76	-0.03	89	327	75	67
89	16.086	0.185	0.085	3.50	86	1.2	-	0.74	-0.02	89	324	74	67
90	16.274	0.188	0.081	3.49	86	1.2	102	0.71	-0.03	89	322	74	67
91	16.461	0.187	0.084	3.49	87	1.2	-	0.69	-0.02	88	321	74	67
92	16.648	0.187	0.082	3.49	87	1.2	-	0.67	-0.02	88	319	74	67
93	16.835	0.187	0.083	3.50	87	1.2	-	0.64	-0.03	88	318	74	67
94	17.019	0.184	0.083	3.50	87	1.2	-	0.63	-0.01	88	316	74	67
95	17.205	0.186	0.082	3.49	87	1.2	-	0.59	-0.04	88	315	74	67

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
96	17.389	0.184	0.082	3.49	87	1.2	-	0.57	-0.02	88	315	74	67
97	17.578	0.189	0.082	3.49	87	1.2	-	0.55	-0.02	87	313	74	67
98	17.765	0.187	0.082	3.51	87	1.2	-	0.53	-0.02	87	311	74	67
99	17.953	0.188	0.083	3.50	87	1.2	-	0.52	-0.01	87	310	74	67
100	18.139	0.186	0.082	3.52	87	1.2	102	0.49	-0.03	87	308	74	67
101	18.326	0.187	0.083	3.50	87	1.2	-	0.46	-0.03	87	307	74	67
102	18.509	0.183	0.079	3.50	87	1.2	-	0.45	-0.01	87	306	74	67
103	18.697	0.188	0.082	3.50	87	1.2	-	0.42	-0.03	87	304	74	67
104	18.883	0.186	0.080	3.50	87	1.2	-	0.40	-0.02	87	302	74	67
105	19.071	0.188	0.083	3.50	88	1.2	-	0.39	-0.01	87	301	74	67
106	19.259	0.188	0.082	3.50	88	1.2	-	0.35	-0.04	86	301	74	67
107	19.447	0.188	0.081	3.50	88	1.2	-	0.34	-0.01	86	297	74	67
108	19.633	0.186	0.083	3.51	88	1.2	-	0.32	-0.02	86	292	74	67
109	19.819	0.186	0.081	3.50	88	1.2	-	0.30	-0.02	86	290	74	67
110	20.005	0.186	0.083	3.51	88	1.2	101	0.29	-0.01	86	288	74	67
111	20.191	0.186	0.084	3.51	88	1.2	-	0.26	-0.03	86	286	73	67
112	20.379	0.188	0.083	3.51	88	1.2	-	0.24	-0.02	85	285	73	67
113	20.566	0.187	0.080	3.51	88	1.2	-	0.23	-0.01	85	283	73	67
114	20.756	0.190	0.079	3.51	88	1.2	-	0.21	-0.02	85	282	73	67
115	20.942	0.186	0.082	3.50	88	1.2	-	0.20	-0.01	85	280	73	67
116	21.130	0.188	0.083	3.52	88	1.2	-	0.17	-0.03	84	279	73	67
117	21.314	0.184	0.079	3.51	88	1.2	-	0.16	-0.01	85	279	73	67
118	21.502	0.188	0.080	3.51	88	1.2	-	0.14	-0.02	85	277	73	67
119	21.687	0.185	0.081	3.52	88	1.3	-	0.12	-0.02	85	277	73	67
120	21.877	0.190	0.085	3.52	88	1.2	100	0.10	-0.02	84	276	73	67
121	22.064	0.187	0.084	3.51	88	1.2	-	0.08	-0.02	85	274	73	67
122	22.253	0.189	0.083	3.51	88	1.2	-	0.06	-0.02	84	274	73	66
123	22.440	0.187	0.084	3.52	88	1.2	-	0.05	-0.01	84	275	73	66
124	22.628	0.188	0.083	3.52	88	1.2	-	0.03	-0.02	84	273	73	67
125	22.813	0.185	0.078	3.51	88	1.2	-	0.01	-0.02	84	271	73	67
126	23.000	0.187	0.084	3.53	89	1.2	100	0.00	-0.01	84	270	73	67
Avg/Tot	23.000	0.183	0.084	3.39	81.1	1.2	100			96.8	433.2	75.0	67.0

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.000		3.04	70	2.1		74	-0.086	7.15	0.517
1	0.165	0.165	3.04	70	2.1	-	74	-0.086	3.12	0.244
2	0.332	0.167	3.02	70	2.0	-	75	-0.096	4.56	0.495
3	0.502	0.170	3.02	70	2.2	-	77	-0.110	7.21	0.498
4	0.673	0.171	3.02	70	1.8	-	77	-0.111	10.79	0.287
5	0.843	0.170	3.02	70	2.1	-	77	-0.096	12.92	0.682
6	1.010	0.167	3.01	70	2.2	-	77	-0.098	10.19	1.232
7	1.181	0.171	3.02	70	2.2	-	76	-0.099	12.52	0.546
8	1.352	0.171	3.04	70	2.2	-	76	-0.099	13.63	0.464
9	1.520	0.168	3.03	71	2.0	-	76	-0.101	14.58	0.529
10	1.690	0.170	3.04	71	2.2	99	77	-0.103	14.88	0.529
11	1.862	0.172	3.04	71	2.1	-	77	-0.104	14.87	0.555
12	2.034	0.172	3.05	71	1.7	-	77	-0.104	15.92	0.965
13	2.202	0.168	3.04	71	1.7	-	77	-0.104	15.29	0.689
14	2.373	0.171	3.05	72	1.7	-	77	-0.103	14.83	0.642
15	2.546	0.173	3.06	72	2.2	-	77	-0.104	14.90	0.608
16	2.714	0.168	3.06	72	1.9	-	78	-0.104	14.92	0.623
17	2.884	0.170	3.05	73	1.7	-	78	-0.105	15.27	0.639
18	3.057	0.173	3.05	73	2.0	-	78	-0.105	15.16	0.622
19	3.229	0.172	3.05	73	2.2	-	78	-0.104	15.31	0.656
20	3.398	0.169	3.05	73	1.7	100	78	-0.103	15.17	0.570
21	3.570	0.172	3.06	74	1.7	-	78	-0.103	14.75	0.515
22	3.744	0.174	3.07	74	1.9	-	78	-0.102	15.03	0.495
23	3.916	0.172	3.07	74	1.9	-	78	-0.103	14.90	0.490
24	4.085	0.169	3.07	75	1.8	-	79	-0.103	15.24	0.489
25	4.258	0.173	3.07	75	2.2	-	79	-0.103	15.37	0.487
26	4.431	0.173	3.07	75	2.2	-	79	-0.102	15.44	0.410
27	4.602	0.171	3.08	76	1.8	-	79	-0.102	15.22	0.376
28	4.773	0.171	3.07	76	2.2	-	79	-0.102	14.97	0.363
29	4.947	0.174	3.08	76	2.2	-	79	-0.102	14.85	0.364
30	5.121	0.174	3.08	77	1.7	100	79	-0.103	14.88	0.405
31	5.291	0.170	3.08	77	2.2	-	79	-0.103	14.91	0.449

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
32	5.463	0.172	3.08	77	1.7	-	79	-0.101	14.80	0.427
33	5.637	0.174	3.08	78	2.1	-	79	-0.102	14.76	0.380
34	5.811	0.174	3.08	78	2.1	-	79	-0.101	14.82	0.329
35	5.982	0.171	3.08	78	2.2	-	79	-0.098	14.61	0.272
36	6.155	0.173	3.08	79	2.3	-	79	-0.101	14.65	0.239
37	6.330	0.175	3.09	79	1.9	-	79	-0.100	14.81	0.233
38	6.504	0.174	3.08	79	2.1	-	79	-0.101	14.71	0.229
39	6.676	0.172	3.08	80	1.7	-	79	-0.098	14.59	0.206
40	6.850	0.174	3.09	80	2.2	100	79	-0.099	14.39	0.184
41	7.025	0.175	3.09	80	1.7	-	79	-0.099	14.24	0.182
42	7.200	0.175	3.10	81	1.9	-	79	-0.097	14.19	0.176
43	7.372	0.172	3.10	81	2.2	-	79	-0.098	14.01	0.171
44	7.546	0.174	3.10	81	2.2	-	79	-0.098	13.89	0.132
45	7.722	0.176	3.11	82	2.2	-	79	-0.097	13.68	0.103
46	7.898	0.176	3.11	82	1.9	-	79	-0.096	13.61	0.083
47	8.071	0.173	3.11	82	2.2	-	79	-0.097	13.48	0.065
48	8.245	0.174	3.12	82	2.2	-	79	-0.094	13.35	0.060
49	8.421	0.176	3.12	83	1.7	-	79	-0.093	13.33	0.046
50	8.597	0.176	3.12	83	1.7	100	79	-0.095	13.28	0.080
51	8.772	0.175	3.12	83	2.2	-	79	-0.096	13.15	0.086
52	8.946	0.174	3.12	84	1.7	-	79	-0.095	12.92	0.087
53	9.121	0.175	3.12	84	1.8	-	79	-0.092	12.42	0.143
54	9.297	0.176	3.12	84	1.7	-	79	-0.090	11.94	0.195
55	9.473	0.176	3.12	84	2.0	-	79	-0.090	11.46	0.210
56	9.647	0.174	3.13	85	1.8	-	79	-0.086	11.07	0.226
57	9.822	0.175	3.13	85	1.7	-	79	-0.087	10.60	0.310
58	9.999	0.177	3.12	85	2.1	-	79	-0.085	10.37	0.402
59	10.177	0.178	3.13	85	1.9	-	79	-0.086	10.21	0.406
60	10.351	0.174	3.13	86	1.7	99	79	-0.084	10.15	0.373
61	10.526	0.175	3.13	86	2.2	-	79	-0.082	10.11	0.345
62	10.703	0.177	3.14	86	2.3	-	79	-0.083	9.98	0.334
63	10.881	0.178	3.15	86	2.0	-	79	-0.081	9.82	0.318

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
64	11.056	0.175	3.14	87	1.7	-	79	-0.081	9.69	0.316
65	11.230	0.174	3.14	87	1.7	-	79	-0.080	9.51	0.344
66	11.407	0.177	3.14	87	1.7	-	78	-0.079	9.40	0.376
67	11.584	0.177	3.14	87	2.0	-	78	-0.077	9.23	0.388
68	11.761	0.177	3.15	87	2.2	-	78	-0.077	9.07	0.461
69	11.937	0.176	3.14	88	1.7	-	78	-0.075	8.81	0.474
70	12.112	0.175	3.15	88	2.0	99	78	-0.077	8.68	0.460
71	12.290	0.178	3.15	88	1.7	-	78	-0.074	8.60	0.418
72	12.468	0.178	3.15	88	1.8	-	78	-0.074	8.47	0.412
73	12.644	0.176	3.15	88	2.0	-	78	-0.074	8.49	0.462
74	12.819	0.175	3.15	89	2.1	-	78	-0.072	8.45	0.579
75	12.995	0.176	3.14	89	1.7	-	78	-0.073	8.53	0.504
76	13.174	0.179	3.15	89	2.1	-	78	-0.071	8.56	0.492
77	13.352	0.178	3.15	89	2.2	-	77	-0.072	8.46	0.492
78	13.528	0.176	3.15	89	1.8	-	77	-0.071	8.48	0.516
79	13.705	0.177	3.16	89	1.7	-	77	-0.072	8.44	0.541
80	13.881	0.176	3.15	90	1.7	100	77	-0.070	8.41	0.569
81	14.060	0.179	3.16	90	1.7	-	77	-0.069	8.32	0.595
82	14.237	0.177	3.15	90	1.8	-	77	-0.070	8.27	0.624
83	14.414	0.177	3.16	90	1.8	-	77	-0.068	8.23	0.635
84	14.590	0.176	3.16	90	1.8	-	77	-0.068	8.21	0.652
85	14.769	0.179	3.15	90	2.0	-	77	-0.069	8.22	0.662
86	14.947	0.178	3.17	90	2.1	-	77	-0.066	8.20	0.680
87	15.124	0.177	3.16	91	2.2	-	77	-0.069	8.18	0.689
88	15.300	0.176	3.16	91	1.9	-	77	-0.066	8.09	0.699
89	15.477	0.177	3.16	91	1.6	-	77	-0.065	8.06	0.704
90	15.657	0.180	3.16	91	1.9	101	77	-0.066	8.02	0.738
91	15.835	0.178	3.16	91	1.7	-	77	-0.067	8.05	0.758
92	16.013	0.178	3.17	91	1.7	-	76	-0.067	8.17	0.710
93	16.188	0.175	3.16	91	1.7	-	76	-0.065	8.30	0.659
94	16.365	0.177	3.16	91	1.7	-	76	-0.064	8.24	0.678
95	16.545	0.180	3.16	91	1.9	-	76	-0.064	8.11	0.669

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT
 Model: Aspen C3
 Run #: 2

Job #: 24-281
 Tracking #: 186
 Technician: AK
 Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
96	16.724	0.179	3.17	92	1.8	-	76	-0.064	8.03	0.685
97	16.901	0.177	3.17	92	2.0	-	76	-0.066	8.08	0.698
98	17.077	0.176	3.17	92	1.8	-	76	-0.065	8.06	0.713
99	17.255	0.178	3.17	92	1.7	-	76	-0.064	7.93	0.755
100	17.434	0.179	3.16	92	2.2	101	76	-0.063	7.91	0.771
101	17.614	0.180	3.17	92	2.2	-	76	-0.063	7.84	0.793
102	17.791	0.177	3.16	92	1.7	-	76	-0.064	7.82	0.815
103	17.968	0.177	3.17	92	2.0	-	76	-0.063	7.69	0.844
104	18.145	0.177	3.17	92	1.9	-	76	-0.062	7.67	0.880
105	18.325	0.180	3.17	92	2.1	-	76	-0.061	7.66	0.921
106	18.504	0.179	3.17	92	1.8	-	76	-0.061	7.57	0.960
107	18.682	0.178	3.18	93	1.8	-	76	-0.059	7.41	1.011
108	18.859	0.177	3.17	93	2.2	-	76	-0.061	6.68	1.300
109	19.037	0.178	3.18	93	1.7	-	76	-0.059	6.64	1.316
110	19.216	0.179	3.17	93	1.8	100	76	-0.061	6.65	1.296
111	19.395	0.179	3.18	93	2.1	-	75	-0.059	6.64	1.299
112	19.573	0.178	3.17	93	2.1	-	75	-0.060	6.88	1.095
113	19.751	0.178	3.18	93	2.2	-	75	-0.058	6.85	1.110
114	19.929	0.178	3.17	93	2.0	-	75	-0.059	6.77	1.136
115	20.108	0.179	3.18	93	2.0	-	75	-0.060	6.74	1.159
116	20.287	0.179	3.18	93	2.1	-	75	-0.058	6.71	1.186
117	20.466	0.179	3.18	93	2.0	-	75	-0.059	6.74	1.226
118	20.643	0.177	3.18	93	2.0	-	75	-0.058	6.74	1.187
119	20.821	0.178	3.18	93	2.1	-	75	-0.059	6.70	1.197
120	21.001	0.180	3.18	93	1.9	99	75	-0.057	6.73	1.211
121	21.181	0.180	3.18	93	1.7	-	75	-0.059	6.74	1.225
122	21.358	0.177	3.18	93	1.7	-	75	-0.058	6.71	1.225
123	21.536	0.178	3.19	93	2.0	-	75	-0.058	6.70	1.256
124	21.714	0.178	3.18	94	1.7	-	75	-0.058	6.61	1.292
125	21.894	0.180	3.18	94	1.9	-	75	-0.058	6.58	1.287
126	22.074	0.180	3.18	94	1.8	99	75	-0.056	6.53	1.271
Avg/Tot	22.074	0.175	3.12	84.1	1.9	100	77.3	-0.082	10.51	0.595

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT

Job #: 24-281

Model: Aspen C3

Tracking #: 186

Run #: 2

Technician: AK

Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)

BOX C TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data						
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)
0	0.000		0.91	72	1.7		70
1	0.122	0.122	0.91	72	1.7	-	70
2	0.256	0.134	0.91	72	1.5	-	71
3	0.393	0.137	0.92	72	1.7	-	71
4	0.527	0.134	0.91	72	1.6	-	72
5	0.664	0.137	0.92	72	1.7	-	72
6	0.800	0.136	0.92	73	1.6	-	71
7	0.938	0.138	0.93	73	1.6	-	72
8	1.074	0.136	0.93	73	1.7	-	72
9	1.212	0.138	0.94	73	1.7	-	72
10	1.350	0.138	0.94	74	1.8	97	72
11	1.488	0.138	0.95	74	1.7	-	73
12	1.627	0.139	0.94	74	1.7	-	73
13	1.765	0.138	0.95	74	1.7	-	73
14	1.905	0.140	0.96	75	1.6	-	73
15	2.044	0.139	0.95	75	1.6	-	73
16	2.184	0.140	0.96	75	1.7	-	73
17	2.323	0.139	0.95	75	1.6	-	73
18	2.462	0.139	0.95	76	1.7	-	74
19	2.602	0.140	0.96	76	1.7	-	74
20	2.741	0.139	0.95	76	1.6	99	74
21	2.881	0.140	0.96	76	1.6	-	74
22	3.022	0.141	0.96	76	1.6	-	74
23	3.161	0.139	0.95	77	1.6	-	74
24	3.302	0.141	0.96	77	1.6	-	74
25	3.443	0.141	0.96	78	1.8	-	74
26	3.582	0.139	0.96	78	1.6	-	75
27	3.724	0.142	0.97	78	1.7	-	75
28	3.865	0.141	0.97	78	1.6	-	75
29	4.006	0.141	0.96	79	1.7	-	75
30	4.148	0.142	0.98	79	1.7	100	75
31	4.290	0.142	0.98	79	1.8	-	75

BOX C TEST DATA - ASTM E2780 / ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

Elapsed Time (min)	Particulate Sampling Data						
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)
32	4.432	0.142	0.98	79	1.8	-	75
33	4.574	0.142	0.98	80	1.7	-	75
34	4.718	0.144	0.99	80	1.6	-	75
35	4.861	0.143	0.99	80	1.6	-	75
36	5.003	0.142	0.98	80	1.8	-	75
37	5.146	0.143	0.98	81	1.6	-	75
38	5.290	0.144	1.00	81	1.8	-	75
39	5.434	0.144	1.00	81	1.8	-	75
40	5.578	0.144	0.99	81	1.8	101	76
41	5.722	0.144	0.99	82	1.8	-	76
42	5.866	0.144	1.00	82	1.8	-	76
43	6.011	0.145	1.01	82	1.7	-	76
44	6.156	0.145	1.01	83	1.6	-	76
45	6.301	0.145	1.01	83	1.8	-	76
46	6.446	0.145	1.00	83	1.7	-	76
47	6.591	0.145	1.00	84	1.6	-	76
48	6.736	0.145	1.00	84	1.7	-	76
49	6.882	0.146	1.01	84	1.6	-	76
50	7.029	0.147	1.02	85	1.7	102	76
51	7.175	0.146	1.02	84	1.7	-	76
52	7.321	0.146	1.02	85	1.7	-	76
53	7.467	0.146	1.01	85	1.6	-	76
54	7.613	0.146	1.01	85	1.7	-	76
55	7.759	0.146	1.01	85	1.7	-	76
56	7.905	0.146	1.01	86	1.7	-	76
57	8.051	0.146	1.02	86	1.8	-	76
58	8.199	0.148	1.02	86	1.6	-	76
59	8.346	0.147	1.03	86	1.8	-	76
60	8.494	0.148	1.03	86	1.8	102	76
Avg/Tot	8.494	0.142	0.97	78.8	1.7	100	74.2

WOODSTOVE SURFACE TEMPERATURE DATA

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

Stove ΔT: 33

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	420	424	271	519	265	379.7	N/A
1	424	427	284	492	270	379.4	N/A
2	424	426	284	509	273	383.2	N/A
3	423	425	278	555	276	391.4	N/A
4	422	424	269	621	278	402.7	N/A
5	419	422	260	671	280	410.4	N/A
6	416	419	250	677	282	408.8	N/A
7	413	417	241	704	284	411.8	N/A
8	409	415	233	735	285	415.4	N/A
9	405	412	225	768	286	419.2	N/A
10	402	409	218	790	287	421.3	N/A
11	400	406	212	814	288	423.9	N/A
12	396	403	206	838	289	426.5	N/A
13	394	401	202	850	289	427.2	N/A
14	392	398	198	856	289	426.6	N/A
15	390	396	194	863	289	426.3	N/A
16	388	394	192	867	290	425.9	N/A
17	386	392	189	874	290	426.0	N/A
18	384	390	186	879	289	425.8	N/A
19	383	389	185	880	289	425.2	N/A
20	382	389	184	879	288	424.4	N/A
21	382	387	183	880	288	424.1	N/A
22	381	387	183	881	288	423.8	N/A
23	380	385	182	884	287	423.6	N/A
24	380	386	181	885	287	423.7	N/A
25	381	385	181	890	286	424.5	N/A
26	381	385	181	893	285	424.9	N/A
27	381	385	181	895	285	425.2	N/A
28	381	384	182	895	284	425.1	N/A
29	381	384	183	895	284	425.3	N/A
30	381	384	184	896	283	425.7	N/A
31	382	385	185	897	282	426.3	N/A
32	382	385	187	896	282	426.2	N/A
33	382	385	188	895	281	426.2	N/A
34	383	386	190	894	280	426.6	N/A
35	385	386	192	893	279	427.0	N/A
36	385	387	193	892	279	427.1	N/A
37	386	387	194	894	278	427.8	N/A
38	387	388	195	894	278	428.3	N/A
39	388	388	196	893	277	428.4	N/A
40	388	389	197	887	277	427.6	N/A
41	390	390	198	882	276	427.1	N/A
42	391	390	199	876	276	426.4	N/A
43	392	391	200	870	275	425.8	N/A
44	393	392	201	864	274	425.1	N/A
45	395	394	203	860	274	425.0	N/A
46	396	394	204	855	274	424.4	N/A
47	397	395	205	851	274	424.3	N/A

WOODSTOVE SURFACE TEMPERATURE DATA

Client: HHT

Job #: 24-281

Model: Aspen C3

Tracking #: 186

Run #: 2

Technician: AK

Date: 3/27/2024

Stove ΔT: 33

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
48	398	395	206	846	273	423.7	N/A
49	400	396	207	843	273	423.7	N/A
50	401	397	208	836	273	422.9	N/A
51	403	398	209	830	273	422.6	N/A
52	404	399	210	823	272	421.6	N/A
53	406	400	211	810	272	419.8	N/A
54	408	400	213	796	272	417.7	N/A
55	409	401	215	781	272	415.5	N/A
56	410	402	216	765	272	413.0	N/A
57	411	403	217	748	272	410.2	N/A
58	412	404	218	731	272	407.3	N/A
59	413	405	219	717	272	405.2	N/A
60	415	406	220	704	272	403.4	N/A
61	416	406	221	693	272	401.5	N/A
62	416	407	222	681	272	399.7	N/A
63	417	407	223	670	273	398.0	N/A
64	418	408	224	660	273	396.6	N/A
65	419	408	225	650	273	395.0	N/A
66	420	409	226	640	273	393.4	N/A
67	421	410	227	631	273	392.2	N/A
68	421	409	228	620	274	390.2	N/A
69	421	410	229	610	274	388.6	N/A
70	422	410	229	601	274	387.2	N/A
71	422	410	230	592	274	385.7	N/A
72	422	410	231	584	275	384.2	N/A
73	422	409	232	577	275	383.0	N/A
74	423	410	232	570	276	382.0	N/A
75	423	409	233	563	276	380.8	N/A
76	423	409	234	557	276	379.9	N/A
77	423	409	235	553	277	379.3	N/A
78	423	409	236	547	277	378.4	N/A
79	423	408	237	542	278	377.7	N/A
80	423	409	239	538	278	377.4	N/A
81	424	408	240	533	279	376.7	N/A
82	424	408	241	529	279	376.1	N/A
83	424	408	242	524	280	375.6	N/A
84	423	408	244	520	280	374.9	N/A
85	423	408	245	516	281	374.5	N/A
86	424	407	246	512	281	373.9	N/A
87	423	406	247	508	282	373.3	N/A
88	423	406	248	505	282	372.8	N/A
89	423	406	249	502	283	372.4	N/A
90	423	405	250	499	283	371.9	N/A
91	422	405	250	496	284	371.3	N/A
92	422	405	251	494	285	371.2	N/A
93	421	404	252	491	285	370.5	N/A
94	420	403	252	488	286	369.9	N/A
95	420	403	253	487	286	369.7	N/A

WOODSTOVE SURFACE TEMPERATURE DATA

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

Stove ΔT: 33

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
96	419	402	254	484	287	369.2	N/A
97	418	401	255	482	287	368.6	N/A
98	418	401	255	479	288	368.1	N/A
99	417	400	256	477	288	367.6	N/A
100	417	400	257	475	288	367.5	N/A
101	417	399	258	473	289	366.8	N/A
102	416	397	258	470	290	366.1	N/A
103	415	396	258	468	290	365.5	N/A
104	414	396	258	466	291	365.0	N/A
105	414	395	259	463	292	364.4	N/A
106	413	394	259	461	292	363.9	N/A
107	413	394	259	459	292	363.4	N/A
108	412	392	259	454	293	362.1	N/A
109	411	392	260	451	293	361.3	N/A
110	410	391	260	447	294	360.1	N/A
111	408	391	259	444	294	359.4	N/A
112	407	388	258	441	295	358.1	N/A
113	406	387	258	437	295	356.7	N/A
114	405	386	258	435	296	355.7	N/A
115	403	385	258	431	297	354.6	N/A
116	402	384	257	429	297	353.7	N/A
117	401	383	258	427	297	353.2	N/A
118	400	382	257	425	298	352.1	N/A
119	399	380	257	423	298	351.2	N/A
120	398	379	257	420	298	350.4	N/A
121	396	378	256	419	299	349.6	N/A
122	395	377	256	419	299	349.0	N/A
123	394	376	256	417	299	348.3	N/A
124	393	375	256	415	299	347.6	N/A
125	392	375	256	413	299	347.0	N/A
126	390	374	256	412	300	346.4	N/A
Average	405.8	398.1	228.0	655.5	282.7	394.0	N/A

LAB SAMPLE DATA - ASTM E2515

Client: HHT

Model: Aspen C3

Run #: 2

Job #: 24-281

Tracking #: 186

Technician: AK

Date: 3/27/2024

		Sample ID	Tare, mg	Final, mg	Catch, mg
Filters	A	G00985	241.6	244.2	2.6
	B	G00986	242.9	245.5	2.6
	C - 1st Hour	G00987	250.5	252.5	2.0
	Amb	G00988	240.6	240.7	0.1
Probes	A	5A	116757.3	116757.7	0.4
	B	5B	116875.4	116875.7	0.3
	C - 1st Hour	5C	115855.0	115855.2	0.2
O-rings	A	5A	3536.4	3536.8	0.4
	B	5B	3532.2	3532.8	0.6
	C - 1st Hour	5C	3376.7	3377.0	0.3

Placed in Dessicator on:

3/27/2024

Balance Audit (mg):

200.0

200.0

200.0

		Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time
Filters	A	244.8	3/29 10:00	244.4	4/1 8:30	244.2	4/2 9:15		
	B	245.6	3/29 10:00	245.5	4/1 8:30				
	C - 1st Hour	252.7	3/29 10:00	252.5	4/1 8:30				
	Amb	240.7	3/29 10:00	240.7	4/1 8:30				
Probes	A	116757.7	3/29 10:00	116757.7	4/1 8:30				
	B	116875.9	3/29 10:00	116875.7	4/1 8:30				
	C - 1st Hour	115855.3	3/29 10:00	115855.2	4/1 8:30				
O-Rings	A	3536.7	3/29 10:00	3536.8	4/1 8:30				
	B	3533.0	3/29 10:00	3532.8	4/1 8:30				
	C - 1st Hour	3377.0	3/29 10:00	3377.0	4/1 8:30				

Train A Aggregate, mg: 3.4

Train B Aggregate, mg: 3.5

Train C Aggregate, mg: 2.5

Ambient, mg: 0.1

ASTM E2780 Wood Heater Run Sheets

Client: HHT Job Number: 24-281 Tracking #: 186
Model: Aspen C3 Run Number: 2 Test Date: 3/27/24

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): N/A – Single Burn Rate
Targeted Burn Category: N/A – Single Burn Rate

Preburn Notes

Time	Notes
	-None-

Test Notes

Test Burn Start Time: 11:16 Test Fuel Loaded by: 25 seconds
Door Closed: 100 seconds Air Control Set at: N/A seconds
Other Loading Notes: Used alternate loading config due to loading difficulties – see photos

Time	Notes
	-None-

Test Burn End Time: 13:21

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.98 CO (%): 4.300
Mid Gas CO₂ (%): 10.06 CO (%): 2.538

Calibration Results:

	Pre Test			Post Test		
	Zero	Span	Mid	Zero	Span	Mid
Time	10:08	10:09	10:10	13:57	13:58	13:59
CO ₂	0.00	16.98	10.07	0.03	16.94	10.04
CO	0.000	4.300	2.526	0.011	4.273	2.497

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Technician Signature: 

Date: 4/8/2024

ASTM E2780 Wood Heater Run Sheets

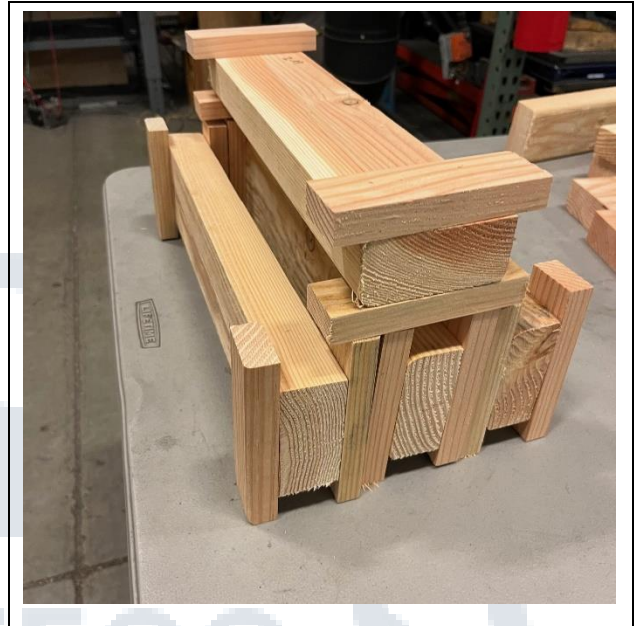
Client: HHT
Model: Aspen C3

Job Number: 24-281
Run Number: 2

Tracking #: 186
Test Date: 3/27/24



Test Fuel Front/Side View



Test Fuel Iso View



Test Fuel Loaded in Stove

N/A – Single Burn Rate

Air Setting

Technician Signature: _____

A handwritten signature in black ink, appearing to read "H. H. H.", written over a horizontal line.

Date: 4/8/2024

ASTM E2515 - Glass Fiber Filters

Date:	3/18/24	3/19/24					
Time:	12:30	8:30					
	Weight 1	Weight 2	Weight 3	Weight 4	Initial	Project	Run
G00965	241.6	241.7	-	-	SB	24-268	#2
G00966	241.8	241.9	-	-	SB	↓	↓
G00967	241.2	241.4	-	-	SB	↓	↓
G00968	241.3	241.2	-	-	SB	↓	↓
G00969	240.4	240.4	-	-	SB	24-268	#3
G00970	242.6	242.4	-	-	SB	↓	↓
G00971	241.2	241.4	-	-	SB	↓	↓
G00972	241.3	241.4	-	-	SB	↓	↓
G00973	240.9	241.0	-	-	SB	24-268	#4
G00974	241.4	241.4	-	-	SB	↓	↓
G00975	241.4	241.2	-	-	SB	↓	↓
G00976	241.1	241.1	-	-	SB	↓	↓
G00977	240.6	240.6	-	-	SB	24-268	#5
G00978	241.2	241.3	-	-	SB	↓	↓
G00979	241.7	241.7	-	-	SB	↓	↓
G00980	241.5	241.7	-	-	SB	↓	↓

Date:	3/21/24	3/22/24					
Time:	16:20	11:00					
	Weight 1	Weight 2	Weight 3	Weight 4	Initial	Project	Run
G00981	241.6	241.5	-	-	SB	24-281	#1
G00982	240.5	240.6	-	-	SB	↓	↓
G00983	240.7	240.6	-	-	SB	↓	↓
G00984	242.0	241.9	-	-	SB	↓	↓
G00985	241.7	241.6	-	-	SB	↓	#2
G00986	242.9	242.9	-	-	SB	↓	↓
G00987	250.5	250.5	-	-	SB	↓	↓
G00988	240.5	240.6	-	-	SB	↓	↓
G00989	231.4	231.3	-	-	SB		
G00990	239.9	239.9	-	-	SB		
G00991	240.5	240.4	-	-	SB		
G00992	241.2	241.3	-	-	SB		
G00993	241.1	241.2	-	-	SB		
G00994	241.4	241.5	-	-	SB		
G00995	240.5	240.5	-	-	SB		
G00996	241.4	241.4	-	-	SB		

ASTM E2515 - Probe Samples 1-10

Date:	3/18/24	3/19/24					
Time:	13:00	8:30					
	Weight 1	Weight 2	Weight 3	Weight 4	Initial	Project	Run
1A	115626.8	115627.0	—	—	SB	24-268	#3
1B	115902.1	115902.2	—	—	SB		
1C	116432.9	116432.8	—	—	SB		
2A	116057.3	116057.4	—	—	SB	24-268	#4
2B	116173.6	116173.8	—	—	SB		
2C	116428.9	116428.8	—	—	SB		
3A	115880.5	115880.5	—	—	SB	24-268	#5
3B	116120.4	116120.5	—	—	SB		
3C	116618.1	116618.1	—	—	SB		
4A	116022.6	116022.6	—	—	SB	24-281	#1
4B	116182.0	116181.8	—	—	SB		
4C	116997.2	116997.3	—	—	SB		
5A	116757.4	116757.3	—	—	SB	24-281	#2
5B	116875.5	116875.4	—	—	SB		
5C	115855.2	115855.0	—	—	SB		

Date:							
Time:							
	Weight 1	Weight 2	Weight 3	Weight 4	Initial	Project	Run
6A							
6B							
6C							
7A							
7B							
7C							
8A							
8B							
8C							
9A							
9B							
9C							
10A							
10B							
10C							

ASTM E2515 - O-Ring Samples 1-10

Date:	3/18/24	3/19/24					
Time:	12:30	8:30					
	Weight 1	Weight 2	Weight 3	Weight 4	Initial	Project	Run
1A	3569.0	3569.0	—	—	SB	24-268	#3
1B	3557.4	3557.4	—	—	SB		
1C	4167.3	4167.4	—	—	SB		
2A	3554.1	3554.1	—	—	SB	24-268	#4
2B	3573.0	3573.1	—	—	SB		
2C	3391.5	3391.5	—	—	SB		
3A	3580.6	3580.5	—	—	SB	24-268	#5
3B	3569.1	3569.2	—	—	SB		
3C	3623.4	3623.5	—	—	SB		
4A	3377.0	3377.0	—	—	SB	24-281	#1
4B	3580.6	3580.6	—	—	SB		
4C	3373.0	3373.0	—	—	SB		
5A	3536.3	3536.4	—	—	SB	24-281	#2
5B	3532.2	3532.2	—	—	SB		
5C	3376.8	3376.7	—	—	SB		

Date:							
Time:							
	Weight 1	Weight 2	Weight 3	Weight 4	Initial	Project	Run
6A							
6B							
6C							
7A							
7B							
7C							
8A							
8B							
8C							
9A							
9B							
9C							
10A							
10B							
10C							

Pre-Conditioning Data

Client: HHT	Job #: 24-281
Model: Aspen C3	Tracking #: 186
Date(s): 1/15/2024 - 2/15/2024	Technician: Bud Fongeallaz

Elapsed Time (hrs)	Flue (°F)	Catalyst Exit (°F)	Notes: Indicate initial air setting and any changes in in setting during conditioning, as well as weight and average moisture content of all fuel additions.
0	584	N/A	Added 9.6 lbs single burn rate. Moisture 19.825%
1	598	N/A	
2	456	N/A	
3	522	N/A	Added 9.8lbs single burn rate. Moisture 20.9%
4	603	N/A	
5	645	N/A	Added 10.0lbs single burn rate. Moisture 20.825%
6	604	N/A	
7	630	N/A	Added 9.9lbs single burn rate. Moisture 20.2%
8	600	N/A	
9	322	N/A	
10	534	N/A	Added 9.7lbs single burn rate. Moisture 20.075%
11	680	N/A	
12	655	N/A	Added 10.2lbs single burn rate. Moisture 19.65%
13	546	N/A	
14	486	N/A	
15	655	N/A	Added 9.8lbs single burn rate. Moisture 20.0%
16	420	N/A	
17	568	N/A	Added 9.6lbs single burn rate. Moisture 21.25%
18	652	N/A	
19	534	N/A	Added 8.6lbs single burn rate. Moisture 20.12%
20	400	N/A	
21	587	N/A	Added 10.5lbs single burn rate. Moisture 19.575%
22	678	N/A	
23	620	N/A	Added 8.1lbs single burn rate. Moisture 19.175%
24	498	N/A	
25	654	N/A	Added 10.4lbs single burn rate. Moisture 20.05%
26	462	N/A	
27	563	N/A	Added 9.2lbs single burn rate. 19.5%
28	372	N/A	
29	630	N/A	Added 11.3lbs single burn rate. Moisture 19.25%
30	668	N/A	
31	480	N/A	Added 8.8lbs single burn rate. Moisture 19.2%
32	411	N/A	
33	630	N/A	Added 10.0lbs single burn rate. Moisture 22.575%
34	682	N/A	
35	700	N/A	Added 7.7lbs single burn rate. Moisture 21.875%
36	436	N/A	
37	503	N/A	Added 11.4lbs single burn rate. Moisture 22.125%
38	644	N/A	
39	660	N/A	Added 10.6lbs single burn rate. Moisture 21.2%
40	400	N/A	
41	560	N/A	Added 9.6lbs single burn rate. Moisture 19.475%
42	601	N/A	
43	603	N/A	Added 9.9lbs single burn rate. Moisture 17.925%
44	498	N/A	
45	612	N/A	Added 11.7lbs single burn rate. Moisture 20.125%
46	606	N/A	
47	641	N/A	Added 8.8lbs single burn rate. Moisture 22.225%
48	502	N/A	
49	311	N/A	
50	632	N/A	Added 8.4lbs single burn rate. Moisture 17.675%

Sample Calculations – ASTM E2780 & E2515

Client: HHT
Model: Aspen C3
Run: 1

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

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

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

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

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

BR – Dry burn rate, kg/hr

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

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

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

m_n – Total particulate matter collected, mg

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

E_T – Total particulate emissions, g

PR - Proportional rate variation

PM_R – Particulate emissions for test run, g/hr

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

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

ASTM E2780 equation (1)

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

Where,

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

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

Sample Calculation:

$$FM_S = 12.4 \%$$

$$M_{Swb} = 1.6 \text{ lbs}$$

0.4536 = Conversion factor from lbs to kg

$$M_{Sdb} = [(1.6 \times 0.4536) (100/(100 + 12.4))]$$

$$M_{Sdb} = \mathbf{0.66 \text{ kg}}$$

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

ASTM E2780 equation (2)

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

Where,

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

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

Sample Calculation (test fuel piece 1):

$$M_{CPnwb} = 1.85$$

$$FM_{CPn} = 21.8$$

$$= 1.9 \quad (100/(100+ 21.8))$$

$$= 1.5 \text{ lbs}$$

Total dry crib weight, excluding spacers = 6.46 lbs

$$M_{Cdb} = \mathbf{2.93 \text{ kg}}$$

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

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

Where,

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

Sample calculation:

$$V_C = 351.8 \text{ in}^3$$

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

$$D_{Cdb} = 6.46 / 351.8 * 1728$$

$$= \mathbf{31.73 \text{ lbs/ft}^3}$$

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

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

Sample calculation:

$$M_{FTAdb} = 0.66 + 2.93$$

$$= 3.59 \text{ kg}$$

BR – dry burn rate, kg/hr

ASTM E2780 equation (5)

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

Where,

θ = Total length of test run, min

Sample Calculation:

$$M_{Bdb} = 3.59 \quad \text{kg}$$

$$\theta = 111 \quad \text{min}$$

$$BR = \frac{60 \times 3.59}{111}$$

$$BR = \mathbf{1.94} \quad \text{kg/hr}$$

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

ASTM E2515 equations (9)

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

Where:

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

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

Sample calculation:

$$F_p = \frac{18.20}{19.68} = 0.925$$

$$V_s = 0.925 \times 85.49 \times 0.99 \times 0.300 \times \left(\left(\frac{99.5}{29.94} + \frac{460}{-0.14} \right) \times \frac{28.78}{13.6} \right)^{1/2}$$

$$V_s = 18.95 \text{ ft/s}$$

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

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

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

ASTM E2515 equation (3)

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

Where:

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

Sample calculation:

$$Q_{sd} = 3600 \times (1 - 0.02) \times 18.95 \times 0.1963 \times \frac{528}{99.5 + 460} \times \frac{29.94 + \frac{-0.14}{13.6}}{29.92}$$

$Q_{sd} = 12387.5$ dscf/hr

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

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

Where:

K_1	=	17.64 °R/in. Hg
V_m	=	Volume of gas sample measured at the dry gas meter, dcf
Y	=	Dry gas meter calibration factor, dimensionless
P_{bar}	=	Barometric pressure at the testing site, in. Hg
ΔH	=	Average pressure differential across the orifice meter, in. H ₂ O
T_m	=	Absolute average dry gas meter temperature, °R

Sample Calculation:

Using equation for Train A:

$$V_{m(std)} = 17.64 \times 20.139 \times 1.004 \times \frac{\left(29.94 + \frac{3.40}{13.6} \right)}{\left(80.0 + 460 \right)}$$

$$V_{m(std)} = \mathbf{19.937} \text{ dscf}$$

Using equation for Train B:

$$V_{m(std)} = 17.64 \times 19.375 \times 1.005 \times \frac{\left(29.94 + \frac{3.13}{13.6} \right)}{\left(81.8 + 460 \right)}$$

$$V_{m(std)} = \mathbf{19.122} \text{ dscf}$$

Using equation for ambient train:

$$V_{m(std)} = 17.64 \times 9.09 \times 1.013 \times \frac{\left(\underline{29.935} + \frac{0.00}{13.6} \right)}{\left(67.6 + 460 \right)}$$

$$V_{m(std)} = \mathbf{9.216} \text{ dscf}$$

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 A:

$$m_n = 0.5 + 1.9 + 0.6$$

$$m_n = 3.0 \text{ mg}$$

Using equation for Train B:

$$m_n = 0.2 + 1.8 + 0.7$$

$$m_n = 2.7 \text{ mg}$$

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

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

Where:

K₂ = Constant, 0.001 g/mg

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

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

Sample calculation:

For Train A:

$$C_s = 0.001 \times \frac{3.0}{19.94}$$

$$C_s = \mathbf{0.00015} \text{ g/dscf}$$

For Train B

$$C_s = 0.001 \times \frac{2.7}{19.12}$$

$$C_s = \mathbf{0.00014} \text{ g/dscf}$$

For Ambient Train

$$C_r = 0.001 \times \frac{0.1}{9.22}$$

$$C_r = \mathbf{0.000011} \text{ g/dscf}$$

E_T – Total Particulate Emissions, g

ASTM E2515 equation (15)

$$E_T = (c_s - c_r) \times Q_{std} \times \theta$$

Where:

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

Sample calculation:

For Train A

$$E_T = (0.000150 - 0.000011) \times 12387.5 \times 111 / 60$$
$$E_T = \mathbf{3.20} \text{ g}$$

For Train B

$$E_T = (0.000141 - 0.000011) \times 12387.5 \times 111 / 60$$
$$E_T = \mathbf{2.99} \text{ g}$$

Average

$$E = \mathbf{3.09} \text{ g}$$

PR - Proportional Rate Variation

ASTM E2515 equation (16)

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

Where:

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

Sample calculation (for the first 10-min interval of Train 1):

$$PR = \left(\frac{111 \times 1.656 \times 18.95 \times (104.2 + 460) \times (80.0 + 460)}{10 \times 20.139 \times 19.01 \times (99.5 + 460) \times (69.9 + 460)} \right) \times 100$$

$$PR = 93 \%$$

PM_R – Particulate emissions for test run, g/hr

ASTM E2780 equation (6)

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

Where,

E_T = Total particulate emissions, grams

θ = Total length of full integrated test run, min

Sample Calculation:

$$E_T \text{ (Dual train average)} = 3.09 \text{ g}$$

$$\theta = 111 \text{ min}$$

$$PM_R = 60 \times (3.09 / 111)$$

$$PM_R = 1.67 \text{ g/hr}$$

PM_F – Particulate emission factor for test run, g/dry kg of fuel burned
ASTM E2780 equation (7)

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

Sample Calculation:

$$E_T \text{ (Dual train average)} = 3.09 \text{ g}$$

$$M_{Bdb} = 3.59 \text{ kg}$$

$$PM_F = 3.09 / 3.59$$

$$PM_F = \mathbf{0.86} \text{ g/kg}$$

Stack Loss Efficiency and CO emissions calculations are done in accordance with CSA B415.1, using the password protected excel spreadsheet provided with the test standard. No alterations or alternative calculations are used for determining efficiency or CO emissions. The following pages are a sample of the calculations page from the B415.1 Spreadsheet (V2_4 - Dated April 15, 2010).

Manufacturer: HHT
Model: Aspen C3
Date: 03/26/24
Run: 1
Control #: 24-281
Test Duration: 111 min

	HHV	LHV
Eff	70.89%	76.62%
Comb Eff	96.14%	96.14%
HT Eff	73.73%	79.69%
Output	26,933	kJ/h
Burn Rate	1.92	kg/h
Grams CO	193	g
Input	37,993	kJ/h
MC wet	16.90	
Averages	0.57	11.05

Note: In the "Input data", "Calc. % O₂", "Fuel Properties", and "Mass Balance" columns, [e], [d], [g], [a], [b], [c], [h], [u], [w], [j], and [k] refer to their respective variables in Clauses 13.7.3 to 13.7.5.

Ultimate CO₂
CO_{2-ult} 19.64
F₀
1.063

Overall Heating Efficiency: 70.89%
Combustion Efficiency: 96.14%
Heat Transfer Efficiency: 73.73%

Air Fuel
Dry Molecular W
Dry Moles Exhaus
Air Fuel Ratio

Heat Output: 25,549 Btu/h 26,933 kJ/h
Heat Input: 36,041 Btu/h 37,993 kJ/h

Burn Duration: 1.85 h
Burn Rate: 4.23 lb/h 1.918 kg/h
Stack Temp: 458.3 Deg. F 236.8 Deg. C

INPUT DATA				Oxygen Calculation			Input Data		Combust Eff	Heat Transfer	Net Eff	Air Fuel	Wet Wt
Elapsed Time	Weight Remaining (kg)	% CO [e]	% CO ₂ [d]	Excess Air EA	Total O ₂	Calc. % O ₂ [g]	Flue Gas (°C)	Room Temp (°C)	%	%	%	Ratio	Now Wt
0	4.27	0.05	7.02	178.2%	20.47	13.44	168.8	19.1	100.0%	75.5%	75.5%	16.8	4.27
1	4.19	0.27	4.08	351.9%	20.65	16.44	172.6	19.1	95.9%	65.8%	63.1%	27.1	4.19
2	4.12	0.79	3.77	330.7%	20.64	16.47	224.9	19.1	86.6%	55.4%	48.0%	25.3	4.12
3	4.07	0.55	4.72	272.9%	20.59	15.60	259.3	19.2	92.1%	56.8%	52.3%	22.1	4.07
4	3.98	0.52	8.03	129.7%	20.38	12.08	330.3	19.1	95.2%	62.8%	59.8%	13.7	3.98
5	3.89	0.24	9.23	107.4%	20.31	10.97	336.1	19.2	98.2%	65.4%	64.2%	12.5	3.89
6	3.82	0.72	13.26	40.5%	20.02	6.40	291.1	19.4	95.8%	74.3%	71.2%	8.4	3.82
7	3.75	0.54	13.61	38.8%	20.01	6.12	290.8	19.3	96.9%	74.7%	72.4%	8.3	3.75
8	3.68	0.60	14.46	30.4%	19.95	5.18	294.9	19.3	96.8%	75.2%	72.7%	7.8	3.68
9	3.60	0.58	14.73	28.3%	19.93	4.91	301.7	19.3	96.9%	75.0%	72.7%	7.7	3.60
10	3.52	0.60	15.30	23.6%	19.89	4.30	309.0	19.3	96.9%	75.1%	72.8%	7.4	3.52
11	3.44	0.66	15.42	22.2%	19.88	4.13	314.7	19.4	96.6%	74.9%	72.3%	7.4	3.44
12	3.36	0.51	15.45	23.1%	19.89	4.18	319.5	19.4	97.4%	74.7%	72.7%	7.4	3.36
13	3.28	0.65	15.80	19.4%	19.85	3.72	324.1	19.4	96.7%	74.7%	72.2%	7.2	3.28
14	3.20	0.93	16.14	15.1%	19.81	3.21	331.8	19.4	95.5%	74.5%	71.1%	6.9	3.20
15	3.11	1.09	16.30	12.9%	19.79	2.94	337.4	19.5	94.8%	74.2%	70.4%	6.8	3.11
16	3.02	1.21	16.29	12.3%	19.78	2.89	340.4	19.6	94.2%	74.1%	69.8%	6.7	3.02
17	2.94	1.03	16.07	14.9%	19.81	3.23	342.9	19.6	95.0%	73.8%	70.1%	6.9	2.94
18	2.85	0.98	16.18	14.5%	19.81	3.14	343.6	19.6	95.2%	73.9%	70.3%	6.9	2.85
19	2.77	1.03	16.26	13.7%	19.80	3.03	344.4	19.7	95.0%	73.9%	70.2%	6.8	2.77
20	2.68	1.03	16.34	13.1%	19.79	2.94	345.6	19.7	95.0%	73.9%	70.2%	6.8	2.68
21	2.60	1.16	16.47	11.4%	19.78	2.72	347.0	19.7	94.5%	73.9%	69.8%	6.7	2.60
22	2.51	1.20	16.56	10.6%	19.77	2.60	346.2	19.8	94.4%	74.0%	69.8%	6.6	2.51
23	2.42	1.83	16.65	6.3%	19.72	2.16	350.8	19.9	91.7%	73.7%	67.6%	6.3	2.42
24	2.34	0.96	16.30	13.8%	19.80	3.02	343.1	19.9	95.4%	74.0%	70.6%	6.8	2.34
25	2.26	0.58	15.68	20.8%	19.87	3.90	335.8	19.9	97.1%	74.0%	71.8%	7.3	2.26
26	2.19	0.43	15.32	24.7%	19.90	4.36	331.5	19.8	97.8%	74.0%	72.3%	7.5	2.19
27	2.11	0.42	15.36	24.5%	19.90	4.33	328.5	19.8	97.8%	74.2%	72.6%	7.5	2.11
28	2.04	0.45	15.57	22.6%	19.88	4.09	330.2	19.8	97.7%	74.2%	72.5%	7.4	2.04
29	1.97	0.48	15.78	20.8%	19.87	3.85	330.1	19.8	97.6%	74.4%	72.6%	7.3	1.97
30	1.91	0.52	15.83	20.1%	19.86	3.76	330.8	19.8	97.4%	74.4%	72.4%	7.2	1.91
31	1.84	0.56	15.88	19.5%	19.85	3.70	331.6	19.8	97.2%	74.4%	72.3%	7.2	1.84
32	1.76	0.56	15.94	19.0%	19.85	3.63	333.1	19.9	97.2%	74.3%	72.2%	7.2	1.76
33	1.70	0.50	16.04	18.7%	19.85	3.55	332.0	19.8	97.5%	74.5%	72.6%	7.2	1.70
34	1.64	0.41	15.82	21.0%	19.87	3.84	328.4	19.8	97.9%	74.5%	73.0%	7.3	1.64
35	1.57	0.31	15.31	25.7%	19.91	4.44	322.2	19.9	98.4%	74.5%	73.3%	7.6	1.57
36	1.51	0.29	14.93	29.0%	19.93	4.86	318.4	19.9	98.5%	74.4%	73.3%	7.8	1.51
37	1.46	0.29	14.85	29.8%	19.94	4.95	313.7	19.9	98.5%	74.6%	73.5%	7.8	1.46

Ratio (A/F)	
Weight (M _g)	30.12
st Gas (N ₂)	365.87
o (A/F)	10.51

%HC
1.32

Combustion Efficiency: 96.14%
 Total Input (kJ): 70,287 66,664 (Btu)
 Total Output (kJ): 49,826 47,258 (Btu)
 Efficiency: 70.89%
 Total CO (g): 193.17

Moisture of Wood (wet basis): 16.8975
 Initial Dry Weight W_{t_{do}} (kg): 3.55
 Moisture Content Dry 20.33

Load Weight (kg): 4.27
 Fuel Heating HHV LHV HHV
 Value in kJ/kg - CV: 19,810 18,329 Btu/lb 8522.5

70.06	1.09	69.26	70330	4.06	6.87	2.74	19810.00	16.90	79.54	21.10	2.88	9.75	0.07	0.29	38.41
% Wet Consumed	Dry Wt. Now	% Dry Consumed	Total Input	Fuel Properties				Mw Moisture Fuel Burnt	Mass Balance (moles/100 mole dry flue gas)					kg Wood per 100 mole dfp	
x	W _{t_{dn}}	y		Carbon /12= [a]	Hydrogen /1= [b]	Oxygen /16= [c]	Calorific Value		[h]	[u]	[w]	[j]	[k]	Nk	CO ₂
0.00	3.55	0.00	0	4.06	6.87	2.74	19810.00	16.90	79.50	21.09	1.74	5.99	-0.01	0.17	40.63
1.81	3.48	1.81	1830	4.06	6.87	2.74	19810.00	16.90	79.21	21.01	1.07	3.66	0.01	0.11	38.22
3.40	3.43	3.40	1008	4.06	6.87	2.74	19810.00	16.90	78.97	20.95	1.15	3.76	0.09	0.11	33.10
4.68	3.38	4.68	1195	4.06	6.87	2.74	19810.00	16.90	79.13	20.99	1.31	4.39	0.06	0.13	36.17
6.80	3.31	6.80	1494	4.06	6.87	2.74	19810.00	16.90	79.36	21.05	2.12	7.17	0.06	0.21	38.06
8.93	3.23	8.93	1344	4.06	6.87	2.74	19810.00	16.90	79.56	21.10	2.34	7.99	0.02	0.23	39.69
10.63	3.17	10.63	1158	4.06	6.87	2.74	19810.00	16.90	79.62	21.12	3.47	11.71	0.09	0.34	38.45
12.22	3.11	12.22	1158	4.06	6.87	2.74	19810.00	16.90	79.72	21.15	3.50	11.89	0.07	0.35	39.05
13.92	3.05	13.92	1232	4.06	6.87	2.74	19810.00	16.90	79.76	21.16	3.73	12.65	0.08	0.37	38.99
15.73	2.99	15.73	1307	4.06	6.87	2.74	19810.00	16.90	79.78	21.16	3.79	12.86	0.08	0.38	39.09
17.64	2.92	17.64	1270	4.06	6.87	2.74	19810.00	16.90	79.81	21.17	3.93	13.35	0.08	0.39	39.09
19.34	2.86	19.34	1270	4.06	6.87	2.74	19810.00	16.90	79.79	21.17	3.98	13.50	0.09	0.40	38.93
21.25	2.79	21.25	1307	4.06	6.87	2.74	19810.00	16.90	79.86	21.18	3.95	13.42	0.07	0.39	39.34
23.06	2.73	23.06	1344	4.06	6.87	2.74	19810.00	16.90	79.82	21.17	4.07	13.82	0.09	0.41	38.98
25.08	2.66	25.08	1457	4.06	6.87	2.74	19810.00	16.90	79.72	21.15	4.24	14.29	0.13	0.42	38.31
27.21	2.58	27.21	1457	4.06	6.87	2.74	19810.00	16.90	79.66	21.13	4.32	14.54	0.15	0.43	37.92
29.22	2.51	29.22	1344	4.06	6.87	2.74	19810.00	16.90	79.61	21.12	4.35	14.60	0.17	0.43	37.62
31.03	2.45	31.03	1382	4.06	6.87	2.74	19810.00	16.90	79.67	21.13	4.25	14.29	0.15	0.42	38.03
33.16	2.37	33.16	1457	4.06	6.87	2.74	19810.00	16.90	79.70	21.14	4.26	14.36	0.14	0.42	38.17
35.18	2.30	35.18	1419	4.06	6.87	2.74	19810.00	16.90	79.69	21.14	4.29	14.45	0.14	0.43	38.07
37.19	2.23	37.19	1419	4.06	6.87	2.74	19810.00	16.90	79.69	21.14	4.31	14.53	0.15	0.43	38.06
39.21	2.16	39.21	1419	4.06	6.87	2.74	19810.00	16.90	79.64	21.13	4.38	14.73	0.17	0.44	37.77
41.23	2.09	41.23	1457	4.06	6.87	2.74	19810.00	16.90	79.63	21.12	4.42	14.83	0.17	0.44	37.70
43.36	2.01	43.36	1419	4.06	6.87	2.74	19810.00	16.90	79.36	21.05	4.62	15.33	0.26	0.46	36.25
45.27	1.94	45.27	1270	4.06	6.87	2.74	19810.00	16.90	79.72	21.15	4.28	14.44	0.13	0.43	38.26
46.97	1.88	46.97	1232	4.06	6.87	2.74	19810.00	16.90	79.85	21.18	4.02	13.66	0.08	0.40	39.18
48.78	1.82	48.78	1232	4.06	6.87	2.74	19810.00	16.90	79.88	21.19	3.89	13.26	0.06	0.39	39.55
50.48	1.76	50.48	1195	4.06	6.87	2.74	19810.00	16.90	79.89	21.19	3.90	13.29	0.05	0.39	39.59
52.18	1.70	52.18	1158	4.06	6.87	2.74	19810.00	16.90	79.89	21.19	3.96	13.48	0.06	0.39	39.53
53.77	1.64	53.77	1120	4.06	6.87	2.74	19810.00	16.90	79.89	21.19	4.02	13.68	0.06	0.40	39.45
55.37	1.58	55.37	1120	4.06	6.87	2.74	19810.00	16.90	79.88	21.19	4.05	13.76	0.07	0.40	39.34
56.96	1.53	56.96	1158	4.06	6.87	2.74	19810.00	16.90	79.87	21.18	4.07	13.82	0.08	0.40	39.25
58.66	1.47	58.66	1120	4.06	6.87	2.74	19810.00	16.90	79.87	21.19	4.08	13.87	0.08	0.41	39.24
60.15	1.41	60.15	1046	4.06	6.87	2.74	19810.00	16.90	79.90	21.19	4.09	13.92	0.07	0.41	39.41
61.64	1.36	61.64	1083	4.06	6.87	2.74	19810.00	16.90	79.93	21.20	4.01	13.67	0.05	0.40	39.66
63.23	1.30	63.23	1046	4.06	6.87	2.74	19810.00	16.90	79.94	21.20	3.86	13.17	0.04	0.38	39.90
64.61	1.26	64.61	934	4.06	6.87	2.74	19810.00	16.90	79.92	21.20	3.76	12.84	0.03	0.37	39.94
65.89	1.21	65.89	896	4.06	6.87	2.74	19810.00	16.90	79.92	21.20	3.73	12.76	0.03	0.37	39.95

Moisture Content M_{Cwb} : 16.89751

Dry kg : 3.55

CA: 49

HY: 7

OX: 43.9

LHV
7885.2

37.79	2.15	0.25	303.48	34.02	11.30	509.39	8989.25	6602.75	6380.79	6318.45	9008.96	7622.97	292.92	38903.22	23199.20
Moles per kg of Dry Wood					Moisture	Stack Temp K	Heat Content Change - Ambient to Stack Temperature Flue Gas Constituent						Room Temp K		
O ₂	CO	HC	N ₂	H ₂ O	Present		CO ₂	O ₂	CO	N ₂	CH ₄	H ₂ O		CO ₂	O ₂
77.81	0.27	-0.09	460.42	34.69	11.30	441.98	6018.93	4506.19	4376.17	4328.88	5845.57	5234.95	292.21	244.52	350.61
153.90	2.48	0.11	741.64	34.29	11.30	445.76	6179.15	4622.46	4488.17	4439.86	6009.25	5368.64	292.21	236.15	711.41
144.59	6.93	0.78	693.13	32.97	11.30	498.04	8436.76	6242.96	6044.69	5983.18	8354.45	7225.14	292.26	279.26	902.67
119.63	4.22	0.42	606.83	33.68	11.30	532.48	9966.82	7323.55	7078.06	7008.76	9982.62	8456.19	292.32	360.52	876.12
57.28	2.48	0.27	376.19	33.98	11.30	603.43	13233.14	9587.85	9232.29	9149.12	13551.40	11018.94	292.26	503.64	549.20
47.16	1.05	0.08	342.21	34.37	11.30	609.21	13503.29	9772.49	9407.25	9323.10	13852.36	11226.85	292.32	535.96	460.89
18.56	2.09	0.27	230.92	33.97	11.30	564.21	11399.89	8323.15	8030.71	7954.92	11534.92	9590.03	292.54	438.32	154.46
17.56	1.56	0.20	228.72	34.12	11.30	563.93	11389.26	8315.93	8023.88	7948.13	11522.96	9581.93	292.48	444.78	146.04
13.97	1.61	0.21	215.02	34.10	11.30	568.09	11582.84	8450.38	8151.87	8075.27	11733.92	9734.20	292.43	451.66	118.09
13.02	1.53	0.20	211.66	34.12	11.30	574.82	11892.82	8664.99	8355.97	8278.08	12073.21	9976.98	292.43	464.84	112.84
10.98	1.52	0.20	203.94	34.11	11.30	582.15	12230.36	8897.94	8577.31	8498.06	12444.29	10240.21	292.48	478.06	97.68
10.43	1.66	0.23	201.45	34.07	11.30	587.87	12492.25	9078.05	8748.29	8668.01	12733.58	10443.48	292.59	486.31	94.68
10.64	1.30	0.17	203.33	34.18	11.30	592.65	12715.17	9231.39	8893.85	8812.71	12979.76	10616.55	292.59	500.27	98.21
9.18	1.61	0.22	196.88	34.08	11.30	597.26	12933.05	9381.21	9036.06	8954.07	13220.50	10785.62	292.54	504.15	86.15
7.61	2.20	0.31	189.19	33.91	11.30	604.93	13291.06	9626.38	9268.51	9185.20	13618.24	11061.89	292.59	509.18	73.25
6.84	2.54	0.36	185.27	33.80	11.30	610.54	13553.59	9805.71	9438.42	9354.16	13910.91	11263.79	292.65	513.90	67.12
6.68	2.79	0.40	183.89	33.73	11.30	613.59	13693.86	9901.11	9528.68	9443.95	14068.21	11371.01	292.76	515.21	66.15
7.65	2.44	0.34	188.59	33.84	11.30	616.04	13809.65	9980.10	9603.50	9518.36	14197.52	11459.90	292.76	525.12	76.30
7.41	2.32	0.33	188.05	33.87	11.30	616.71	13841.26	10001.66	9623.91	9538.66	14232.84	11484.15	292.76	528.28	74.09
7.10	2.40	0.34	186.64	33.84	11.30	617.54	13878.68	10026.97	9647.82	9562.45	14275.10	11512.54	292.82	528.37	71.18
6.84	2.41	0.34	185.66	33.84	11.30	618.71	13934.05	10064.70	9683.55	9597.99	14337.03	11554.99	292.82	530.38	68.89
6.24	2.66	0.38	182.62	33.77	11.30	620.15	14002.67	10111.44	9727.79	9642.00	14413.82	11607.55	292.82	528.88	63.13
5.93	2.73	0.39	181.24	33.75	11.30	619.32	13956.74	10079.57	9697.46	9611.86	14363.69	11571.47	292.98	526.14	59.74
4.70	3.99	0.57	172.82	33.37	11.30	623.98	14174.50	10227.40	9837.27	9750.95	14608.47	11737.51	293.09	513.81	48.03
7.09	2.24	0.32	187.08	33.89	11.30	616.26	13807.51	9977.48	9600.70	9515.64	14197.67	11456.47	293.09	528.22	70.74
9.74	1.44	0.19	199.51	34.14	11.30	608.93	13462.72	9742.28	9377.95	9294.11	13812.58	11191.82	293.04	527.49	94.89
11.26	1.12	0.14	206.23	34.23	11.30	604.65	13265.30	9607.62	9250.42	9167.28	13592.08	11040.30	292.93	524.64	108.22
11.15	1.08	0.14	205.91	34.24	11.30	601.65	13124.21	9510.99	9158.81	9076.18	13435.34	10931.41	292.93	519.59	106.07
10.38	1.13	0.15	202.85	34.23	11.30	603.32	13200.45	9563.03	9208.10	9125.21	13520.42	10989.98	292.98	521.84	99.29
9.62	1.20	0.16	199.77	34.20	11.30	603.21	13195.22	9559.45	9204.71	9121.83	13514.61	10985.94	292.98	520.55	92.00
9.35	1.30	0.17	198.44	34.17	11.30	603.98	13231.81	9584.51	9228.46	9145.45	13555.27	11014.18	292.98	520.49	89.62
9.14	1.38	0.19	197.41	34.15	11.30	604.71	13267.92	9609.41	9252.12	9168.97	13594.99	11042.31	292.93	520.76	87.82
8.94	1.39	0.19	196.63	34.15	11.30	606.21	13334.34	9654.49	9294.75	9211.38	13669.68	11092.94	293.04	523.22	86.30
8.73	1.23	0.17	196.31	34.19	11.30	605.15	13286.73	9622.10	9264.10	9180.89	13616.31	11056.53	292.98	523.67	84.03
9.63	1.02	0.13	200.32	34.26	11.30	601.59	13119.48	9507.57	9155.51	9072.92	13430.50	10927.47	292.98	520.31	91.52
11.56	0.82	0.10	208.25	34.32	11.30	595.37	12825.57	9305.77	8964.05	8882.58	13105.10	10699.87	293.04	511.70	107.59
12.99	0.78	0.09	213.75	34.34	11.30	591.54	12644.25	9181.00	8845.59	8764.82	12904.96	10559.03	293.09	504.99	119.23
13.33	0.77	0.09	215.06	34.34	11.30	586.82	12424.07	9029.49	8701.74	8621.84	12661.93	10388.00	293.09	496.33	120.34

SUMS					AVERAGE	SUMS						
69459.55	198153.72	25382.23	196599.10	65273.91	5508.67	20449.28	2700.51	17748.77	49880.82	2712.48	193.17	13.45
Energy Losses (kJ/kg of Dry Fuel)					Total Loss Rate							
Flue Gas Constituent						Total Loss	Chemical Loss 1	Sensible and Latent Loss	Total Output	Chem Loss 2	Grams Produced	
CO	N ₂	CH ₄	H ₂ O Comb	H ₂ O Fuel MC							CO	HC
78.21	1993.11	-76.61	1707.06	555.83	4852.73	0.00	0	0.00	0	0	0.00	0.00
713.25	3292.77	102.20	1692.01	557.34	7305.14	674.83	74	600.60	1155	74	6.42	0.17
2004.25	4147.10	699.19	1687.68	578.31	10298.46	524.21	135	389.07	484	135	9.88	0.63
1223.43	4253.13	380.16	1765.57	592.22	9451.15	570.17	95	475.49	625	95	7.12	0.41
725.84	3441.82	243.92	1868.64	621.17	7954.22	599.83	71	528.71	894	71	5.24	0.33
305.61	3190.49	69.13	1897.06	623.51	7082.66	480.70	25	456.00	864	25	1.99	0.08
607.68	1836.92	247.53	1819.59	605.02	5709.53	333.68	49	284.87	824	49	3.42	0.26
454.20	1817.91	179.66	1827.38	604.93	5474.90	319.97	36	283.79	838	36	2.55	0.19
467.80	1736.32	190.96	1831.23	606.65	5402.73	336.12	40	296.11	896	40	2.80	0.21
444.43	1752.13	181.72	1840.63	609.39	5405.98	356.71	40	316.40	950	40	2.82	0.21
443.30	1733.10	184.10	1849.33	612.37	5397.94	346.00	39	306.79	924	39	2.73	0.21
483.92	1746.21	203.16	1853.97	614.66	5482.92	351.45	43	308.52	918	43	2.98	0.23
378.27	1791.88	155.15	1865.68	616.62	5406.09	356.72	34	322.43	950	34	2.39	0.18
470.36	1762.90	198.75	1866.18	618.53	5507.02	373.76	44	329.53	971	44	3.06	0.24
641.52	1737.71	278.11	1865.94	621.65	5727.36	421.11	66	355.29	1035	66	4.52	0.36
742.00	1733.08	324.43	1867.14	623.93	5871.60	431.71	76	355.43	1025	76	5.22	0.42
816.91	1736.67	358.37	1866.62	625.14	5985.06	406.20	78	328.62	938	78	5.31	0.43
714.74	1795.03	310.89	1875.44	626.15	5923.68	413.20	70	343.64	969	70	4.77	0.38
678.68	1793.78	294.99	1878.21	626.42	5874.45	431.92	70	362.31	1025	70	4.77	0.38
703.21	1784.70	306.47	1877.77	626.74	5898.44	422.56	70	352.24	997	70	4.82	0.39
705.04	1781.94	307.65	1879.06	627.22	5900.18	422.69	71	352.16	997	71	4.83	0.39
779.93	1760.81	342.24	1876.59	627.81	5979.39	428.36	78	350.22	991	78	5.34	0.43
798.03	1742.04	350.87	1874.31	627.41	5978.54	439.57	82	357.45	1017	82	5.61	0.46
1168.17	1685.13	519.29	1859.19	629.28	6422.90	460.14	117	342.66	959	117	8.00	0.66
655.73	1780.23	285.12	1878.48	626.11	5824.63	373.35	59	314.71	896	59	4.02	0.32
420.06	1854.27	175.15	1882.92	623.12	5577.91	347.02	36	311.00	885	36	2.50	0.19
326.68	1890.53	130.88	1883.13	621.41	5485.49	341.27	28	313.57	891	28	1.95	0.14
316.25	1868.85	126.37	1879.95	620.18	5437.24	328.02	26	302.03	867	26	1.83	0.13
330.88	1851.04	134.07	1881.02	620.84	5438.98	317.87	26	291.42	840	26	1.85	0.14
351.43	1822.26	144.44	1879.62	620.79	5431.10	307.17	27	279.87	813	27	1.90	0.14
380.40	1814.81	157.89	1878.95	621.11	5463.27	308.99	30	279.36	811	30	2.06	0.16
402.36	1810.08	168.09	1878.67	621.43	5489.21	320.81	32	288.36	837	32	2.25	0.17
405.13	1811.25	169.62	1880.22	622.00	5497.74	310.94	32	279.31	809	32	2.20	0.17
360.46	1802.28	149.79	1881.39	621.59	5423.21	286.28	26	260.07	759	26	1.82	0.14
298.01	1817.50	120.36	1880.54	620.13	5348.37	292.41	22	270.14	791	22	1.56	0.12
238.07	1849.80	90.57	1876.35	617.56	5291.64	279.33	17	262.44	766	17	1.21	0.08
227.91	1873.44	83.94	1872.31	615.97	5297.79	249.69	14	235.38	684	14	1.03	0.07
225.29	1854.20	82.28	1866.64	614.04	5259.11	237.96	14	224.40	658	14	0.98	0.07



Owner's Manual

Operation & Care

INSTALLER: Leave this manual with party responsible for use and operation.

OWNER: Retain this manual for future reference.

Contact your dealer with questions on installation, operation, or service.

NOTICE: SAVE THESE INSTRUCTIONS

VERMONT  CASTINGS

Aspen C3 Wood Stove



For use in the United States and Canada

Installation and service of this appliance should be performed by qualified personnel. Hearth & Home Technologies recommends HHT Factory Trained or NFI certified professionals.

hearthED
FACTORY TRAINING
Fuel Your Fire



NOTE

To obtain a French translation of this manual, please contact your dealer or visit www.vermontcastings.com

Pour obtenir une traduction française de ce manuel, s'il vous plaît contacter votre revendeur ou visitez www.vermontcastings.com

WARNING



If the information in these instructions is not followed exactly, a fire may result causing property damage, personal injury, or death.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- Do not over fire - If appliance or chimney connector glows, you are over firing. Over firing will void your warranty.
- Comply with all minimum clearances to combustibles as specified. Failure to comply may cause house fire.

WARNING



HOT SURFACES!

Glass and other surfaces are hot during operation AND cool down.

Hot glass will cause burns.

- Do not touch glass until it is cooled
- NEVER allow children to touch glass
- Keep children away
- CAREFULLY SUPERVISE children in same room as fireplace.
- Alert children and adults to hazards of high temperatures
- **High temperatures may ignite clothing or other flammable materials.**
- Keep clothing, furniture, draperies and other flammable materials away.

Safety Alert Key:

- **DANGER!** Indicates a hazardous situation which, if not avoided will result in death or serious injury.
 - **WARNING!** Indicates a hazardous situation which, if not avoided could result in death or serious injury.
 - **CAUTION!** Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
 - **NOTICE:** Indicates practices which may cause damage to the appliance or to property.
-

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→ = Contains updated information

A. Warranty Policy

Hearth & Home Technologies LLC

LIMITED WARRANTY

Hearth & Home Technologies LLC ("HHT") extends the following warranty for HHT gas, wood, pellet and electric hearth appliances (each a "Product" and collectively, the "Product(s)") and certain component parts set forth in the table below ("Component Part(s)") that are purchased from a HHT authorized dealer or distributor.

WARRANTY COVERAGE:

HHT warrants that the Products and their Component Parts will be free from defects in materials and workmanship for the applicable period of Warranty coverage set forth in the table below ("Warranty Period"). If a Product or Component Parts are found to be defective in materials or workmanship during the applicable Warranty Period, HHT will, at our discretion, repair the applicable Component Part(s), replace the applicable Component Part(s), or refund the purchase price of the applicable Product(s). The maximum amount recoverable under this Warranty is limited to the purchase price of the Product. This Warranty is transferable from the original purchaser to subsequent owners, but the Warranty Period will not be extended in duration or expanded in coverage for any such transfer. This Warranty is subject to conditions, exclusions, and limitations as described below.

WARRANTY PERIOD:

Warranty coverage begins at the date of installation. In the case of new home constructions, Warranty coverage begins six months after invoice of the final sale of the Product(s) by an independent, authorized HHT dealer or distributor. However, the Warranty coverage shall commence no later than 24 months following the date of Product shipment from HHT, regardless of the installation or purchase date.

Warranty Period		HHT Manufactured Appliances and Venting				
Component Parts	Labor	Gas	Pellet	Wood	Electric	Component Parts Covered by this Warranty
1 Year		X	X	X		All parts including handles, external enameled components and other material except as covered by Warranty Conditions, Warranty Exclusions, and Warranty Limitations listed
2 Years					X	All parts except as covered by Warranty Conditions, Warranty Exclusions, and Warranty Limitations listed
			X	X		Glass, Electrical components limited to heating element/igniters, Top feed auger assembly, Blowers, Junction Box, Remotes/Wall switches, linear actuator, power cord, vacuum switch, snap disc, wire harnesses and thermocouple
		X				Electrical components limited to modules, remotes/wall switches, valves, pilots, blowers, junction boxes, wire harnesses, transformers and lights (excluding light bulbs)
		X		X		Cement Refractory Panels, Glass Liner Panels
3 years			X			Firepots, burnpots, Harman mechanical feeders
5 years		X		X		Catalysts, Vented and Vent Free burners and logs
10 years	1 year	X				Burners, logs and metal/fiber refractory components of HHT manufactured fireplaces or stoves, venting due to poor workmanship
10 years	3 years		X	X		Castings, Medallions & Baffles, FlexBurn® System (engine, inner cover, access cover and fireback), Firebox and heat exchanger, HHT Chimney & Terminations, Manifolds
20 years	3 years	X				Firebox and heat exchanger
All purchased replacement parts and optional accessories						
1 Year	None	X	X	X	X	All purchased replacement parts and optional accessories

WARRANTY CONDITIONS:

- Because HHT cannot control the quality of any Products sold by unauthorized sellers, this Warranty only covers Products that are purchased through an HHT authorized dealer or distributor unless otherwise prohibited by law; a list of HHT authorized dealers is available on the HHT branded websites.
- This Warranty is only valid while the applicable Product remains at the site of original installation.
- This Warranty is only valid in the country in which the HHT authorized dealer or distributor that sold the applicable Product is authorized to sell applicable Product.
- Contact your installing distributor or dealer for Warranty service. If the installing dealer or distributor is unable to provide necessary parts, contact the nearest HHT authorized dealer or supplier. Additional service fees may apply if you are seeking Warranty service from a dealer other than the dealer from whom you originally purchased the applicable Product.
- No HHT consumer should bear cost of warranty service or costs incurred while servicing warranty claims (i.e., travel, gas, or mileage) when the service is performed within the terms of this Warranty. Check with your dealer or distributor in advance for any costs to you when arranging a warranty call. Travel and shipping charges for parts are not covered by this Warranty.

WARRANTY EXCLUSIONS:

This Warranty does not cover the following:

- Changes in surface finishes as a result of normal use. As a heating appliance, some changes in color of interior and exterior surface finishes may occur. This is not a flaw and is not covered under the Warranty.
- Damage to printed, plated, or enameled surfaces caused by fingerprints, accidents, misuse, scratches, melted items or other external sources and residues left on the plated surfaces from the use of abrasive cleaners or polishes.
- Repair or replacement of parts that are subject to normal wear and tear during the Warranty Period are not covered. These parts include: paint, wood and pellet gaskets, firebricks, wood grates, flame guides, batteries and the discoloration of glass.
- Minor expansion, contraction, or movement of certain parts causing noise. These conditions are normal and complaints related to this noise are not covered by this Warranty.
- Damages resulting from: (1) failure to install, operate, or maintain the applicable Product in accordance with the installation instructions, operating instructions, and listing agent identification label furnished with the applicable Product; (2) failure to install the applicable Product in accordance with local building codes; (3) shipping or improper handling; (4) improper operation, abuse, misuse, continued operation with damaged, corroded or failed components, accident, or improperly/incorrectly performed repairs; (5) environmental conditions, inadequate ventilation, negative pressure, or drafting caused by tightly sealed constructions, insufficient make-up air supply, or handling devices such as exhaust fans or forced air furnaces or other such causes; (6) use of fuels other than those specified in the operation instructions; (7) installation or use of components not supplied with the applicable Product or any other components not expressly authorized and approved by HHT; (8) modification of the appliance not expressly authorized and approved by HHT in writing; and/or (9) interruptions or fluctuations of electrical power supply to the applicable Product.
- Non-HHT venting components, hearth connections or other accessories used in conjunction with the applicable Product.
- Any part of a pre-existing fireplace system in which an insert or a decorative gas applicable Product is installed.
- HHT's obligation under this Warranty does not extend to the Product's capability to heat the desired space. Information is provided to assist the consumer and the dealer in selecting the proper Product for the application. Consideration must be given to the Product location and configuration, environmental conditions, insulation and air tightness of the structure.

This warranty is void if:

- The applicable Product has been over-fired, operated in atmospheres contaminated by chlorine, fluorine, or other damaging chemicals. Over-firing can be identified by, but not limited to, warped plates or tubes, deformation/warping of interior cast iron structure or components, rust colored cast iron, bubbling, cracking and discoloration of steel or enamel finishes.
- The applicable Product is subjected to prolonged periods of dampness or condensation.
- There is any damage to the applicable Product due to water or weather damage which is the result of, but not limited to, improper chimney or venting installation.

LIMITATIONS OF REMEDIES AND LIABILITY:

- **EXCEPT TO THE EXTENT PROVIDED BY LAW, HHT MAKES NO EXPRESS WARRANTIES OTHER THAN THE WARRANTY SPECIFIED HEREIN. The owner's exclusive remedy and HHT's sole obligation under this Warranty or in contract, tort or otherwise, shall be limited to, at HHT's sole option, replacement of the Component Part(s), repair of the Component Part(s), or refund of the original purchase price of the applicable Product(s). In no event will HHT be liable for any incidental or consequential damages caused by defects in the applicable Product. Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This Warranty gives you specific legal rights and you may also have other rights which vary from State to State. THE DURATION OF ANY IMPLIED WARRANTY IS LIMITED TO DURATION OF THE EXPRESSED WARRANTY SPECIFIED ABOVE FOR THE APPLICABLE PRODUCT. Some States do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.**

1 Product Specific and Important Safety Information

A. Appliance Certification

MODEL:	Aspen C3
LABORATORY:	OMNI Test Laboratories, Inc
REPORT NO.	0135WS044S
TYPE:	Solid Fuel Type Room Heaters / Space Heaters for Use with Solid Fuel
STANDARD(s):	ASTM E2515, ASTM E2780, UL1482, ULC-S627, CSA B415.1

B. BTU & Efficiency Specifications

EPA Certification Number:	196-19
EPA Certified Emissions:	1.76 g/h
*LHV Tested Efficiency:	81.4%
**HHV tested Efficiency:	71.0%
***EPA BTU Output:	24,300
****Peak BTU/Hour Output:	35,200
Other Important Information	
Vent Size:	6 Inch (152 mm)
Firebox Size:	1.25 cu. ft.
Outside Air Size:	3 Inch
Max. Wood Length:	18"
Ideal Wood Length:	16"
Fuel	Seasoned Cordwood (20% moisture) or compressed logs
* Weighted average LHV efficiency using Douglas Fir dimensional lumber and data collected during EPA emissions test.	
**Weighted average HHV efficiency using Douglas Fir dimensional lumber and data collected during EPA emissions test.	
***Efficiencies are based on test results calculated using B415; these calculated efficiencies are then used to calculate output BTU's.	
****A peak BTU out of the appliance calculated using the maximum first hour burn rate from the High EPA Test and the BTU content of cord wood (8600) times the efficiency.	

Certified to comply with 2020 US particulate emissions standard using crib wood at 1.99 g/hr., Certified to comply with 2020 particulate emission standards for single burn rate heaters. This single burn rate wood heater is not approved for use with a flue damper.

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

The Vermont Castings Aspen C3 Wood Appliance meets the U.S. Environmental Protection Agency's crib wood emission limits for wood appliances sold after May 15, 2020.

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

C. Mobile Home Approved (USA & Canada)

- This appliance is approved for mobile home installations in the USA & Canada when not installed in a sleeping room and when an outside combustion air inlet is provided.
- The structural integrity of the mobile home floor, ceiling, and walls must be maintained.
- The unit must be bolted to the floor. This can be done using an appropriate fastener for the application.
- The appliance must be properly grounded to the frame of the mobile home with #8 copper ground wire, and chimney must be listed to UL103 HT or a listed UL-1777 full length six inch (152mm) diameter liner must be used.
- Outside air must be provided in a mobile home installation.

D. Glass Specifications

This appliance is equipped with 5mm ceramic glass. Replace glass only with 5mm ceramic glass. Please contact your dealer for replacement glass.

E. California Safety Information



WARNING

This product and the fuels used to operate this product (wood), and the products of combustion of such fuels, can expose you to chemicals including carbon black, which is known to the State of California to cause cancer, and carbon monoxide, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to: www.P65Warnings.ca.gov



WARNING



Fire Risk.

Hearth & Home Technologies disclaims any responsibility for, and the warranty will be voided by, the following actions:

- Installation and use of any damaged appliance.
- Modification of the appliance.
- Installation other than as instructed by Hearth & Home Technologies.
- Installation and/or use of any component part not approved by Hearth & Home Technologies.
- Operating appliance without fully assembling all components.
- Operating appliance without legs attached (if supplied with appliance).
- Do NOT Overfire - If appliance or chimney connector glows, you are overfiring.

Any such action that may cause a fire hazard.

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage.

For assistance or additional information, consult a qualified installer, service agency or your dealer.

NOTE: Hearth & Home Technologies, manufacturer of this appliance, reserves the right to alter its products, their specifications and/or price without notice.

Vermont Castings is a registered trademark of Hearth & Home Technologies.

2 Operating Instructions



CAUTION

Approved for use with wood fuel only. The use of any other fuel will void the product warranty and may cause damage to the appliance and/or your home.



WARNING

"NEVER USE GASOLINE, GASOLINE-TYPE LANTERN FUEL, KEROSENE, CHARCOAL LIGHTER FLUID, OR SIMILAR LIQUIDS TO START OR "FRESHEN UP" A FIRE IN THIS HEATER. KEEP ALL SUCH LIQUIDS WELL AWAY FROM THE HEATER WHILE IN USE".

SAFETY NOTICE

IF THIS APPLIANCE IS NOT PROPERLY INSTALLED, OPERATED AND MAINTAINED, A HOUSE FIRE MAY RESULT. FOR YOUR SAFETY, FOLLOW INSTALLATION DIRECTIONS. CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTION REQUIREMENTS IN YOUR AREA.

A. General Information

Before you install and operate your Aspen C3 wood stove, please read the entire contents of this manual. Pay particular attention to the explanation of draft and its effect on stove performance. By following the installation and operating guidelines, you will ensure proper draft and gain maximum efficiency and enjoyment from your stove.

Building a fire too close to the glass may cause damage to the glass, creating a serious risk of fire and property damage.



WARNING

DO NOT BURN GARBAGE OR FLAMMABLE LIQUIDS SUCH AS GASOLINE, NAPTHA, OR ENGINE OIL.



WARNING

DO NOT OPERATE THE STOVE WITH THE LOAD DOOR OPEN. OPERATION WITH THE LOAD DOOR OPEN CAN CAUSE AN OVER-FIRING CONDITION TO OCCUR. OVER-FIRING THE STOVE IS DANGEROUS AND CAN RESULT IN PROPERTY DAMAGE, INJURY OR LOSS OF LIFE.

NOTICE

Due to ash buildup, it is strongly recommended to have your stove professionally cleaned and serviced annually. This includes all parts of the stove, and the venting system.

Installation and repair of this stove should be done by a qualified service person. We recommend that the stove be inspected before use and at least annually by a qualified service person. Periodic cleaning is required throughout the heating season and at the end of each winter for the stove to work efficiently.

Safety Tips:

Conveniently locate a "Class A" fire extinguisher to contend with small fires. Be sure the fire extinguisher works and is clearly visible. All occupants of the house should know where it is, and how it operates. Have heavy stove gloves available near the stove. Have special safety accessories (e.g., Child Guard Screen) available for use if small children will be in the home.

In the event of a stove pipe or chimney fire....

- Evacuate the house immediately
- Notify the fire department
- If the fire isn't too threatening, closing down the stove tight, (primary air, all doors) will help to smother the fire.
- Inspect your stove, vent pipe and chimney for any damage caused by the fire and correct any damage before using your stove again.

DO NOT USE CHEMICALS OR FLUIDS TO START THE FIRE. DO NOT BURN GARBAGE OR FLAMMABLE FLUIDS SUCH AS GASOLINE, NAPTHA, OR ENGINE OIL. Also, never use gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or "freshen up" a fire. Keep all such liquids well away from the Aspen C3 while it is in use.

Caution: the Aspen C3 will be hot while in operation. Keep children, clothing and furniture away. Contact may cause skin burns.

DO NOT OVERFIRE THIS HEATER. Overfiring may cause a house fire, or can result in permanent damage to the stove. If any part of the stove glows, you are overfiring.



WARNING

This wood heater has a manufactured-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.

B. Draft Management:

Your stove is only one part of a system that includes the chimney, the operator, the fuel and the home. The other parts of the system will affect how well the stove works. When there is a good match between all the parts, the stove works well.

Wood stove operation depends on natural (unforced) draft. Natural draft occurs when exhaust gas is hotter (and therefore lighter) than the outdoor air at the top of the chimney. The greater the temperature difference, the stronger the draft. As the hot exhaust gas rises out of the chimney it generates suction that draws air into the stove for combustion. A slow, lazy fire indicates a weak draft. A brisk fire, supported only by air entering the stove through the normal inlets, indicates a good draft. The inlets are passive; they regulate how much air can enter the stove, but they do not move air into it.

The efficiency of a modern woodburning appliance, (in which the amount of air available for combustion is regulated), depends on the chimney to keep exhaust gases warm all the way outdoors. The characteristics of your chimney - whether it is steel or masonry, interior or exterior, matched or mismatched to the stove collar - determine how quickly it will warm up and how well it will sustain the optimum temperatures necessary to maintain strong draft and efficient combustion. Here follows a description of various flue system characteristics and related effects on stove performance.

Masonry Chimney:

Although masonry is the traditional material used for chimney construction, it can have distinct performance disadvantages when used to vent a controlled-combustion woodstove. Masonry forms an effective 'heat sink' - that is, it absorbs and holds heat for long periods of time. The large mass, however, may take a long time to become hot enough to sustain a strong draft. The larger the chimney (in total mass), the longer it will take to warm up. Cold masonry will actually cool exhaust gases enough to diminish draft strength. This problem is compounded if the chimney is located outside the home or if the chimney flue has a cross-sectional size larger than the stove outlet.

Steel Chimney:

Most factory-made 'Class A' steel chimneys have a layer of insulation around the inner flue. This insulation keeps the smoke warm and protects the surrounding structure from the high flue temperatures. Because the insulation is less dense than masonry, the inner steel liner warms up more quickly than a masonry chimney. Although steel chimneys are not as attractive as their masonry counterparts, they are very durable and generally outperform masonry.

Inside/Outside Location:

Because the chimney's function is to keep the smoke warm, it is best to locate it inside the house. This location uses the house as insulation for the flue and allows some radiant heat release from the flue into the home. Since an interior chimney does not continuously lose its heat to the outdoors, it takes less heat from the stove to get it warm and keep it warm.

Flue Sizing:

The flue size for a controlled-combustion appliance should be based on the cross-sectional volume of the stove flue outlet. In this case, more is definitely not better. Hot gases lose heat through expansion; if a stove with a six-inch flue collar (28 square inch area) is vented into a 10" x 10" flue, the gases will expand to over three times their original volume. As gases cool with expansion, draft strength decreases. If an oversized flue is also outside the house, the heat it absorbs will be conducted to the outdoor air and the flue will remain relatively cool.

It is common for a masonry flue to be oversized for the stove. Such a chimney can take quite a while to warm up and the stove performance will likely be disappointing. The best solution to an oversize flue problem is the installation of an insulated steel chimney liner of the same diameter as the appliance flue outlet. The liner keeps the exhaust gas warm and the result is a stronger draft. An uninsulated liner is a second choice - although the liner will keep the exhaust restricted to its original volume, the air around the liner will require time and heat energy to warm up.

Check your local codes. You may be required to install a flue liner in any oversize or masonry flue.

Pipe & Chimney Layout:

Every bend in the flue will act as a brake on the exhaust as it flows from the firebox to the chimney cap. The ideal pipe and chimney layout is straight up from the stove through a completely straight chimney. Use this layout if at all possible as it will promote optimum stove performance and simplify maintenance.

If the stovepipe must elbow to enter a chimney, locate the elbow about midway between the stove top and the chimney thimble. This configuration lets the smoke speed up before it must turn, keeps some pipe in the room for heat transfer, and allows long-term flexibility for installing a different appliance without relocating the thimble.

There should be no more than eight feet of single-wall stove pipe between the stove and a chimney. Longer runs can cool the smoke enough to cause draft and creosote problems. Use double-wall stove pipe for longer runs.

Single Venting:

Your stove requires a dedicated flue. Do not connect the stove to a flue used by any other appliance. Chimney draft is a natural form of energy and follows the path of least resistance. If the stove is vented to a flue that also serves an open fireplace or another appliance, the draft will also pull air in through those avenues. The additional air flow will lower flue temperatures, reduce draft strength and promote creosote development; overall stove performance will suffer. The effect is similar to that of a vacuum cleaner with a hole in the hose. In some extreme instances, the other appliance can even impose a negative draft and result in a dangerous draft reversal.

C. Fuel Specifications

Select only **dry, seasoned wood**. Wood for burning should never be exposed to rain or extremely damp conditions. Hardwoods are favored because they are heavier and contain more heating capacity (BTU's) per load than do softwoods. Fuel wood should be split and stored under cover for "seasoning" - at least a year is recommended. Your stove is not an incinerator - do not burn garbage, painted or treated wood, plastic, or other debris.

Keep the area around the stove free from clutter. Keep all combustibles, including fuel, beyond the code-required clearance distance (48" or 1215mm in the U.S., 1525mm or 60" in Canada). Never store fuel in front of the stove where it could interfere with door operation, safe loading, and ash removal.



WARNING

BURNING COLORED PAPER, CARDBOARD, SOLVENTS, TRASH AND GARBAGE OR ALTERING THE STOVE FOR HIGHER HEAT OUTPUT MAY CAUSE DAMAGE TO THE STOVE AND COULD RESULT IN A HOUSE FIRE. USE ONLY APPROVED FUELS AND FOLLOW ONLY THESE OPERATION GUIDELINES.



CAUTION

ALWAYS WEAR FIRE RETARDANT GLOVES WHEN OPERATING THE STOVE.

Fuel:

Even the best stove installation will not perform well if poor fuel is used. If available, always use hardwood that has been air-dried ('seasoned') 12-18 months. Softwood burns more rapidly than hardwood and has a high resin content conducive to creosote production. Decayed wood of any type has little heat value and should not be used.

All unseasoned ('green') wood has a high moisture content. Much of its heat value will be used to evaporate moisture before the wood can burn. This significantly reduces not only the amount of energy available to warm your home, but also the intensity of the fire and temperature of the exhaust gas. Incomplete combustion and cool flue temperatures promote creosote formation and weak draft.

You can judge the moisture content of wood by its appearance and weight or use a commercially available moisture meter for an exact measurement. Unseasoned wood will be a third heavier than dry wood. Also, look for cracks ('checking') in the ends of the log that result from contraction as the wood dries. The longer and wider the cracks, the dryer the wood is. Purchase your fuel from a reputable dealer.

Creosote:

Creosote is a by-product of low-temperature stove operations, weak draft or both. It is a tar that results when unburned gases condense inside the flue system at temperatures below 290°F. Creosote is volatile and can generate chimney fire. All of the installation characteristics that adversely affect chimney draft also promote creosote condensation. Consequently, you can minimize creosote accumulation with an effective chimney design and the use of operational techniques that encourage good draft and complete combustion.

Backpuffing:

Backpuffing is a condition that results when the draft is too weak to pull flue gases out of the chimney system as fast as the fire is generating more. Volatile gases build up within the firebox until reaching a density and temperature at which they ignite. With this ignition, you may hear a muffled popping sound and see a bit of smoke forced out of the air inlets.

This condition is most likely to occur in the spring or fall when moderate outdoor temperatures and low intensity fires combine to inhibit draft strength. Avoid large loads of firewood at one time. You should always see lively, dancing flames in the firebox; a lazy, smoky fire is inefficient and will promote draft problems.

D. Combustion Process

How the Aspen C3 Works:

Combustion control is achieved in the Aspen C3 through two separate air delivery systems.

The Aspen C3 features Continuous Combustion Control™ (C3) technology, a heat activated technology that automatically adjusts and delivers just the right amount of air to optimize efficiency and heat output. In short, it keeps the fire in the “sweet spot”. As the fuel burns, an automatic thermostat reacts to the heat radiating from the stove and, consequently, adjusts the air shutter attached to it.

As the fire intensity (and heat output) builds, the thermostat slowly closes the air shutter, thereby restricting incoming combustion air. As the fire intensity then wanes (and heat output lessens), the thermostat responds and gradually opens the air shutter which allows more combustion air to again enliven the fire. This ebb and flow action functions continuously to prolong the burn cycle until the fuel bed is exhausted.

Another separate supply of oxygen is delivered to the upper area of the firebox to support combustion of gases released from the main fuel bed. This **Secondary Air** enters the stove and is heated while passing through separate channels before being delivered at the top of the firebox.

Burn Only High-Quality Wood

THE ASPEN C3 IS DESIGNED TO BURN NATURAL WOOD ONLY; DO NOT BURN ANY OTHER FUELS.

You will enjoy the best results when burning wood that has been adequately air-dried. Avoid burning “green” wood that has not been properly seasoned. The wood should be no longer than 18” (410 mm) in length, however, you will find that thinner cuts ease refueling and promote the most efficient combustion.

The best hardwood fuels include oak, maple, beech, ash, and hickory that has been split, stacked, and air-dried outside under cover for at least one year.

For areas that do not have a supply of hardwood, commonly burned softwoods include tamarack, yellow pine, white pine, Eastern red cedar, fir, and redwood. These too should be properly dried.

Keep wood a safe distance from the heater and keep it out of the areas around the heater used for refueling and ash removal.

E. Building & Maintaining a Fire



WARNING

OPERATE THIS STOVE ONLY WITH THE DOOR FULLY CLOSED.



CAUTION

The baffle boards are FRAGILE. Use extreme caution when loading firewood to prevent:

- **Cracking, breaking or damaging the baffle boards DO NOT operate the appliance without the baffle boards.**

BURN SOLID WOOD FUEL ONLY, AND BURN IT DIRECTLY ON THE GRATE. DO NOT ELEVATE THE FUEL. DO NOT BURN COAL OR OTHER FUELS.

Cast iron is extremely strong, but it can be broken with a sharp blow from a hammer or from the thermal shock of rapid and extreme temperature change.

The cast plates expand and contract with changes in temperature. When you first begin using your Aspen C3, minimize thermal stress by allowing the plates to adjust gradually during three or four initial break-in fires following Steps.

1. Place several sheets of crumpled newspaper in the stove. Avoid using glossy or colored paper, as these burn poorly. At the front of the firebox, place on the paper six or eight pieces of dry kindling split to a finger-width size, and on the kindling lay two or three larger sticks of split dry wood approximately 1-2” (25-51 mm) in diameter.
 2. Light the newspaper and close the door. Gradually build up the fire by adding a few 3-5” (80-120 mm) diameter splits. **If this is one of the first few “break-in” fires, let the fire burn brightly, and then let it die out.**
- Some odor from the stove’s hot metal, the paint, and the cement is normal for the first few fires.

NOTE: Some chimneys need to be “primed,” or warmed up, before they will draw sufficiently to sustain a fire. To correct this situation, roll up a couple pieces of newspaper, place them on top of the kindling and toward the back of the stove, light them, and close the door. This should heat the chimney enough to initiate strong draft.

Once the draft is established, open the front door and light the rest of the fuel bed at the bottom. Do not light the main bed of fuel until the chimney begins drawing.

Option 1: Standard firestarting method above with all steps.

Option 2: “Top-down” method to start a fire. Smoke emissions when starting a fire can be difficult to control because the stove is not yet heated to its optimum temperature. One method of reducing emissions during a cold start-up is the use of a “top-down” kindling procedure. In this, place larger pieces of kindling on the bottom of the kindling pile followed by smaller and smaller pieces as the pile is added to. Very finely split pieces should be on the top.

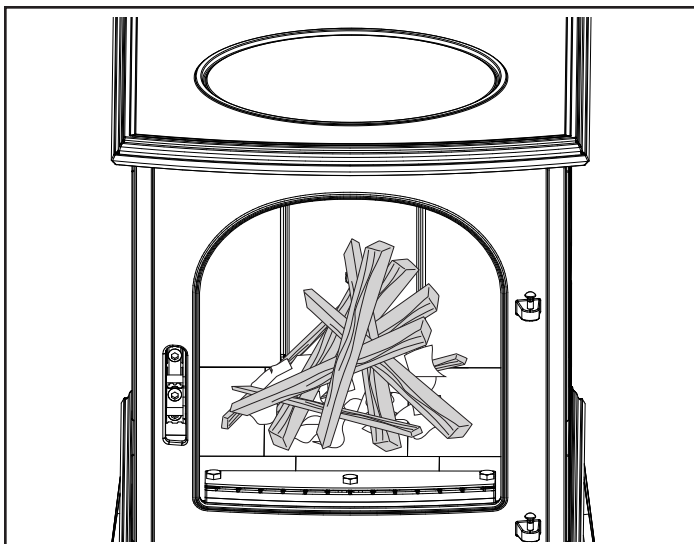


Figure 2.1 - Start a fire with small, dry kindling.

Light the kindling pile with a match at the top and allow the kindling to burn downward into the larger pieces. This reduces smoke by slowly increasing the fire size without creating an air-starved condition.

3. **After the stove has been broken-in** using Steps 1-2, continue to build the fire gradually. Add larger wood with a diameter of 3-4" (75-102 mm).

Refuel While the Embers Are Still Hot:

Reload the Aspen C3 while it is still hot and there are plenty of glowing embers to re-kindle the fire. Include some smaller pieces of wood in the new load of fuel to help the stove return to its operating temperature quickly. Wear stove gloves, and follow this procedure when you reload your stove:

1. Use a fireplace tool to break up the charcoal. Pull the charcoal from the back to the front. This will encourage efficient combustion as the fuel burns from front to rear. Take care, however, not to block the primary air box with coals or ash, Figure 2.2.
2. Load wood - smaller, split pieces first. Close the door.

Ash Disposal:

Remove ash before it reaches the top of the primary air box, Figure 2.2. Check the level at least once a day, and before each re-fueling.

Dispose of ashes into a metal container with a tight-fitting lid kept outdoors. Put the closed container of ash on a noncombustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ash is disposed of by burial in soil or otherwise locally dispersed, keep it in the closed container until all cinders have thoroughly cooled. You can use wood ash as a garden fertilizer.

Empty the ashes regularly, typically every one to three days. The frequency will vary depending on how you operate your Aspen C3.



CAUTION

Never use your household or shop vacuum cleaner to remove ash from the stove; always remove and dispose of the ash properly.

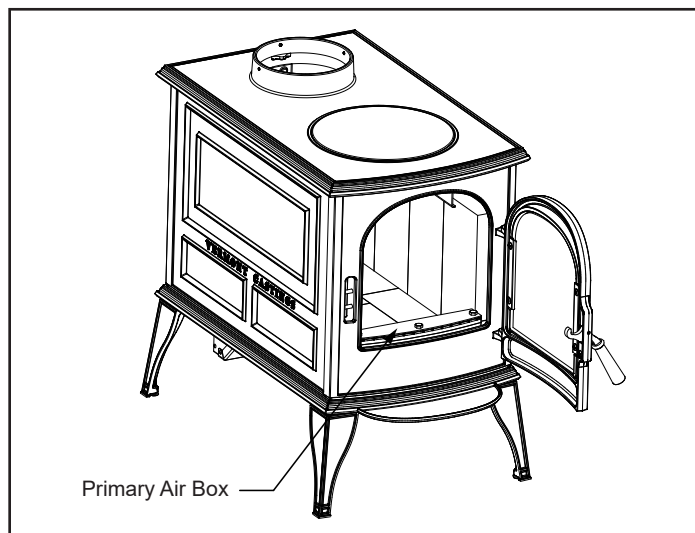


Figure 2.2

Tips & Tricks for Managing Heat Output

While the Aspen C3 has no manual air controls, there are several tricks to managing heat output and burn times.

- a. **Log size:** Smaller splits will burn faster and with more heat output than larger splits.

Larger split logs or unsplit rounds will burn longer with lower heat output.

Firebox loading also has a significant effect on heat output and burn times.

For overnight burns, a full firebox of larger splits or logs is best.



For burning in the shoulder seasons a hot fire of small splits burned down to coals can be most effective at not overheating the living space.


Lastly, heat output can effectively be regulated by loading 1-2 logs as needed throughout the day rather than continuously filling the firebox.

- b. **Coaling:** When running the stove continuously at high rates of fire, coals may accumulate in the rear of the firebox. In order to burn these coals down to allow space for the loading of fresh fuel, rake the coals from the rear of the firebox to the front. Place several splits of kindling on the coals and allow them to burn down. Once the coals have burned down, they can be leveled and fresh fuel can be added.

F. Opacity (Visible Smoke)

This is the measure of how cleanly your appliance is burning. Opacity is measured in percent; 100% opacity is when an object is totally obscured by the smoke column from a chimney, and 0% opacity means that no smoke column can be seen. As you become familiar with your appliance, you should periodically check the opacity. This will allow you to know how to burn as nearly smoke-free as possible (goal of 0% opacity).

 WARNING	
	<p>Fire Risk</p> <p>Keep combustible materials, gasoline and other flammable vapors and liquids clear of appliance.</p> <ul style="list-style-type: none">• Combustible materials may ignite.• Do NOT store flammable materials in the appliance's vicinity.• DO NOT USE GASOLINE, LANTERN FUEL, KEROSENE, CHARCOAL LIGHTER FLUID OR SIMILAR LIQUIDS TO START OR "FRESHEN UP" A FIRE IN THIS Appliance.• Keep all such liquids well away from the appliance while it is in use.



 CAUTION	
<p>When burning your first fire, you will experience smoke and odor from the appliance resulting from the curing of paint and burning off of any oils remaining from manufacturing.</p> <p>OPEN WINDOWS DURING INITIAL BURN TO DISSIPATE SMOKE AND ODORS!</p> <ul style="list-style-type: none">• Odors may be irritating to sensitive individuals.• Smoke detectors may activate.	

Smoke and CO Detectors

The use of smoke and carbon monoxide (CO) detectors throughout the home is strongly advised, even if not required by building codes or insurance regulations. It is a good idea to install a smoke detector in the living areas and each bedroom. Follow the smoke/CO detector manufacturer's placement and installation instructions and maintain regularly.

You may not, however, wish to install a detector in the immediate vicinity of the stove. Depending on the sensitivity of the unit, the alarm can be set off while you are tending the fire or emptying the ashes. If you install a detector in the same room, locate it as far away from the stove as possible.

G. Negative Pressure

 WARNING	
	<p>Asphyxiation Risk</p> <ul style="list-style-type: none">• Negative pressure can cause spillage of combustion fumes, soot and carbon monoxide.• Appliance needs to draft properly for safety.

Negative pressure results from the imbalance of air available for the appliance to operate properly. It can be strongest in lower levels of the house.

Causes include:

- Exhaust fans (kitchen, bath, etc.)
- Range hoods
- Combustion air requirements for furnaces, water appliances and other combustion appliances
- Clothes dryers
- Location of return-air vents to furnace or air conditioning
- Imbalances of the HVAC air handling system
- Upper level air leaks such as:
 - Recessed lighting
 - Attic hatch
 - Duct leaks

To minimize the effects of negative air pressure:

- Install outside air to the stove with the intake facing prevailing winds during the heating season
- Ensure adequate outdoor air for all combustion appliances and exhaust equipment
- Ensure furnace and air conditioning return vents are not located in the immediate vicinity of the appliance
- Avoid installing the appliance near doors, walkways or small isolated spaces
- Recessed lighting should be a "sealed can" design
- Attic hatches weather stripped or sealed
- Attic mounted duct work and air handler joints and seams taped or sealed.

3 Maintenance

Keep Your Stove Looking New and Working Its Best

Let the fire in the stove go out and allow the stove to cool completely before beginning any maintenance procedure.

Care of the Cast Iron Surface

An occasional dusting with a dry rag will keep the painted cast iron of your Aspen C3 looking new.

The stove's paint can be touched up as needed. First, mask the areas, such as glass or handles, around the spot to be painted. Clean the spot with a wire brush. Remove the optional cook plate if installed and set it aside.

Then, touch up the stove with high temperature stove paint. Apply the paint sparingly; two light coats of paint are better than a single heavy one. Approved touch-up paint can be purchased at any approved Vermont Castings dealer.

A. Cleaning & Replacement of the Glass

Most of the carbon deposits on the glass will burn off during hot fires.

However, the ash residue that accumulates on the glass surface should be removed regularly to prevent etching. To clean the glass, follow this procedure:

- Be sure the glass is completely cool. DO NOT clean glass while hot.
- Clean the glass with water or a cleaner made especially for this purpose. Do not use abrasive cleaners. Use cleaning agents sparingly and be sure to keep them off the outer surfaces of the stove.
- Rinse the glass thoroughly.
- Dry the glass completely.

Replace Broken Glass Immediately

Do not operate your stove if the glass in the door is damaged.

If you need to replace the glass, use only the high temperature 5 mm ceramic glass supplied by Vermont Castings part no. SRV3-40-950144. Do not use substitutes.

To reduce the risk of breaking the glass, avoid striking the glass or slamming the doors.

Removing the Glass

1. Remove the door by raising the door until the lower and upper hinge pin clears its holes. Place the door face down on a padded work surface.
2. Remove the screws that hold the glass retainer clips in place, and remove the clips.
3. Carefully lift the broken glass panel from the door.

Installing the Glass

Check the gasket around the window; it should be soft and resilient so that the glass will seal properly against the door. Replace the gasket if it has hardened or if it is compressed.

1. Center the glass on the gasket.
2. Secure the glass with the retainer clips. Tighten all screws, Figure 3.1.
3. Replace the door on the stove.
4. Open and close the door to check that it fits and works properly.

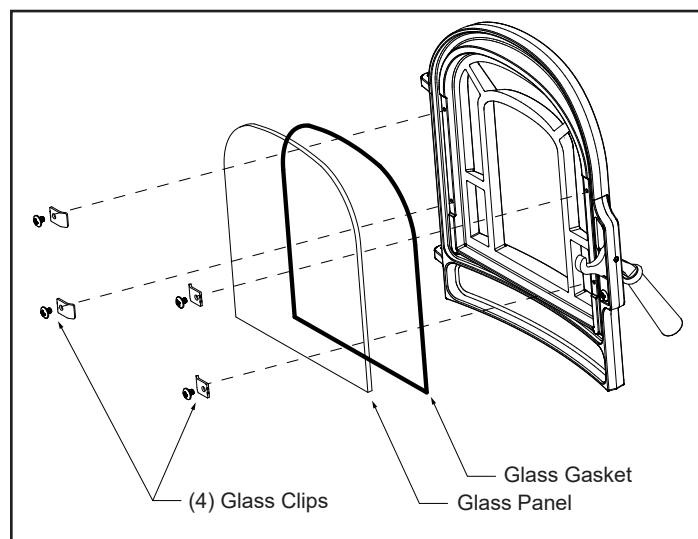


Figure 3.1 - Door glass installation.

B. Gasket Replacement (as Needed)

Your Aspen C3 uses fiberglass rope gaskets to make a tight seal between some parts. With use, particularly on moving parts, gaskets can become brittle and compressed and can begin to lose their effectiveness. These will need periodic replacement.

The sizes of replaceable gasket are listed below, along with their applications.

Gasket Diameter...

...And the Parts it Seals

3/8" Round

Door Gasket (40" Needed)

3/16" Round w/PSA

Gasket for glass (36" Needed)

If you need to change a gasket, first obtain an appropriate replacement from your Vermont Castings' Authorized Dealer.

Wait until the fire is out and the stove has cooled. Be sure to follow the standard safety procedure for working with dusty materials: wear safety goggles and a dust mask.

The procedure for replacing gaskets is the same, regardless of the gasket location. Follow these steps:

1. Remove the existing gasket by grasping an end and pulling firmly. (Figure 3.4)
2. Remove old cement using a wire brush.
3. Apply fresh furnace cement to the gasket channel. A 1/4" wide bead is sufficient.
4. Install new gasket being careful not to stretch.

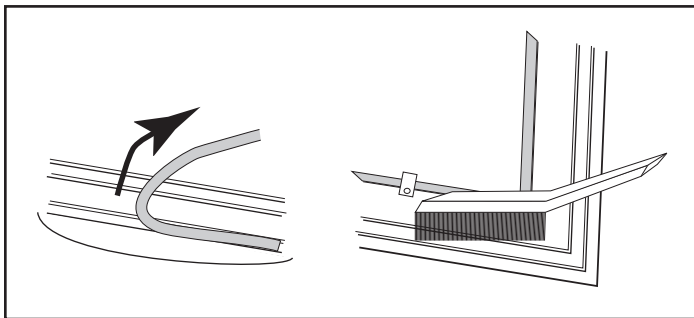


Figure 3.4 - Remove gasket then clean channel with wire brush.

C. Door Latch Adjustment

The front door of the stove should close securely to prevent accidental opening and should close tightly to prevent air from leaking into the fire chamber.

Over a period of time, the gasket around the door will compress and the latch may need adjustment. To adjust the handle, follow this procedure:

1. Slightly loosen the 1/4-20 hex head bolt located at the rear of the latch assembly inside the firebox, Figure 3.2.
2. Tighten the top 1/4-20 phillips-head screw, Figure 3.3.

Adjust as needed until a snug fit is achieved.

Test the door seal. Close the door on a dollar bill and attempt to pull it free. If the bill is freed with little resistance, the gasket isn't snug enough at that spot. Continue to make small adjustments until the setting is right.

If proper resistance can't be achieved the gasket need to be replaced.

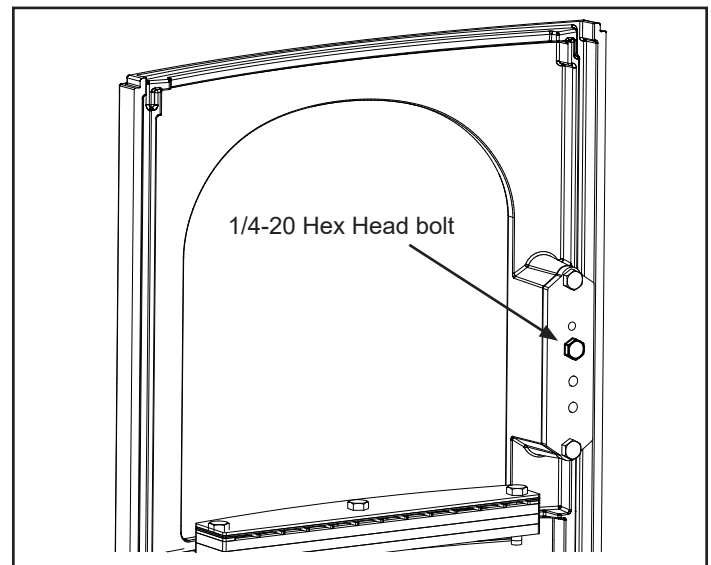


Figure 3.2 - Loosen 1/4-20 Hex head Bolt

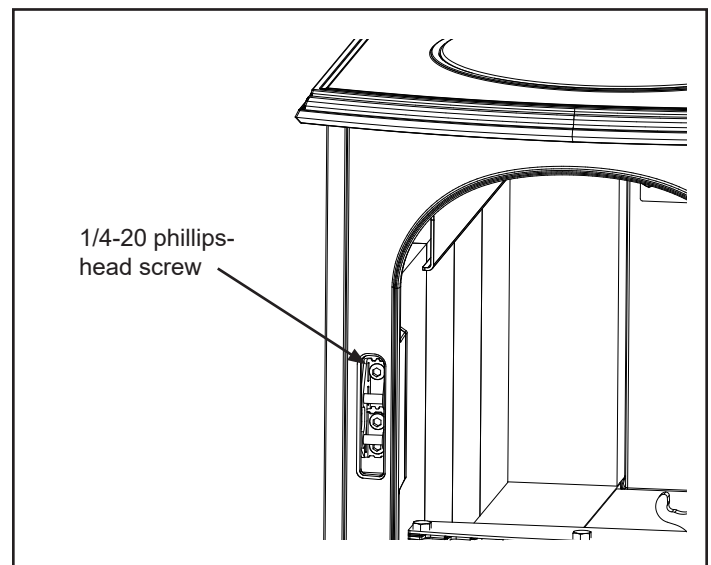


Figure 3.3 - Tighten 1/4-20 phillips-head screw

D. The Chimney System

Your Aspen C3 is designed to reduce creosote build-up significantly. However, regular chimney inspection and maintenance must still be performed. For safety, good stove performance, and to protect your chimney and chimney connector, inspect your chimney and chimney connector on a regular schedule. Clean the system if necessary. Failure to keep the chimney and connector system clean can result in a serious chimney fire.



WARNING

Inspect and Clean Chimney Frequently – Under certain conditions of use, creosote buildup may occur rapidly.

When wood is burned slowly, it produces tar, organic vapors and moisture that combine to form creosote. The creosote vapors condense in the relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited, this creosote makes an extremely hot fire within the flue system that can damage the chimney and overheat adjacent combustible material. If a significant layer of creosote has accumulated —1/8" (3 mm) or more — it should be removed to reduce the risk of a chimney fire.

You can never be too safe. Contact your local fire authority for information on what to do in the event of a chimney fire, and have a clearly understood plan on how to handle one.

If you do experience a chimney fire, act promptly to:

- Close the damper and air control lever.
- Get everyone out of the house.
- Call the Fire Department.

Inspect the system every two weeks during the heating season as part of a regular maintenance schedule. To inspect the chimney, let the stove cool completely. Then, using a mirror and a strong light, sight up through the flue collar into the chimney flue. If you cannot inspect the flue system in this fashion, the stove must be disconnected to provide better viewing access.

Clean the chimney using a brush the same size and shape as the flue liner. Flexible fiberglass rods are used to run the brush up and down the liner, causing any deposits to fall to the bottom of the chimney where they can be removed through the clean-out door.

Clean the chimney connector by disconnecting the sections, taking them outside, and removing any deposits with a stiff wire brush. Reinstall the connector sections after cleaning, being sure to secure the joints between individual sections with sheet metal screws.

If you cannot inspect or clean the chimney yourself, contact a professional chimney sweep or your local Vermont Castings dealer.

Unit Maintenance Schedule - The Stove

Daily:

- Ashes should be removed before they reach the bottom of door. Check accumulation at least once a day.
- Keep the area around the stove clear of any combustible materials such as wood, furniture or clothing.

Two Months:

- Check door handle to be sure it is working properly. Gasketing becomes compressed after a period of time. Adjust handle tightness if necessary.
- Check leg bolts; tighten if necessary.

Annual Spring Cleaning:

- Check gasketing for wear, and replace if necessary.
- Remove ashes from the firebox replace with a moisture absorbing material (such as kitty litter) to keep the interior of the stove dry.
- Touch up the black paint.

Chimney Connector

Two Weeks

- Inspect the chimney connector and chimney. Clean if necessary.

Two Months:

- Inspect the chimney and chimney connector. Pay particular attention to the horizontal runs of chimney connector, and the elbows. Clean the system if necessary.

Annual Spring Cleaning:

- Disassemble the chimney connector and take it outdoors for inspection and cleaning. Replace weak sections of connector.
- Inspect the chimney for signs of deterioration. Repairs to a masonry chimney should be made by a professional mason. Replace damaged sections of prefabricated chimney. Your local Vermont Castings dealer or a chimney sweep can help determine when replacement is necessary.
- Thoroughly clean the chimney.

4 Troubleshooting Guide

With proper installation, operation, and maintenance your wood appliance will provide years of trouble-free service. If you do experience a problem, this troubleshooting guide will assist you or a qualified service person in the diagnosis of a problem and the corrective action to be taken.

Start Fire Problems	Possible Cause	Solution
<ul style="list-style-type: none"> • Can not get fire started • Excessive smoke spillage • Burns too slowly • Not enough heat output 	Not enough kindling/paper or no kindling/paper	Use dry kindling, more paper. Arrange kindling & wood for air movement.
	Not enough air for fire to ignite	Check for restricted termination cap
		Check for blockage of outside air (if installed).
		Check for flue blockage.
		Pre-warm flue before starting fire (refer to Building a Fire Section).
		Check for adequate vent height (refer to Chimney Height Section).
		Refer to Negative Pressure section
	Wood condition is too wet, too large	Use dry, seasoned wood (refer to Seasoned Wood Section).
	Bed of coals not established before adding wood	Start with paper & kindling to establish bed of coals (refer to Building a Fire Section).
Fire burns too fast	Flue blockage such as birds' nests or leaves in termination cap	Have chimney inspected for creosote and cleaned by a certified chimney sweep.
	Down draft or negative pressure Competition with exhaust devices	Do not use exhaust fans during start-up (refer to Negative Pressure Section).
	Extremely dry or soft wood	Mix in hardwood.
		Mix in larger pieces of wood after fire is established.
		Check for correct vent height; too much vertical height creates overdrafting.
Overdrafting		Check location of vent termination (refer to Chimney Termination Requirement Section).

Contact your dealer for additional information regarding operation and troubleshooting.
Visit www.vermontcastings.com to locate a dealer.

5 Reference Materials

A. Service & Maintenance Log

[illegible]

B. Service Parts List

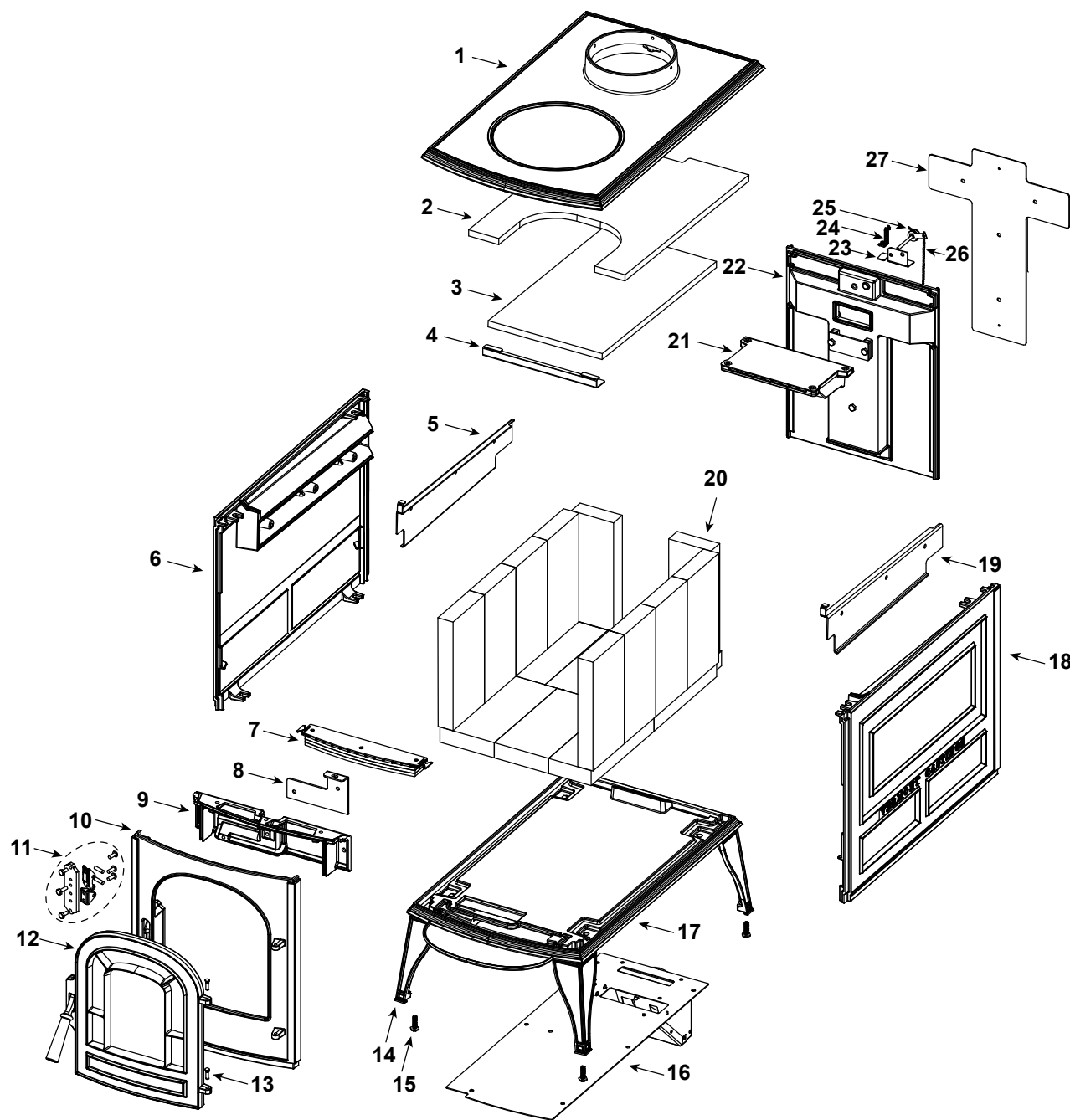


Service Parts

Wood Stove
0002505

Aspen C3

Beginning Manufacturing Date: July 2019
Ending Manufacturing Date: Active



Part number list on following page.

09/21

Beginning Manufacturing Date: July 2019
Ending Manufacturing Date: Active

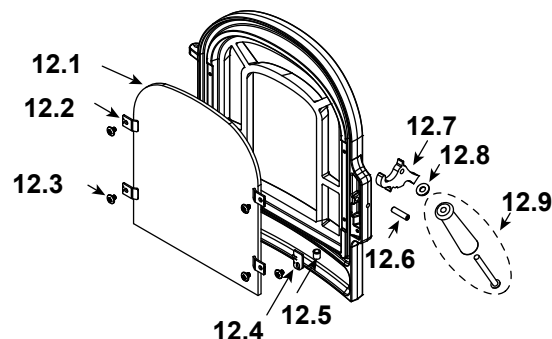
IMPORTANT: THIS IS DATED INFORMATION. Parts must be ordered from a dealer or distributor. **Hearth and Home Technologies does not sell directly to consumers.** Provide model number and serial number when requesting service parts from your dealer or distributor.



Stocked
at Depot

ITEM	DESCRIPTION	COMMENTS	PART NUMBER	
1	Top		SRV4-00-950054	
	Gasket, Fiberglass 3/8 Adhesive	15 Ft	1-00-30002422	Y
2	Blanket, Superwool		SRV3-44-950122	
3	Refractory Baffle		SRV3-40-859031	
4	Front Refractory Holder		SRV2-00-859112	
5	Side Cover, Left		SRV2-00-950148	
6	Left Side		SRV4-00-950119	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
	Gasket, Fiberglass 3/8 Adhesive	15 Ft	1-00-30002422	
7	Dog Box Combustion Assembly		SRV1-10-950011	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
8	Front Lower Primary Air Channel Cover		SRV2-00-950057	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
9	Front Lower Primary Air Channel		SRV4-00-950056	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
10	Front		SRV4-00-950052	
	Gasket, Fiberglass 3/8 Adhesive	15 Ft	1-00-30002422	
11	Front Latch Kit		SRV1-00-950101	

#12 Load Door Assembly



12	Load Door Assembly		SRV1-10-950100	
12.1	Glass		SRV3-40-950144	Y
12.2	Glass Clip	Pkg of 2	SRV8950-100/2	Y
	Gasket, Door	15 Ft	1-00-1203589	Y
	Gasket, Glass	10 Ft	1-00-1186258229	Y
12.3	Pan Head Phillips 10-24 x 1/4 (5 req)	Pkg of 10	1200980-10	
12.4	Detent Plate		SRV2-00-950141	Y
12.5	Ball Spring Plunger		3-31-73765	
12.6	SSS CP 1/4-20 x 1	Pkg of 10	1200436-10	
12.7	Door Latch		SRV2-00-950104	
12.8	Washer, Flat 1/4	Pkg of 10	1202473-10	
12.9	Wood Handle w/Bolt		1-00-00247	Y

Additional service part numbers appear on following page.

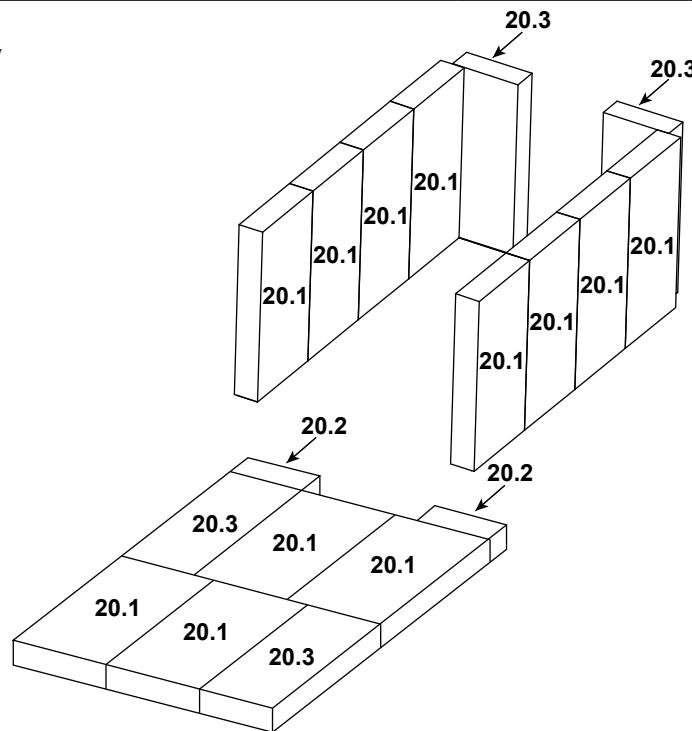
IMPORTANT: THIS IS DATED INFORMATION. Parts must be ordered from a dealer or distributor. **Hearth and Home Technologies does not sell directly to consumers.** Provide model number and serial number when requesting service parts from your dealer or distributor.



Stocked
at Depot

ITEM	DESCRIPTION	COMMENTS	PART NUMBER	
13	Door Pin 3/16 x 3/4		1600535	
14	Leg	Qty 4 req	SRV4-00-950090	
15	Leg Leveler	Pkg of 10	1201745-10	
16	Air Control Assembly		SRV1-10-950110	
17	Bottom		SRV4-00-950051	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
	Fiberglass 3/8 low	15 Ft	1-00-1203589	
	5/16 Adhesive Backed	15 Ft	1-00-1203591	Y
18	Right Side		SRV4-00-950120	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
	Gasket, Fiberglass 3/8 Adhesive	15 Ft	1-00-30002422	
19	Side Cover, Right		SRV2-00-950058	

#20 Firebrick Assembly



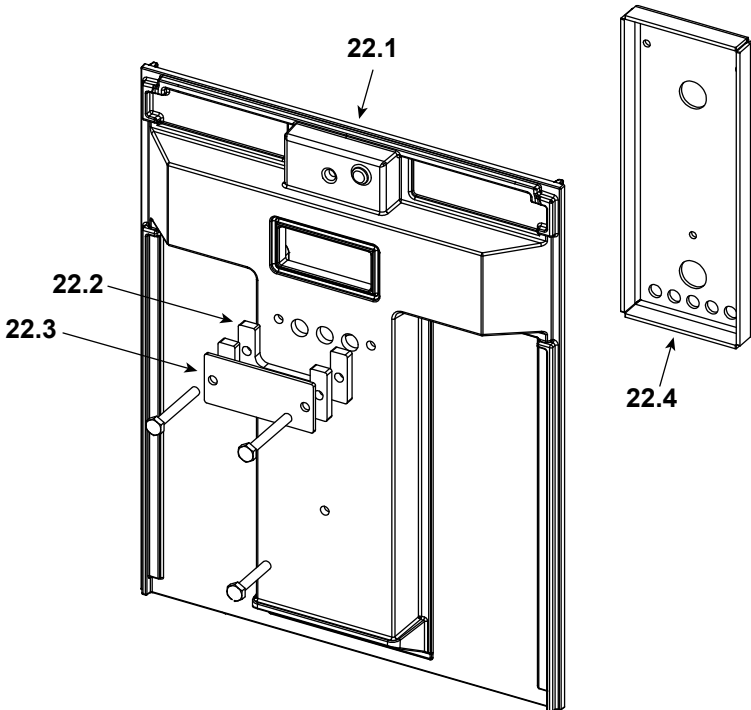
20	Firebrick Complete Assembly		SRV1-10-9500023	Y
20.1	Firebrick, 9" x 4 1/2" x 1 1/4"	Qty 12 req	832-0550	
		Pkg of 6	832-3040	
20.2	Firebrick, 3 1/2" x 1 1/2" x 1 1/4"	Qty 2 req	SRV4-40-950018	
20.3	Firebrick, 9" x 3 1/2" x 1 1/4"	Qty 4 req	SRV4-40-950019	
21	Rear Secondary Manifold Assembly		SRV1-10-950139	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y

Additional service part numbers appear on following page.

IMPORTANT: THIS IS DATED INFORMATION. Parts must be ordered from a dealer or distributor. **Hearth and Home Technologies does not sell directly to consumers.** Provide model number and serial number when requesting service parts from your dealer or distributor.



Stocked
at Depot

ITEM	DESCRIPTION	COMMENTS	PART NUMBER	
<p>#22 Rear Vertical Shield</p> 				
22.1	Back		SRV4-00-950050	
	Gasket, PSA 3/16	10 Ft	1-00-1186258229	Y
22.2	Outer, Rear Vertical Shield		SRV2-00-950146	
22.3	Outer Cover, Rear Vertical Shield		SRV2-00-950154	
22.4	Inner, Rear Vertical Shield		SRV2-00-950145	
23	Blocker Plate		SRV2-00-950155	
24	Ball Chain Bracket		SRV2-00-950137	
25	Probe Assembly Secondary		1601489A	Y
26	Ball Chain	17 Inches	30007431A	Y
27	Back Cover		SRV2-00-950119	
	Touch-Up Paint	Classic Black	3-42-19905	
	Finish Bag		SRV8000-003	
	Mobile Home Brackets	Pkg of 2	SRV586189	
	Outside Air Kit		1-10-09542	

Additional service part numbers appear on following page.

C. Contact Information



CONTACT INFORMATION

Hearth & Home Technologies
352 Mountain House Road
Halifax, PA 17032

Please contact your Vermont Castings dealer with any questions or concerns.

For the number of your nearest Vermont Castings dealer

log onto www.vermontcastings.com

CAUTION



DO NOT DISCARD THIS MANUAL

- Important operating and maintenance instructions included.
- Read, understand and follow these instructions for safe installation and operation.
- Leave this manual with party responsible for use and operation.



We recommend that you record the following pertinent information for your heating appliance.

Date purchased/installed: _____

Serial Number: _____ Location on appliance: _____

Dealership purchased from: _____ Dealer phone: _____

Notes: _____

This product may be covered by one or more of the following patents: (United States) 5341794, 5263471, 6688302, 7216645, 7047962 or other U.S. and foreign patents pending.



Installation Manual

Installation & Appliance Set-Up

INSTALLER: Leave this manual with party responsible for use and operation.

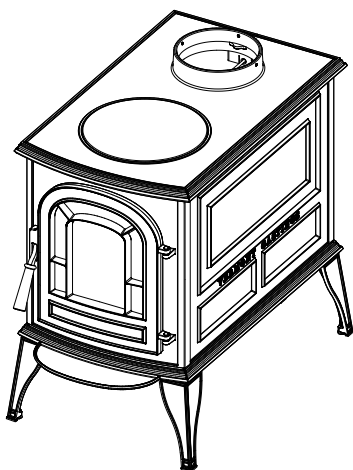
OWNER: Retain this manual for future reference.

NOTICE: DO NOT DISCARD THIS MANUAL

NOTICE: SAVE THESE INSTRUCTIONS

VERMONT  CASTINGS

Aspen C3 Wood Stove



For use in the United States and Canada

Installation and service of this appliance should be performed by qualified personnel. Hearth & Home Technologies recommends HHT Factory Trained or NFI certified professionals.



NOTE

To obtain a French translation of this manual, please contact your dealer or visit www.vermontcastings.com

Pour obtenir une traduction française de ce manuel, s'il vous plaît contacter votre revendeur ou visitez www.vermontcastings.com

WARNING



If the information in these instructions is not followed exactly, a fire may result causing property damage, personal injury, or death.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- Do not over fire - If appliance or chimney connector glows, you are over firing. Over firing will void your warranty.
- Comply with all minimum clearances to combustibles as specified. Failure to comply may cause house fire.

WARNING



HOT SURFACES!

Glass and other surfaces are hot during operation AND cool down.

Hot glass will cause burns.

- Do not touch glass until it is cooled
- NEVER allow children to touch glass
- Keep children away
- CAREFULLY SUPERVISE children in same room as fireplace.
- Alert children and adults to hazards of high temperatures
- **High temperatures may ignite clothing or other flammable materials.**
- Keep clothing, furniture, draperies and other flammable materials away.

Safety Alert Key:

- **DANGER!** Indicates a hazardous situation which, if not avoided will result in death or serious injury.
- **WARNING!** Indicates a hazardous situation which, if not avoided could result in death or serious injury.
- **CAUTION!** Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE:** Indicates practices which may cause damage to the appliance or to property.

Please read this entire manual before you install and use your new room heater. Failure to follow instructions may result in property damage, bodily injury, or even death.

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6 Mobile Home Installation

➔ = Contains updated information

1 Important Safety Information

A. Appliance Certification

MODEL:	Aspen C3
LABORATORY:	OMNI Test Laboratories, Inc
REPORT NO.	0135WS044S
TYPE:	Solid Fuel Type Room Heaters / Space Heaters for Use with Solid Fuel
STANDARD(s):	ASTM E2515, ASTM E2780, UL1482, ULC-S627-00, CSA B415.1

B. BTU & Efficiency Specifications

EPA Certification Number:	196-19
EPA Certified Emissions:	1.76 g/h
*LHV Tested Efficiency:	81.4%
**HHV tested Efficiency:	71.0%
***EPA BTU Output:	24,300
****Peak BTU/Hour Output:	35,200
Other Important Information	
Vent Size:	6 Inch (152 mm)
Firebox Size:	1.25 cu. ft.
Outside Air Size:	3 Inch
Max. Wood Length:	18"
Ideal Wood Length:	16"
Fuel	Seasoned Cordwood (20% moisture) or compressed logs
* Weighted average LHV efficiency using Douglas Fir dimensional lumber and data collected during EPA emissions test.	
**Weighted average HHV efficiency using Douglas Fir dimensional lumber and data collected during EPA emissions test.	
***Efficiencies are based on test results calculated using B415; these calculated efficiencies are then used to calculate output BTU's.	
****A peak BTU out of the appliance calculated using the maximum first hour burn rate from the High EPA Test and the BTU content of cord wood (8600) times the efficiency.	

Certified to comply with 2020 US particulate emissions standard using crib wood at 1.99 g/hr., Certified to comply with 2020 particulate emission standards for single burn rate heaters. This single burn rate wood heater is not approved for use with a flue damper.

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

C. Mobile Home Approved (USA & Canada)

- This appliance is approved for mobile home installations in the USA & Canada when not installed in a sleeping room and when an outside combustion air inlet is provided.
- The structural integrity of the mobile home floor, ceiling, and walls must be maintained.
- The unit must be bolted to the floor. This can be done using an appropriate fastener for the application.
- The appliance must be properly grounded to the frame of the mobile home with #8 copper ground wire, and chimney must be listed to UL103 HT or a listed UL-1777 full length six" (152mm) diameter liner must be used.
- Outside air must be installed in a mobile home installation.

D. Glass Specifications

This appliance is equipped with 5mm ceramic glass. Replace glass only with 5mm ceramic glass. Please contact your dealer for replacement glass.

WARNING



Fire Risk.

Hearth & Home Technologies disclaims any responsibility for, and the warranty will be voided by, the following actions:

- Installation and use of any damaged appliance.
- Modification of the appliance.
- Installation other than as instructed by Hearth & Home Technologies.
- Installation and/or use of any component part not approved by Hearth & Home Technologies.
- Operating appliance without fully assembling all components.
- Operating appliance without legs attached (if supplied with it).
- Do NOT Over fire - If appliance or chimney connector glows, you are over firing.

Any such action that may cause a fire hazard.

NOTE: This installation must conform with local codes. In the absence of local codes you must comply with the UL1482-11, UL 737-11, (UM) 84-HUD and NPFA211 in the U.S.A. and the ULC S627-00 and CAN/CSA-B365 Installation Codes in Canada. **APPROVED FOR MOBILE HOME INSTALLATIONS IN the USA & CANADA.**

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage.

For assistance or additional information, consult a qualified installer, service agency or your dealer.

NOTE: Hearth & Home Technologies, manufacturer of this appliance, reserves the right to alter its products, their specifications and/or price without notice.

Hearth & Home Technologies WILL NOT warranty appliances that exhibit evidence of firing. Evidence of firing includes, but is not limited to:

- Warped Damper
- Deteriorated refractory
- Deteriorated interior components

E. Non-Combustible Materials

Material which will not ignite and burn, composed of any combination of the following:

- | | |
|------------|-----------|
| - Steel | - Plaster |
| - Brick | - Iron |
| - Concrete | - Tile |
| - Glass | - Slate |

Materials reported as passing **ASTM E 136, Standard Test Method for Behavior of Metals, in a Vertical Tube Furnace of 750° C.**

F. Combustible Materials

Material made of/or surfaced with any of the following materials:

- | | |
|----------------|------------------------|
| - Wood | - Compressed Paper |
| - Plant Fibers | - Plastic |
| - Plywood/OSB | - Sheet Rock (drywall) |

Any material that can ignite and burn: flame proofed or not, plastered or non-plastered.

G. California Safety Information



WARNING

This product and the fuels used to operate this product (wood), and the products of combustion of such fuels, can expose you to chemicals including carbon black, which is known to the State of California to cause cancer, and carbon monoxide, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to: www.P65Warnings.ca.gov

H. Smoke, CO Detectors & Safety Tips

Smoke and CO Detectors

The use of smoke and carbon monoxide (CO) detectors throughout the home is strongly advised, even if not required by building codes or insurance regulations. It is a good idea to install a smoke detector in the living areas and each bedroom. Follow the smoke/CO detector manufacturer's placement and installation instructions and maintain regularly.

You may not, however, wish to install a detector in the immediate vicinity of the stove. Depending on the sensitivity of the unit, the alarm can be set off while you are tending the fire or emptying the ashes. If you install a detector in the same room, locate it as far away from the stove as possible.

Safety Tips

Conveniently locate a "Class A" fire extinguisher to contend with small fires. Be sure the fire extinguisher works and is clearly visible. All occupants of the house should know where it is, and how it operates. Have heavy stove gloves available near the stove. Have special safety accessories (e.g., Child Guard Screen) available for use if small children will be in the home.

In the event of a stove pipe or chimney fire....

- Evacuate the house immediately
- Notify the fire department
- If the fire isn't too threatening, closing down the stove tight, (damper, primary air, all doors) will help to smother the fire.
- Inspect your stove, vent pipe and chimney for any damage caused by the fire and correct any damage before using your stove again.



WARNING



Fire Risk

- Do not leave the fire unattended when the door is unlatched
- Operate only with front doors and ash pan door closed.
- Unstable firewood could fall out of the firebox creating a fire hazard to your home.

2 Getting Started

A. Design & Installation Considerations

Consideration must be given to:

- Safety
- Convenience
- Traffic flow
- Chimney and chimney connector required

It is a good idea to plan your installation on paper, using exact measurements for clearances and floor protection, before actually beginning the installation. If you are not using an existing chimney, place the appliance where there will be a clear passage for a factory-built listed chimney through the ceiling and roof.

We recommend that a qualified building inspector and your insurance company representative review your plans before and after installation.

If this appliance is in an area where children may be near it is recommended that you purchase a decorative barrier to go in front of the appliance. Remember to always keep children away while it is operating and do not let anyone operate this appliance unless they are familiar with these operating instructions.



CAUTION

Check building codes prior to installation.

- Installation **MUST** comply with local, regional, state and national codes and regulations.
- Consult insurance carrier, local building, fire officials or authorities having jurisdiction about restrictions, installation inspection, and permits.



WARNING



Asphyxiation Risk

- **DO NOT CONNECT THIS APPLIANCE TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.**
- **DO NOT CONNECT TO ANY AIR DISTRIBUTION DUCT OR SYSTEM.**

May allow flue gases to enter the house.

B. Fire Safety

To provide reasonable fire safety, the following should be given serious consideration:

1. Install at least one smoke detector on each floor of your home to ensure your safety. They should be located away from the heating appliance and close to the sleeping areas. Follow the smoke detector manufacturer's placement and installation instructions, and be sure to maintain regularly.

2. A conveniently located Class A fire extinguisher to contend with small fires resulting from burning embers.
3. A CO detector should be installed in the room with the appliance.
4. A practiced evacuation plan, consisting of at least two escape routes.
5. A plan to deal with a chimney fire as follows:

In the event of a chimney fire:

- a. Evacuate the house immediately
- b. Notify fire department.

Notice: Hearth & Home Technologies assumes no responsibility for the improper performance of the appliance system caused by:

- Inadequate draft due to environmental conditions
- Down drafts
- Tight sealing construction of the structure
- Mechanical exhausting devices
- Over drafting caused by excessive chimney heights
- Ideal performance is with a chimney height of 16 Feet (4.88m) measured from the base of the appliance.

C. Negative Pressure



WARNING



Asphyxiation Risk

- Negative pressure can cause spillage of combustion fumes, soot and carbon monoxide.
- Appliance needs to draft properly for safety.

Negative pressure results from the imbalance of air available for the appliance to operate properly. It can be strongest in lower levels of the house.

Causes include:

- Exhaust fans (kitchen, bath, etc.)
- Range hoods
- Combustion air requirements for furnaces, water appliances and other combustion appliances
- Clothes dryers
- Location of return-air vents to furnace or air conditioning
- Imbalances of the HVAC air handling system
- Upper level air leaks such as:
 - Recessed lighting
 - Attic hatch
 - Duct leaks

To minimize the effects of negative air pressure:

- Install outside air with the intake facing prevailing winds during the heating season
- Ensure adequate outdoor air for all combustion appliances and exhaust equipment
- Ensure furnace and air conditioning return vents are not located in the immediate vicinity of the appliance
- Avoid installing the appliance near doors, walkways or small isolated spaces
- Recessed lighting should be a “sealed can” design
- Attic hatches weather stripped or sealed
- Attic mounted duct work and air handler joints and seams taped or sealed
- Basement installations should be avoided



WARNING



Fire Risk.

Hearth & Home Technologies disclaims any responsibility for, and the warranty will be voided by, the following actions:

- Installation and use of any damaged appliance.
- Modification of the appliance.
- Installation other than as instructed by Hearth & Home Technologies.
- Installation and/or use of any component part not approved by Hearth & Home Technologies.
- Operating appliance without fully assembling all components.
- Operating with the front doors open.
- Operating appliance without legs attached (if supplied with appliance).
- Do NOT Over fire - If appliance or chimney connector glows, you are over firing.

Any such action that may cause a fire hazard.

D. Tools And Supplies Needed

Before beginning the installation be sure the following tools and building supplies are available:

- | | |
|---|-------------------------------|
| • Reciprocating saw | • Framing material |
| • Pliers | • High temp caulking material |
| • Hammer | • Gloves |
| • Phillips screwdriver | • Framing square |
| • Flat blade screwdriver | • Electric drill and bits |
| • Plumb line | • Safety glasses |
| • Level | • Tape measure |
| • Misc. screws and nails | |
| • 1/2-3/4 in. length, #6 or #8 self-drilling screws | |

E. Inspect Appliance and Components

- Remove appliance and components from packaging and inspect for damage.
- Report to your dealer any parts damaged in shipment.
- **Read all the instructions before starting the installation. Follow these instructions carefully during the installation to ensure maximum safety and benefit.**



WARNING



Fire Risk

Inspect appliance and components for damage. Damaged parts may impair safe operation.

- Do NOT install damaged components.
- Do NOT install incomplete components.
- Do NOT install substitute components.

Report damaged parts to dealer.



WARNING

When this room heater is not properly installed, a house fire may result. To reduce the risk of fire, follow the installation instructions. Contact local building or fire officials about restrictions and installation inspection requirements in your area.

F. Install Checklist

ATTENTION INSTALLER: Follow this Standard Work Checklist

This standard work checklist is to be used by the installer in conjunction with, not instead of, the instructions contained in this installation manual

Customer: _____

Date Installed: _____

Lot/Address: _____

Location of Appliance: _____

Installer: _____

Dealer/ Distributor Phone #: _____

Serial #: _____

Model : _____

WARNING! Risk of Fire or Explosion! Failure to install appliance according to these instructions can lead to a fire or explosion.

Appliance Install

Verified clearance to combustibles.

Appliance is leveled and connector is secured to appliance.

Hearth extension size/height decided.

Outside Air Installed.

Floor protection requirements have been met.

If appliance is connected to a masonry chimney, it should be cleaned and inspected by a professional. If installed to a factory built metal chimney, the chimney must be installed according to the manufacturer's instructions and clearances.

YES IF NO, WHY?

<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____

Chimney

Chimney configuration complies with diagrams.

Chimney installed, locked and secured in place with proper clearance.

Chimney meets recommended height requirements (Minimum 16 Feet).

Roof flashing installed and sealed.

Terminations installed and sealed.

<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____

Clearances

Combustible materials not installed on non-combustible areas.

Verified all clearances meet installation manual requirements.

Mantels and wall projections comply with installation manual requirements.

Protective hearth strips and hearth extensions installed per manual requirements.

<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____

Appliance Setup

All packaging and protective materials removed.

Firebrick/Refractory, baffle and ceramic blanket (if applicable) installed correctly

All labels have been removed from the door.

All packaging materials are removed from inside/under the appliance.

Manual bag and all of its contents are removed from inside/under the appliance and given to the party responsible for use and operation.

<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____
<input type="checkbox"/>	_____

Hearth & Home Technologies recommends the following:

- Photographing the installation and copying this checklist for your file.
- That this checklist remain visible at all times on the appliance until the installation is complete.

Comments: Further description of the issues, who is responsible (Installer/Builder/Other Trades, etc.) and corrective action needed:

Comments communicated to party responsible _____ by _____ on _____
(Builder/Gen. Contractor) (Installer) (Date)

3 Dimensions and Clearances

A. Appliance Dimensions

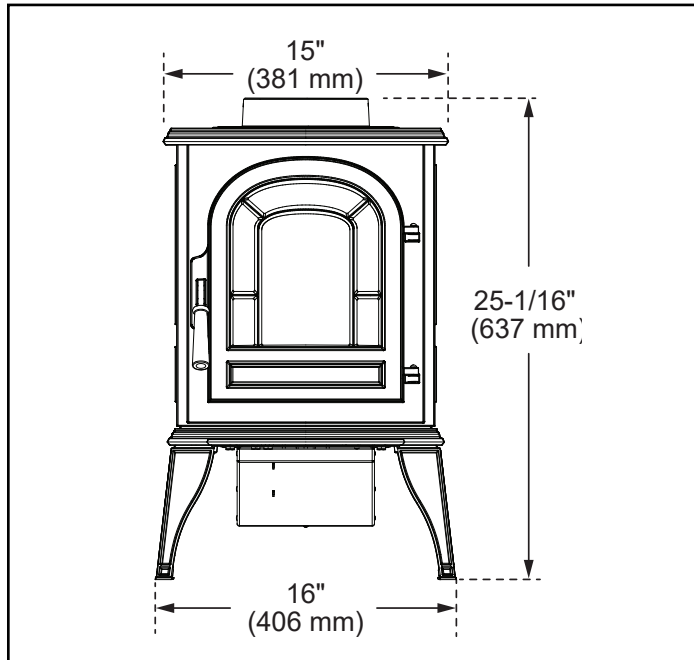


Figure 3.1 - Front View

NOTE: Flue Collar size is 6" (152mm) diameter (ID)

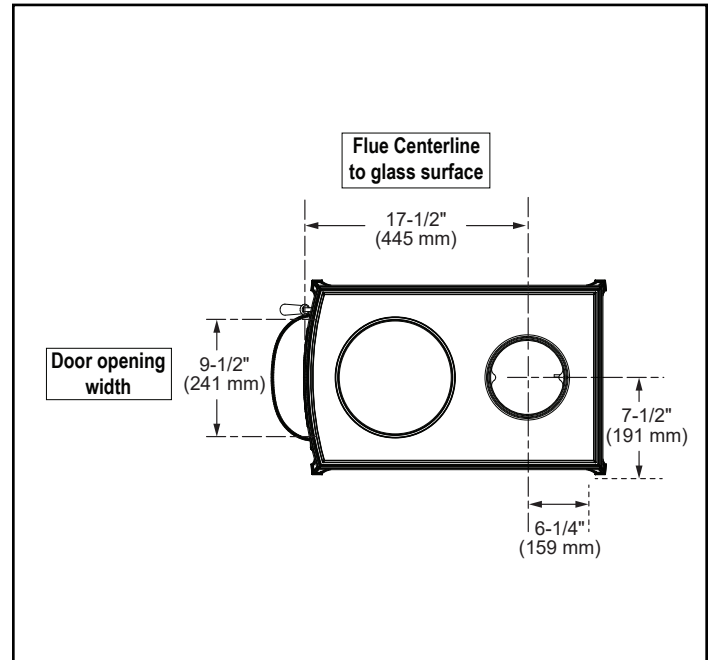


Figure 3.3 - Top View

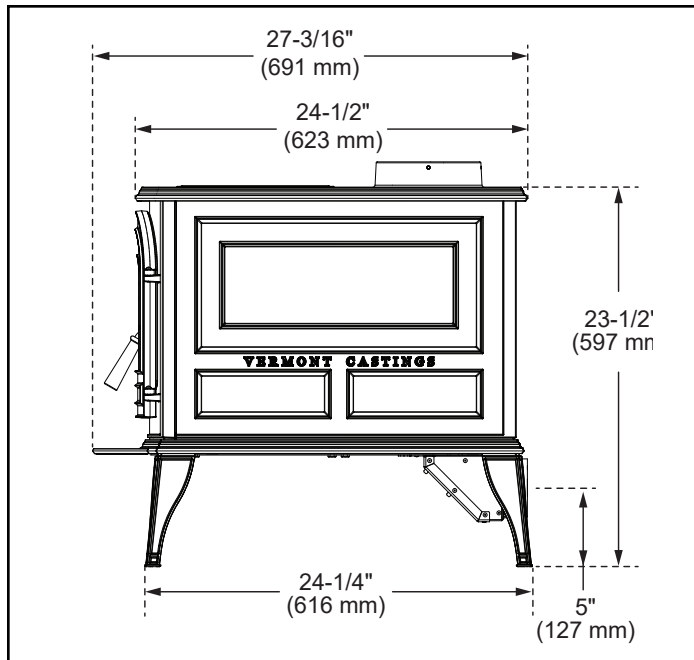


Figure 3.2 - Side View, Outside Air Inlet: 3.5" Diameter (Use with 3" Flex Outside Air Pipe)

B. Hearth Protection Requirements



CAUTION

Hearth and Home Technologies does not recommend adhesive based vinyl flooring due to thermal expansion. Floating-style flooring (LVP - luxury vinyl plank or LVT – luxury vinyl tile) can be used, but it will reach temperatures up to 110 °F in a room with ambient temperature of 70 °F. Consult flooring specifications to ensure compatibility.

HHT recommends wood stoves and inserts have 57 inches of alternative flooring in front of the stove before using LVP/LVT regardless if they sit flush on the floor or are elevated on a raised hearth.

For all other flooring, continue to follow clearance to combustible requirements in the installation manual.

NOTICE: Clearances that do not meet the minimum guidelines could result in damage or buckling to the vinyl flooring and is done at the installer's risk.

The floor area directly under and around the stove will require protection from stray sparks or embers that may escape the firebox. Type 1 hearth pad with no additional "R" value is required.

Use a noncombustible floor protector such as 1/4" non-asbestos mineral board or equivalent, or 24 gauge sheet metal. The floor protector may be covered with a noncombustible decorative material if desired. Do not obstruct the space under the heater.

Protection requirements vary somewhat between the United States and Canada as follows:

U.S. Installations: Non-combustible floor protection is required under the stove and must extend at least 16" from the front of the door opening and 8" from the sides of the door opening. (C, Figure 3.4)

Canadian Installations: Non-combustion floor protection is required under the stove and must extend at least 18" from the front of the stove and 8" from the sides of the stove. It must also extend under the chimney connector and 2" to either side of any horizontal runs. (A, Figure 3.4)

Note: For US installations, floor protection dimensions are measured from the door opening of the unit. For Canadian installations, all dimensions are measured from the sides and front of the unit.

Floor Protection Requirements		
	U.S.	Canada
A	8"	8" [203 mm]
B	16"	18" [457 mm]
C	8"	8" [203 mm]
D	40"	50" [1270 mm]
E	25-1/2"	31" [787 mm]

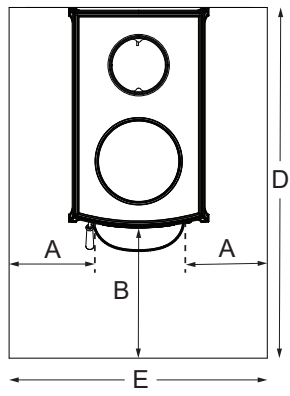
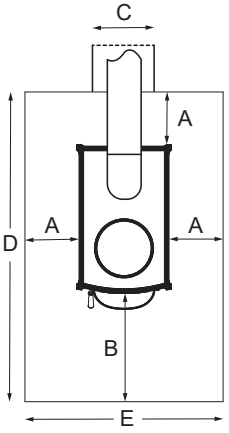



Figure 3.4 - These dimensions are minimum requirements only. Use greater dimensions whenever possible.

Fireplace Hearth Protection:

For all fireplace installations, follow the floor protection guidelines described above.

Keep in mind that many raised hearths will extend less than the required clearance from the front of the heater when it is installed. In such cases, sufficient floor protection as described above must be added in front of the hearth to satisfy the minimum floor protector requirement from the front of the stove: 16" (406 mm) from the front in the United States and 18" (457 mm) from the front in Canada.

Hearth rugs do not satisfy the requirements for floor protection as they are only fire-retardant, not fire proof.

Fireplace installations also have special clearance requirements to the side walls, side decorative trim and fireplace mantel. Refer to the information on fireplace and mantel trim shields in this section.

C. Clearances To Combustibles

Note: It is recommended that you have the unit in place for proper measurements and installation.

NOTE: Double wall pipe clearances are for US installations **ONLY**. Canadian installations must conform with local code. In the absence of local codes you must comply with the ULC S627-00 and CAN/CSA-B365.

Parallel Wall Installation - Vertical Vent		
	Description	Single-Wall Pipe
A	Side Wall to Appliance	14" [356 mm]
B	Back Wall to Appliance	8" [203 mm]
C	Side Wall to Connector Pipe	18-1/2" [470 mm]
D	Back Wall to Connector Pipe	11" [279 mm]
E	Minimum Floor to Ceiling	96" [2438 mm]
	Description	Double-Wall Pipe
A	Side Wall to Appliance	14" [356 mm]
B	Back Wall to Appliance	3" [76 mm]
C	Side Wall to Vent Pipe	18" [457 mm]
D	Back Wall to Vent Pipe	5-1/2" [140 mm]
E	Minimum Floor to Ceiling	96" [2438 mm]

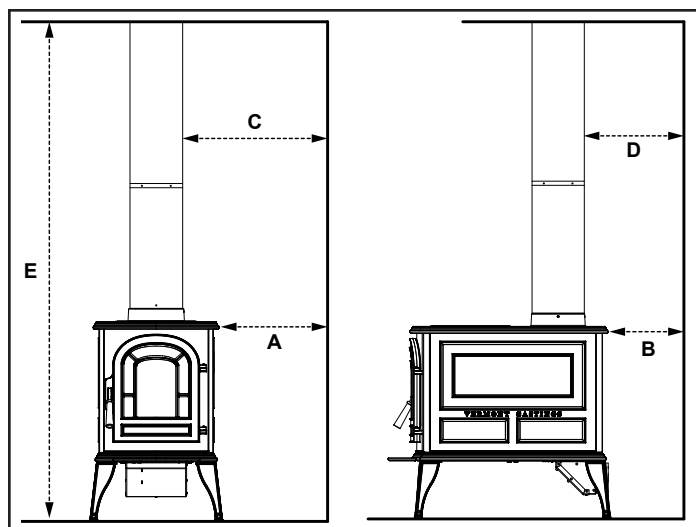


Figure 3.5

Vertical Vent, Corner Configuration		
	Location	Single-Wall Pipe
G	Corner to Wall	6" [152 mm]
H	Vent Pipe to Wall	12-3/4" [324 mm]
	Location	Double-Wall Pipe
G	Corner to Wall	3" [76 mm]
H	Vent Pipe to Wall	9" [229 mm]

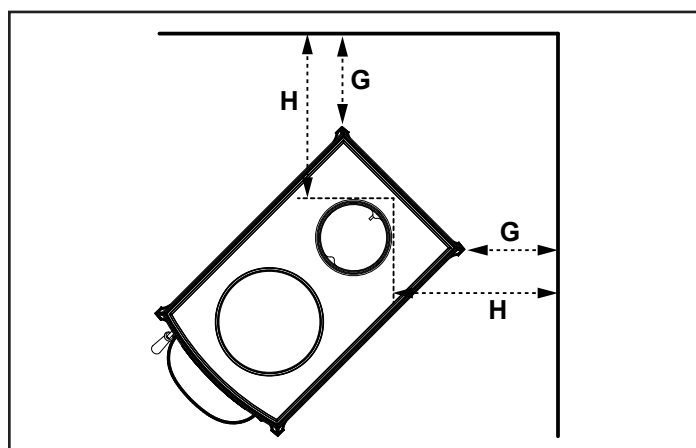


Figure 3.6

Parallel Wall, Backwall Exit w/Reduced Ceiling		
	Description	Single-Wall Pipe
A	Side Wall to Appliance	14" / 356 mm
B	Back Wall to Appliance	8" / 203 mm
C	Side Wall to Connector Pipe	18-1/2" / 470 mm
D	Back Wall to Connector Pipe	11" / 279 mm
E	Ceiling from Floor	63" / 1600 mm
F	Ceiling - from Connector Pipe	20" / 508 mm

Note: If mantle clearance specifications are not listed or to reduce mantle clearances you can follow NFPA 211 regulations to assure safe installation of this product. Please consult with your local building inspector before attempting any clearance reductions.

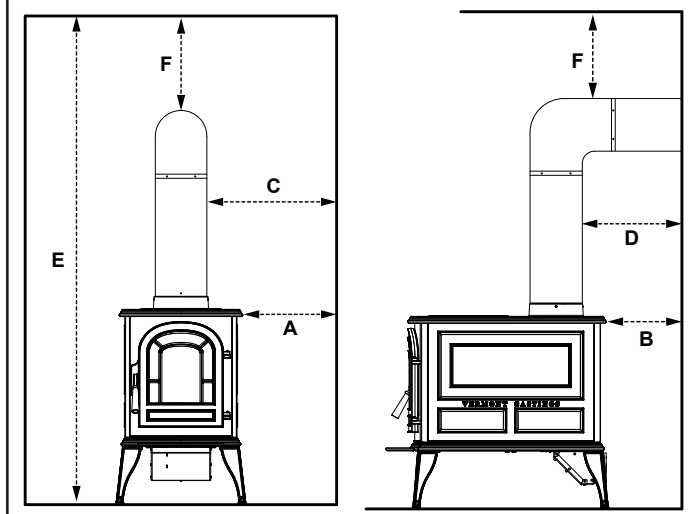


Figure 3.7

Fireplace Clearances:

A fireplace installation requires special clearance between the side of the stove and the right and left walls, the side of the stove and the decorative side trim on the fireplace face, and the top of the stove and the mantel.

Maximum Mantel depth (A, Figure 3.8) of a combustible mantel is 9" (230 mm). At that depth, the clearance to the stove top (B) must be a minimum of 22-1/2" (572 mm).

Top Trim (C) protruding less than 1-1/2" (38 mm) from the face of the fireplace must be a minimum of 12" (305 mm) from the stove top. This clearance may not be reduced by shielding.

For every 1-1/2" (38 mm) increment that the trim or mantel extends in depth, the clearance from the stove top must also be increased by 1-1/2" (38 mm).

Side Trim must have a minimum clearance of 8" (203 mm), measured from the stove's top edge. (D, Figure 3.9)

When:

A = 9" (229 mm) Max.

B = 22-1/2" (572 mm) Min.

A = 7-1/2" (191 mm) Max.

B = 21" (533 mm) Min.

A = 6" (152 mm) Max.

B = 19-1/2" (495 mm) Min.

A = 4-1/2" (114 mm) Max.

B = 18" (457 mm) Min.

A = 3" (76 mm) Max.

B = 16-1/2" (419 mm) Min.

A = 1-1/2" (38 mm) Max.

B = 15" (381 mm) Min.

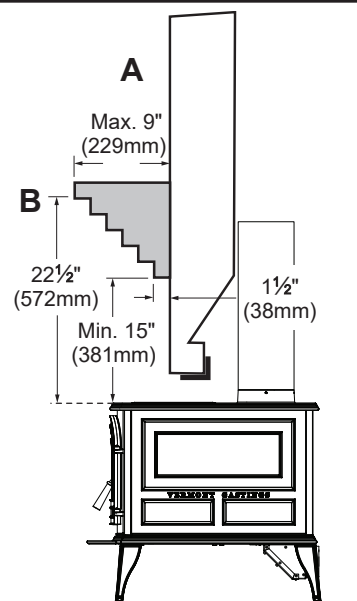


Figure 3.8 - Mantel and trim clearances.

B	Mantel	22-1/2" (572 mm)
C	*Top Trim	12" (305 mm)
D	Side Trim	8" (203 mm)
*Material is less than 1-1/2" (38 mm) Thick		

Figure 3.9 - Mantel and trim clearances.

D. Locating Your Appliance & Chimney

Location of the appliance and chimney will affect performance. As shown in Figure 3.10 the chimney should:

- Install through the warm space enclosed by the building envelope. This helps to produce more draft, especially during lighting and die down of the fire.
- Penetrate the highest part of the roof. This minimizes the affects of wind turbulence and down drafts.

- Consider the appliance location in order to avoid floor and ceiling attic joists and rafters.
- Locate termination cap away from trees, adjacent structures, uneven roof lines and other obstructions.

Your local dealer is the expert in your geographic area and can usually make suggestions or discover solutions that will easily correct your flue problem.

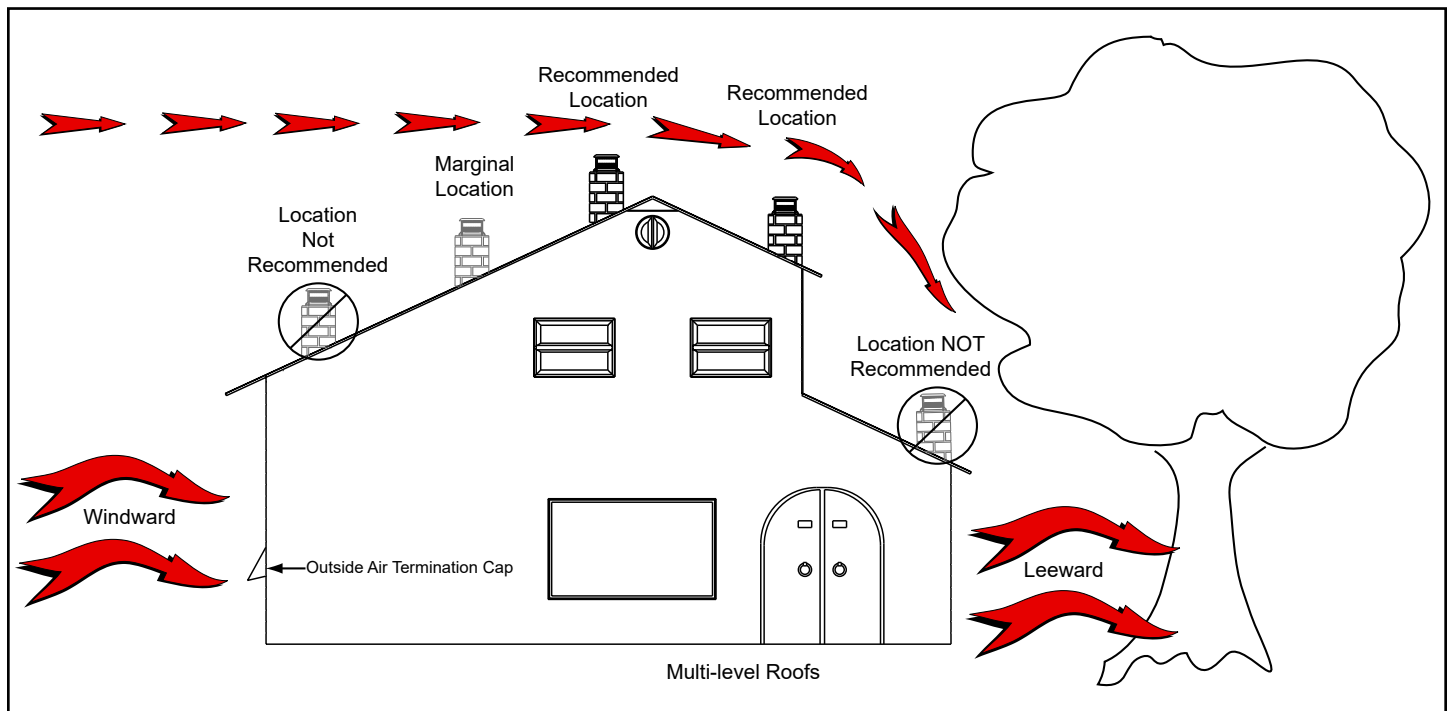


Figure 3.10

E. Chimney Termination Requirements

Follow manufacturer's instructions for clearance, securing flashing and terminating the chimney. Figures 3.11 & 3.12.

- Must have an approved and Listed cap
- Must not be located where it will become plugged by snow or other material
- Must terminate at least 3 feet (91 cm) above the roof and at least 2 feet (61 cm) above any portion of the roof within 10 feet (305 cm).
- Must be located away from trees or other structures

NOTICE: Locating the appliance in a basement or in a location of considerable air movement can cause intermittent smoke spillage from appliance. Do not locate appliance near

- Frequently open doors
- Central heat outlets or returns

NOTICE:

- Chimney performance may vary.
- Trees, buildings, roof lines and wind conditions affect performance.
- Chimney height may need adjustment if smoking or overdraft occurs.

F. Chimney Location (2-10-3 Rule)

These are safety requirements and are not meant to assure proper flue draft.

This appliance is made with a 6" (152 mm) diameter chimney connector as the flue collar on the appliance.

- Changing the diameter of the chimney can affect draft and cause poor performance.
- It is not recommended to use offsets and elbows at altitudes above 4000 feet above sea level and or when there are other factors that affect flue draft.

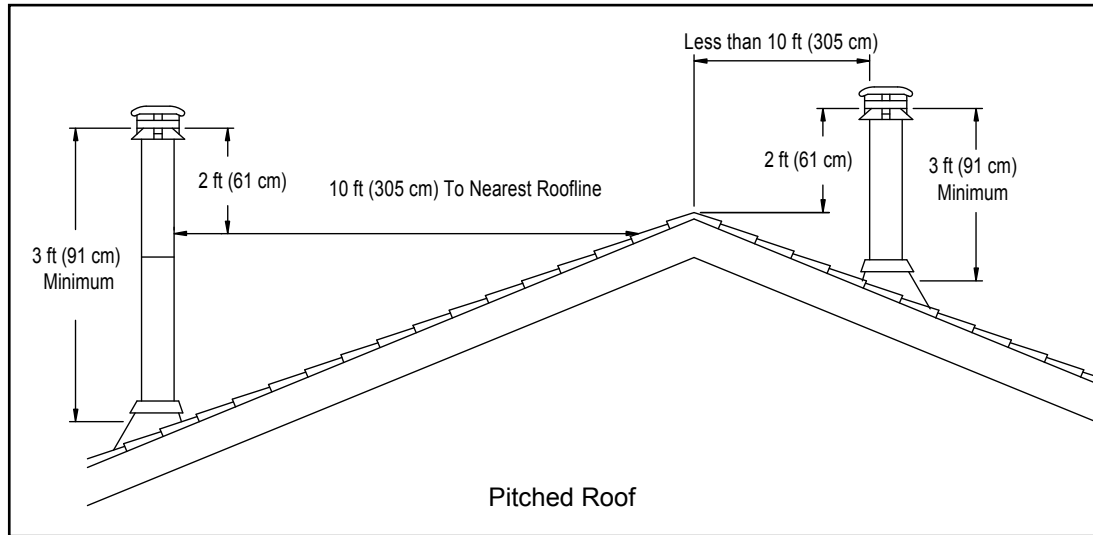


Figure 3.11

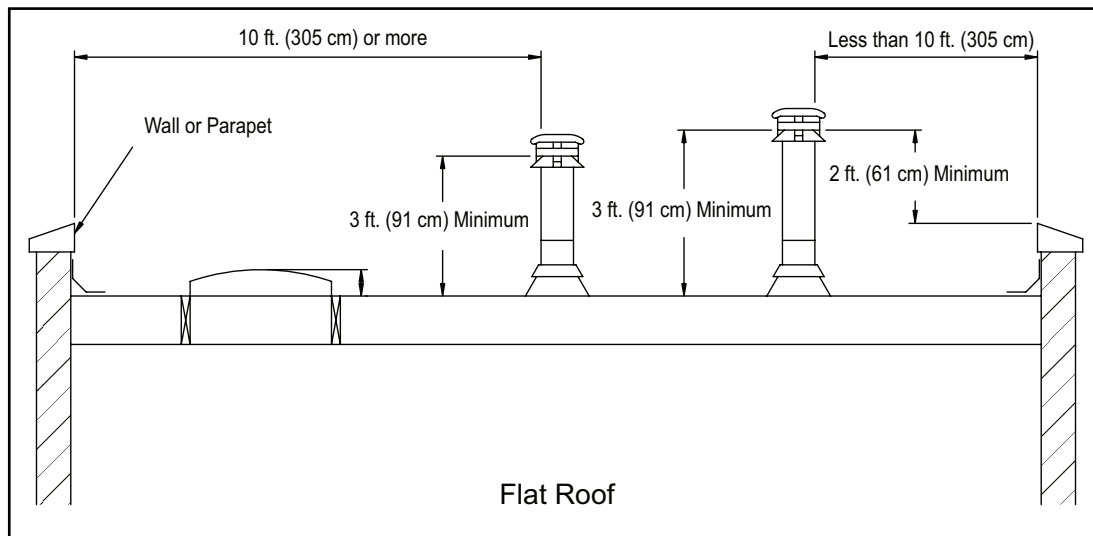


Figure 3.12

4 Chimneys & Venting

A. Venting & Draft Management

A stove is part of a system, which includes the chimney, the operator, the fuel, and the home. The other parts of the system will affect how well the stove works. When there is a good match between all the parts, the system works well.

Wood stove or insert operation depends on natural (unforced) draft. Natural draft occurs when the exhaust is hotter (and therefore lighter) than the outdoor air at the top of the chimney. The bigger the temperature difference, the stronger the draft. As the hot gases rise through the chimney they provide suction or 'draw' that pulls air into the stove for combustion. A slow, lazy fire with the stove's air inlets fully open indicates a weak draft. A brisk fire, supported only by air entering the stove through the normal inlets, indicates a good draft. The stove's air inlets are passive; they regulate how much air can enter the stove, but they don't move air into it.

Depending on the features of your installation - steel or masonry chimney, inside or outside the house, matched to the stove's outlet or oversized - your system may warm up quickly, or it may take a while to warm up and operate well. With an 'airtight' stove, one which restricts the amount of air getting into the firebox, the chimney must keep the stove's exhaust warm all the way to the outdoors in order for the stove to work well. Some chimneys do this better than others. Here's a list of features and their effects.

Note: Elbow and Tee's reduce the draft of a chimney system. Design the installation to minimize changes in direction. No more than 2 tee's or elbows may be used.

Masonry Chimney

Masonry is a traditional material for chimneys, but it can perform poorly when it serves an 'airtight' stove. Masonry is a very effective 'heat sink' - it absorbs a lot of heat. It can cool the chimney gases enough to diminish draft. The bigger the chimney, the longer it takes to warm up. It's often very difficult to warm up an outdoor masonry chimney, especially an oversized one, and keep it warm enough to maintain an adequate draft.

Steel Chimney

Most factory-made steel chimneys have a layer of insulation around the inner flue. This insulation keeps the chimney warm. The insulation is less dense than masonry, so a steel chimney warms up more quickly than a masonry chimney. Steel doesn't have the good looks of masonry, but it performs much better.

Indoor/Outdoor Location

Because the chimney must keep the smoke warm, it's best to locate it inside the house. This uses the house as insulation for the flue and allows some heat release into the home. An indoor chimney won't lose its heat to the outdoors, so it takes less heat from the stove to heat it up and keep it warm.

Single Venting

Each 'airtight' stove requires its own flue. If an airtight stove is vented to a flue that also serves an open fireplace, or a leakier stove, it's easier for the chimney draft to pull air in through those channels and performance of the stove suffers. Imagine a vacuum cleaner with a hole in the hose to understand the effect here. In some cases the other appliance can even cause a negative draft through the stove, and result in a dangerous draft reversal.

Draft

The Vermont Castings Aspen C3 requires a minimum draft of 10 Pa or .04" of W.C. Draft too low can cause low heat output and a sluggish burn. Draft higher than 30 Pa or .12 of W.C. can result in short burn times and overfiring. Ensure the draft of the chimney is in correct range for operating the Aspen C3.

Flue Sizing

The inside size of a chimney for an 'airtight' stove should match the size of the stove's flue outlet. When a chimney serves an airtight stove, more is not better; in fact, it can be a disadvantage. Hot gases lose heat faster as they travel slower through a chimney; if we vent a stove with a six-inch flue collar (28 square inch area) into a 10 x 10" flue, the gases slow to one third their original speed. This allows the gases to cool more rapidly, which weakens draft strength. If an oversized flue is also outside the house, the heat it absorbs gets transferred to the outdoor air and the flue usually stays cool.

It is common for a masonry flue, especially one serving a fireplace, to be oversized for the stove. It can take quite a while to warm up such a flue, and the results can be disappointing. The best solution to an oversized flue is an insulated steel chimney liner, the same diameter as the stove or inserts flue outlet; the liner keeps the exhaust warm, and the result is a stronger draft. A non-insulated liner is a second choice - the liner keeps the exhaust restricted to its original size, but the hot gases still must warm up the air around the liner. This makes the warm-up process take longer.

Pipe & Chimney Layout

Every turn the exhaust must take as it travels to the chimney top will slow it down. The ideal pipe and chimney layout is to vent vertically into a completely straight and vertical chimney. If you are starting from scratch, use this layout if possible. If the stovepipe must elbow to enter a chimney, locate the thimble about midway between the stove top and the ceiling. This achieves several goals: it allows the gases to speed up before they must turn, it leaves some pipe in the room for heat transfer, and it gives you long-term flexibility for installing a different stove without relocating the thimble.

There should be no more than eight feet of single-wall stove pipe between the stove and a chimney; longer runs can cool the exhaust enough to cause draft and creosote problems. With prefabricated chimney, bring it down to six to eight feet from the stove. With a masonry chimney, arrange the pipe so that it turns into the chimney within eight feet of the stove.

B. Venting Components

Chimney Connector: It is also known as flue pipe or appliance pipe. The chimney connector joins the appliance to the chimney. It must be a 6" (152 mm) minimum diameter 24 gauge mild steel black or 26 gauge blued steel, or an approved air-insulated double wall venting pipe.

Thimble: A manufactured or site-constructed device installed in combustible walls through which the chimney connector passes to the chimney. It is intended to keep the walls from igniting. Site constructed thimbles must meet NFPA 211 Standards. Prefabricated must be suitable for use with selected chimney and meet UL103 Type HT Standards. Follow instructions provided by the manufacturer for manufactured thimbles for masonry chimney and prefabricated chimneys.

Chimney: The chimney can be new or existing, masonry or prefabricated and must meet the following minimum requirements specified in section 4C "Chimney Systems".

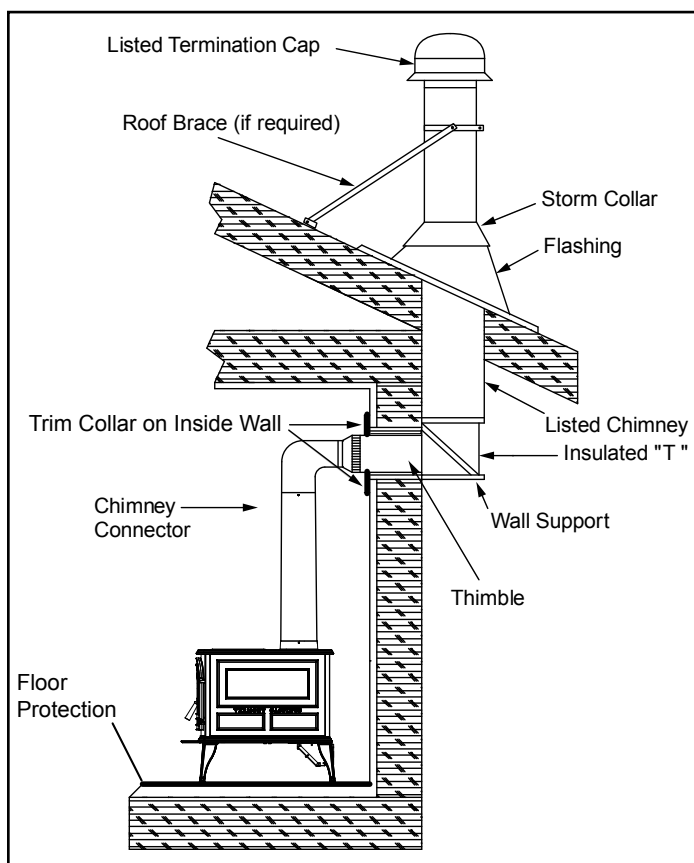


Figure 4.1 - Prefabricated Exterior Chimney

C. Chimney Systems

Prefabricated Metal Chimney

- Must be minimum 6" (152 mm) diameter (ID) high temperature chimney listed to UL 103 HT (2100 °F) or ULC S629M.
- Must use components required by the manufacturer for installation.
- Must maintain clearances required by the manufacturer for installation.
- Refer to manufacturers instructions for installation.

NOTE: In Canada when using a factory-built chimney it must be safety listed, **Type UL103 HT (2100 °F) CLASS "A"** or conforming to **CAN/ULC-S629M, STANDARD FOR 650 °C FACTORY-BUILT CHIMNEYS**.

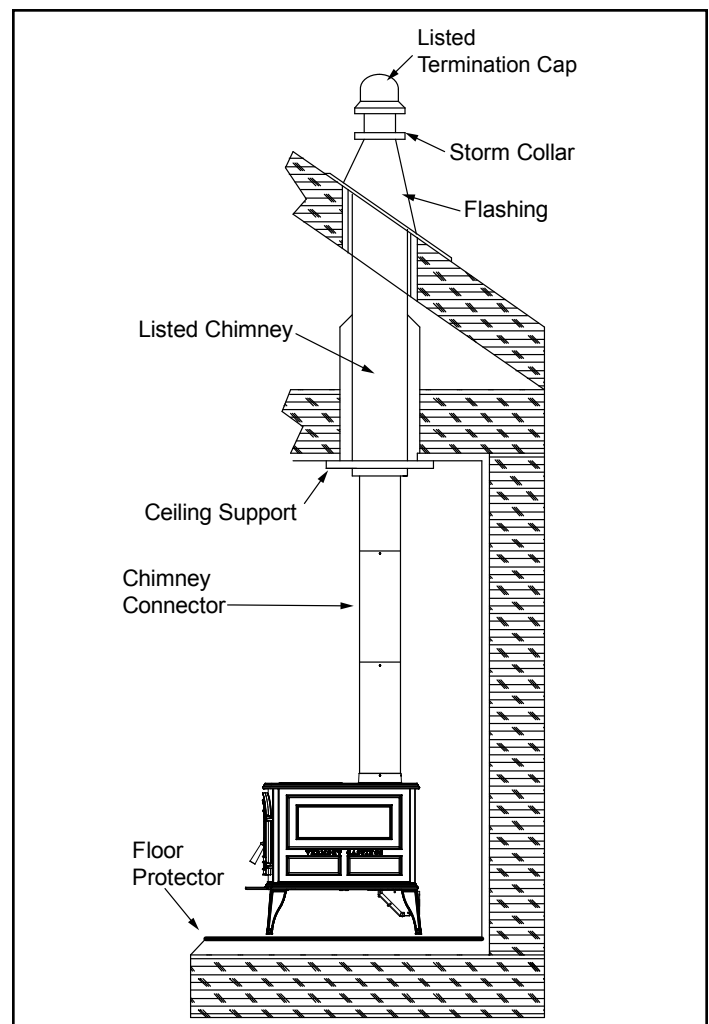


Figure 4.2 - Prefabricated Interior Chimney

Thimble

Site constructed for masonry chimney installation:

Components

- A minimum length of 12" (305 mm) (longer for thicker walls) of solid insulated factory-built chimney length constructed to UL 103 Type HT 6" (152 mm) inside diameter. Chimney needs to extend a minimum of 2" (51 mm) from the interior wall and a minimum of 1" (25 mm) from the exterior wall.
- Wall spacer, trim collar and wall band to fit solid pack chimney selected.
- Minimum 8" (203 mm) diameter clay liner section (if not already present in chimney) and refractory mortar.
- When jurisdiction requires install approved chimney liner in masonry chimney.

Air Clearances

- Masonry chimney clearance must meet NFPA 211 minimum requirement of 2" (51 mm) to sheet metal supports and combustibles.
- Minimum of 1" (25 mm) clearance around the chimney connector.
- Top of wall opening is a minimum of 13-1/2" (343 mm) from ceiling or 4-1/2" (114 mm) below minimum clearance specified by chimney connector manufacturer. NFPA 211 minimum vertical clearance of 18" (457mm) from chimney connector and ceiling or minimum recommended by chimney connector manufacturer. Figure 4.3

Instructions

1. Open inside wall at proper height for the chimney connector to enter the masonry chimney. Figure 4.3
2. Entry hole to masonry chimney must be lined with an 8" (203 mm) minimum diameter clay liner, or equivalent, secured with refractory mortar.
3. Construct a 17" x 17" (432 mm x 432 mm) outside dimension frame from 2 x 2 framing lumber to fit into wall opening. Inside opening of frame should be no less than 14" x 14" (356 mm x 356 mm). Figure 4.4. Attach the wall spacer to the chimney side of the frame.
5. Nail the frame into the wall opening. The spacer should be on the chimney side.
6. Insert the section of the solid insulated chimney into the outer wall of the masonry chimney.
7. Tightly secure the length of the solid insulated chimney with the wall band to the masonry chimney.
8. Insert a section of chimney connector into the chimney. Make sure it does not protrude past the edge of the clay chimney liner inside the chimney.
9. Seal the end of the chimney connector to the clay liner with refractory mortar.
10. Install trim collar around the sold pack chimney section.

Solid Pack Chimney with Metal Supports as a Thimble

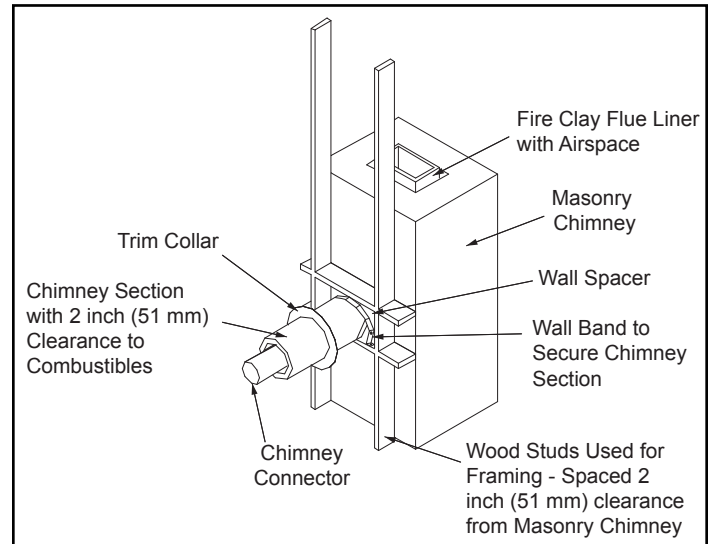


Figure 4.3

WARNING



Fire Risk

Do NOT pack insulation or other combustibles between spacers.

- ALWAYS maintain specified clearances around venting and spacers.
- Install spacers as specified.

Failure to keep insulation or other material away from vent pipe may cause fire.

Solid Pack Chimney with Metal Supports as a Thimble (Cont'd)

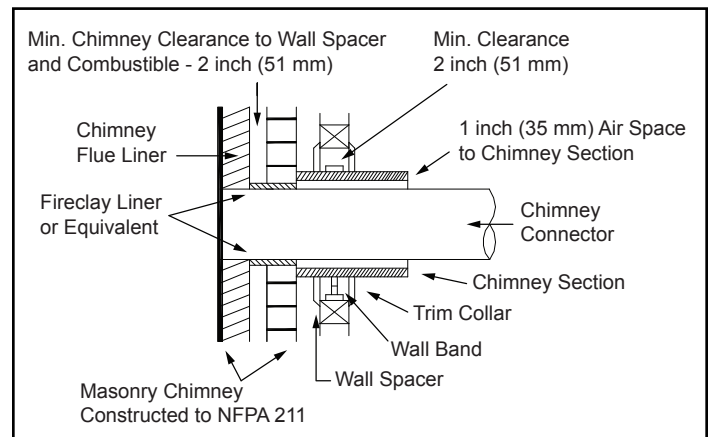


Figure 4.4

Chimney Height / Rise and Run

This product was designed for and tested on a 6" (152mm) chimney, 16 feet (4.88m) high, (includes appliance height) measured from the base of the appliance. The further your stack height or diameter varies from this configuration, the possibility of performance problems exists.

Chimney height may need to be increased by 2 - 3% per each 1000 feet above sea level. It is not recommended to use offsets or elbows at altitudes above 4000 feet above sea level or when there are other factors that affect flue draft.



WARNING



Fire Risk

Inspection of Chimney:

- Chimney must be in good condition.
- Meets minimum standard of NFPA 211
- Factory-built chimney must be 6" (152mm) UL103 HT.



WARNING



Asphyxiation Risk

- **DO NOT CONNECT THIS Appliance TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.**
- **DO NOT CONNECT TO ANY AIR DISTRIBUTION DUCT OR SYSTEM.**

May allow flue gases to enter the house.



WARNING

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to the owner's information manual provided with this appliance. For assistance or additional information consult a qualified installer, service agency or your dealer.

D. Installing Chimney Components

Chimney Connector

Single wall connector or appliance pipe

This must be at least 24 gauge mild steel or 26 gauge blue steel. The sections must be attached to the appliance and to each other with the crimped (male) end pointing toward the appliance. All joints, including the connection at the flue collar, should be secured with 3 sheet metal screws. Make sure to follow the minimum clearances to combustibles. Where passage through the wall, or partition of combustible construction is desired in Canada, the installation shall conform to CAN/CSA-B365.

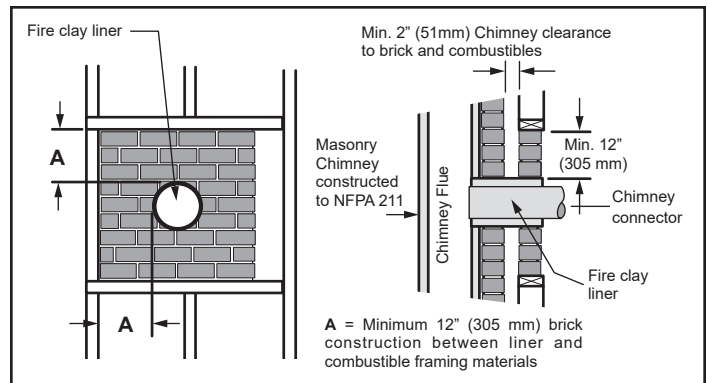


Figure 4.6 - Acceptable method for passing single wall chimney connector through combustible walls.

Note: HHT recommends the use of UL listed single wall thimbles.

Factory-built (Double-Wall) listed chimney connector

A listed connector (vented) must be used when installing this appliance in a mobile home. The listed connectors must conform to each other to ensure a proper fit and seal.

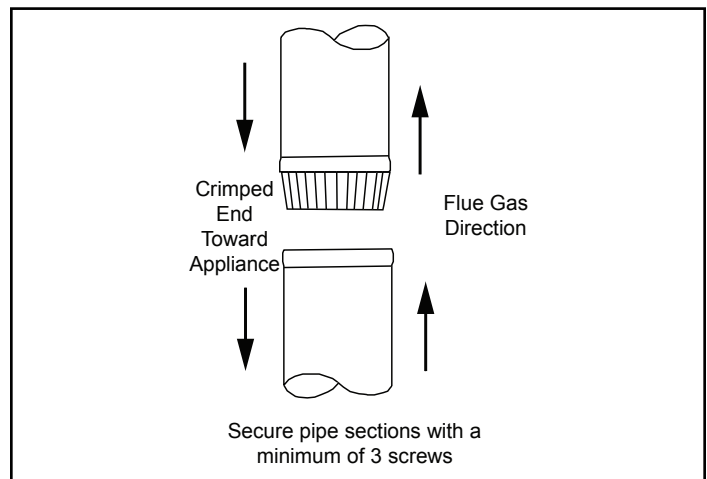


Figure 4.7 - Chimney Connector (Appliance Pipe)



WARNING



Fire Risk

Follow Chimney Connector Manufacturer's Instructions for Proper Installation.

ONLY use connector:

- Within the room, between appliance and ceiling or wall.
- Connector shall NOT pass through:
- Attic or roof space
 - Closet or similar concealed space
 - Floor or ceiling

Maintain minimum clearances to combustibles

5 Appliance Set-Up

A. Removing Unit from Skid

1. Inspect the stove and contents for shipping damage or missing parts. Immediately notify your dealer of any damage. Do not install this stove if any damage is evident or any parts are missing.
2. Remove (4) 5/16 X 2" lag screws from shipping brackets.

B. Install Stove Legs

Leg installation will be accomplished most easily with the help of an assistant who can tilt the stove onto its side while you attach the legs.

1. With your assistant holding the stove up on its side, remove (2) shipping brackets by removing the 3/8" Hex bolts and washers. **Note: DO NOT** discard these bolts and washers as they will be re-used to install the legs.
2. Place legs at each corner of the unit and install the 3/8" hex head bolts and washer previously removed. The shoulder of the legs should seat within the locator bosses cast into the stove bottom at each corner, Figure 5.1. Tighten the bolts with the wrench. **CAUTION: Overtightening can strip tapped threads.**
3. With your assistant, lift the stove up onto its legs and hold it in a tilted position to install the remaining two legs with hex bolts and washers.

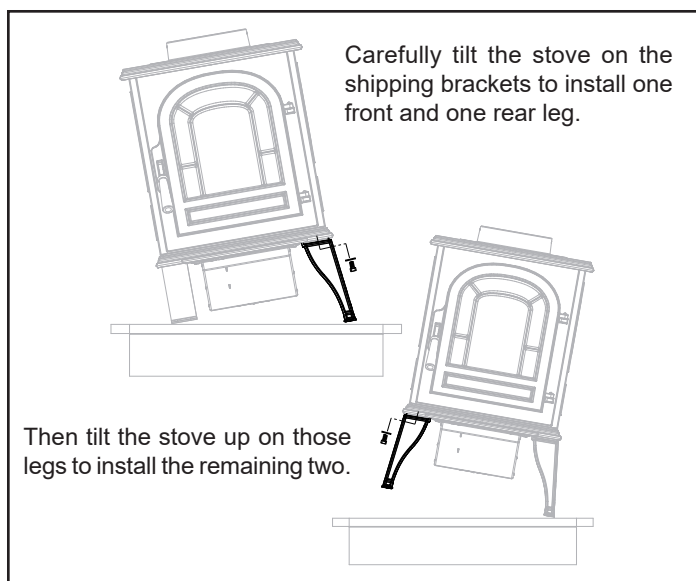


Figure 5.1 - Install legs on one side of stove then the other.

Adjust the Leg Levelers

Lift the stove slightly so there is no weight on the leg while making the adjustment.

C. Install Fire Brick

Install the Firebrick in the following order: Bottom Bricks first, Rear Bricks second and Side Bricks third, Figure 5.2.

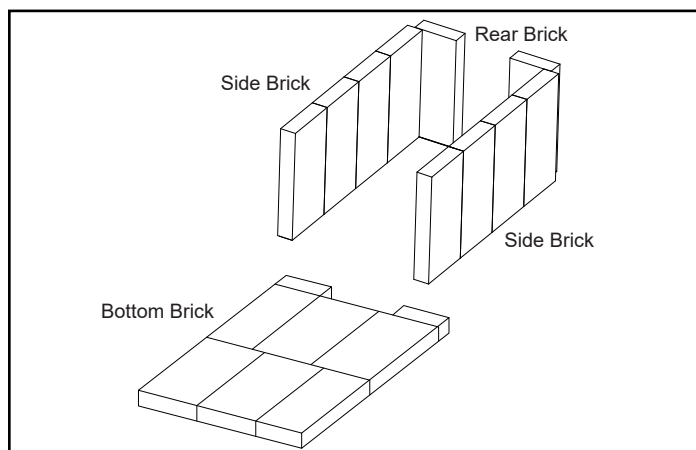


Figure 5.2 - Install Firebrick

CAUTION

Check building codes prior to installation.

- Installation **MUST** comply with local, regional, state and national codes and regulations.
- Consult insurance carrier, local building, fire officials or authorities having jurisdiction about restrictions, installation inspection, and permits.

WARNING



Fire Risk.

Hearth & Home Technologies disclaims any responsibility for, and the warranty will be voided by, the following actions:

- Installation and use of any damaged appliance.
- Modification of the appliance.
- Installation other than as instructed by Hearth & Home Technologies.
- Installation and/or use of any component part not approved by Hearth & Home Technologies.
- Operating appliance without fully assembling all components.
- Operating with the front doors open.
- Operating appliance without legs attached (if supplied with appliance).
- Do NOT Over fire - If appliance or chimney connector glows, you are over firing.

Any such action that may cause a fire hazard.

D. Outside Air Installation

A source of air (oxygen) is necessary in order for combustion to take place. Whatever combustion air is consumed by the fire must be replaced. Air is replaced via air leakage around windows and under doors. In homes that have tightly sealed doors and windows, an outside air source is needed. An Outside Air box is installed from factory to accommodate outside air. An optional outside air kit is available

Items Needed for Installation (not supplied)

- Phillips head screw driver
- Wire ties
- Plastic outside air vent
- 3" Flex or Rigid Duct
- 3" Outside Air Termination Cap with Screen
- Silicone sealant
- Drills and saws necessary for cutting holes through the wall or flooring in your home.

1. Remove all materials from packing box.
2. Using a #2 Phillips screw driver attach the flex adapter to the appliance using 4 screws. Figure 5.3 & 5.4.
3. Floor & Rear Installation: Cut a 3" (76 mm) hole in outside wall or floor to accommodate outside air piping. Use 3" (76 mm) aluminum metal flex or rigid piping to directly connect outside air to appliance intake. Install the termination cap with a rodent screen. Seal between the wall (or floor) and the pipe with silicone to prevent moisture penetration.

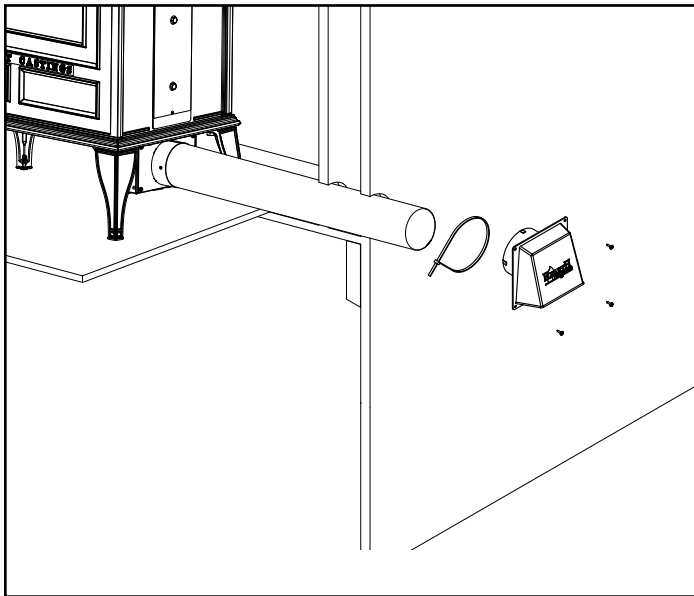


Figure 5.3 - Rear Installation

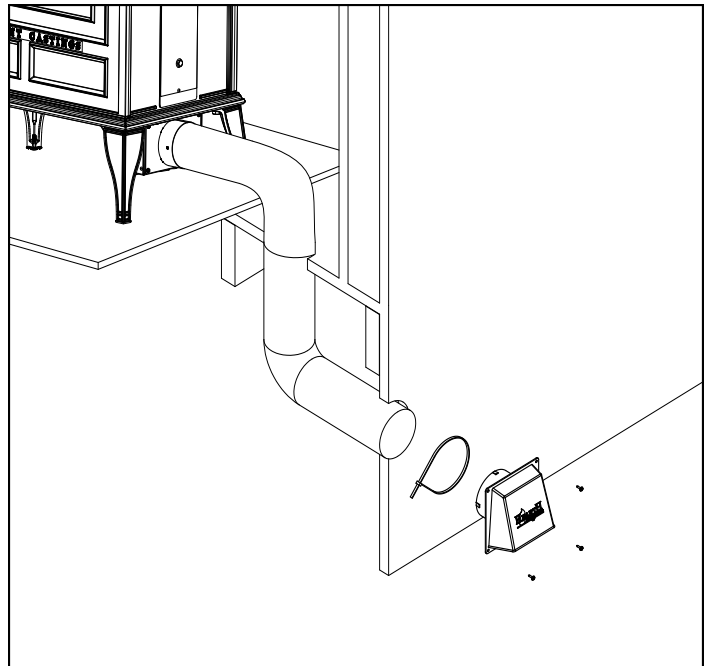


Figure 5.4 - Floor Installation

WARNING



Fire Risk



Asphyxiation Risk

Do not draw outside combustion air from:

- Wall, floor or ceiling cavity
- Enclosed space such as an attic or garage
- Close proximity to exhaust vents or chimneys

Fumes or odor may result

WARNING



Asphyxiation Risk

Outside air inlet must be located to prevent blockage from:

- Leaves
- Snow or ice
- Other debris

Blockage may cause combustion air starvation

Smoke spillage may set off alarms or irritate sensitive individuals.

WARNING



Asphyxiation Risk

Length of outside air supply duct shall NOT exceed the length of the vertical height of the exhaust flue.

- Fire will not burn properly
- Smoke spillage occurs when door is opened due to air starvation

6 Mobile Home Installation - Approved for USA & Canada Installations

A. Mobile Home Installation

Mobile home approval - USA & Canada.

The Aspen C3 is approved for use in manufactured (mobile) homes when installed with the Mobile Home Brackets and any approved local codes.

In addition to the standard installation requirements described in this manual, the following guidelines apply to mobile home installations:

1. The stove must be permanently secured to the floor using the mobile home brackets supplied (located at the rear of the unit under the outside air box) along with screws or lag bolts (not supplied). **Note:** The mobile home brackets will need to be removed from the outside air box. **Note:** The mobile home brackets get installed between the leg leveler and cast leg, Figure 6.1

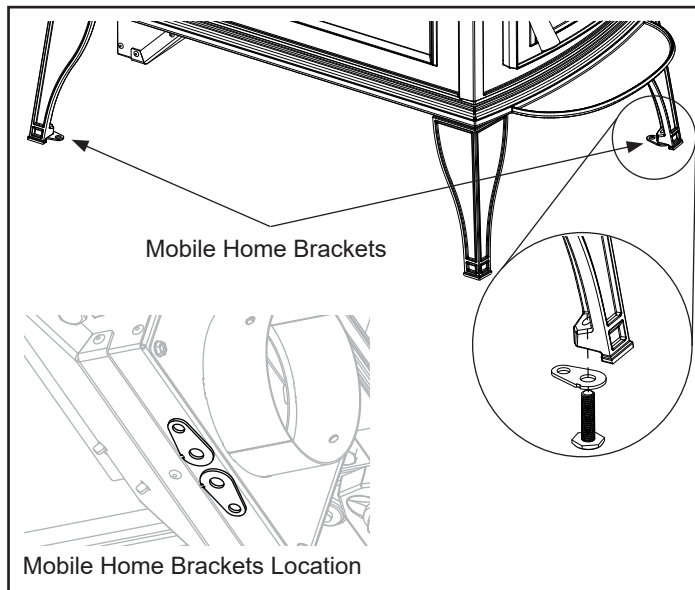


Figure 6.1

2. The stove must have a permanent connection to the outside to supply combustion air.
3. A listed chimney system, including roof thimble, spark arrestor, chimney supports, roof flashing and any other components suitable for use in mobile homes must be used. The chimney system must comply with the standard for Chimneys Factory-Built Residential Type and Building Heating Appliances UL 103.
4. The chimney must be attached directly to the stove and must extend at least 3' (914 mm) above the part of the roof through which it passes. The top of the chimney must extend at least 2' (610 mm) above the highest point of any part of the mobile home structure within 10' (3 m) of the chimney.

5. If the chimney exits the mobile home through a wall at a point 7 feet or less above the ground level on which the mobile home is located, a guard or other noncombustible enclosure must be fitted at the point of exit and extend up to a height of 7' (2.1 m). Any openings in this guard must be smaller than 3/4" (19 mm).
6. Check all local building codes, specifically those related to mobile homes. Other requirements may be applicable to chimney system removal for transportation of the mobile home.
7. Seal all penetrations between the venting system and mobile home structure with silicone (or other acceptable sealant) to completely seal the dwelling from outside air infiltration.

⚠ CAUTION

MAINTAIN STRUCTURAL INTEGRITY OF MOBILE HOME:

- FLOOR, WALL, CEILING AND/OR ROOF. DO NOT CUT THROUGH:
- FLOOR JOIST, WALL STUDS, OR CEILING TRUSSES.
- ANY SUPPORTING MATERIAL THAT WOULD AFFECT THE STRUCTURAL INTEGRITY.

⚠ CAUTION

NEVER DRAW OUTSIDE COMBUSTION AIR FROM:

- WALL, FLOOR OR CEILING CAVITY.
- ENCLOSED SPACE SUCH AS AN ATTIC OR GARAGE

⚠ WARNING

INSTALLATION MUST COMPLY WITH MANUFACTURED HOME AND SAFETY STANDARD (HUD), CFR 3280, PART 24.

⚠ WARNING

NEVER INSTALL IN A ROOM INTENDED FOR SLEEPING.

VERMONT CASTINGS

CONTACT INFORMATION

Hearth & Home Technologies
352 Mountain House Road
Halifax, PA 17032

Please contact your Vermont Castings dealer with any questions or concerns.

For the number of your nearest Vermont Castings dealer

log onto www.vermontcastings.com

CAUTION



DO NOT DISCARD THIS MANUAL

- Important operating and maintenance instructions included.
- Read, understand and follow these instructions for safe installation and operation.
- Leave this manual with party responsible for use and operation.



We recommend that you record the following pertinent information for your heating appliance.

Date purchased/installed: _____

Serial Number: _____ Location on appliance: _____

Dealership purchased from: _____ Dealer phone: _____

Notes: _____

This product may be covered by one or more of the following patents: (United States) 5341794, 5263471, 6688302, 7216645, 7047962 or other U.S. and foreign patents pending.





QUALITY CONTROL SERVICES

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PFS Teco
11785 SE Hwy 212 STE#305
Clackamas, OR 97015

Report Number: DIRI0182484A0912013i231228

A2LA ACCREDITED **CERTIFICATE OF CALIBRATION WITH DATA**

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Scale	Digiweigh	DWP12i 300kg x 0.	82484A0912013i	#050	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
lbs	0.01	QC033	12/28/23	12/14/22	12/2024

FUNCTIONAL CHECKS

SHIFT TEST	LINEARITY	REPEATABILITY	ENVIRONMENTAL CONDITIONS
Test Wt: 100 Tol: 0.05 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Test Wt: HB44 Tol: HB44 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Test Wt: 100 Tol: 0.01 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Good Fair Poor Temperature: 19.3°C

CALIBRATION DATA

Standard	As-Found	As-Left	Expanded Uncertainty
400	399.87	400.01	0.006
200	200.00	200.00	0.005
100	100.02	100.02	0.005
75	75.02	75.02	0.005
50	50.02	50.02	0.005
25	25.00	25.00	0.005

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Avoirdupois Cast W	Rice Lake	25 and 50lb	PWO990-CA	7/18/22	7/2024	20221688

Permanent Information Concerning this Equipment:

Comments/Information Concerning this Calibration

12/28/23: RH-42.5%

Report prepared/reviewed by: R.A. Date: 12-28-23

Technician: C.Call

Signature: [Signature]

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

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

Member: National Conference of Standards Laboratories and Weights & Measures

Dry Gas Meter Calibration

DUT

Manufacturer: APEX
 Model: XC-60
 Lab ID #: 53
 Serial #: 1902130
 Calibration Date: 2/1/2024
 Calibration Expiration: 8/1/2024
 Barometric Pressure: 29.34 in. Hg



Equipment Used:	Ref. Std. DGM	Thermometer	Barometer	Manometer
Manufacturer: Apex		NI	Aquatech	Dwyer
Model: SK25DA		NI-9213	DBX2	475
Lab ID#: 47		215	202	174
Calibration Expiration Date: 4/17/2024		2/28/2024	5/23/2024	4/21/2024
Calibration γ Factor: 0.9988				

Use in accordance with EPA Method 5, sections 10.3 and 16.1. Use only calibrated, NIST traceable reference standard DGM. Calibrate over expected operating flow range of DUT.

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	152.041	148.633	164.152
Standard DGM Temperature (°F)	74.0	75.0	75.0
Standard DGM Pressure (in H ₂ O)	0.00	0.00	0.0
DGM Initial Volume (ft ³)	0.000	0.000	0.000
DGM Final Volume (ft ³)	5.491	5.416	6.003
DGM Temperature (°F)	96.0	98.0	100.0
DGM Pressure (in H ₂ O)	4.55	1.83	2.90
Net Volume for Standard DGM (ft ³)	5.369	5.249	5.797
Net Volume for DGM (ft ³)	5.491	5.416	6.003
Dry Gas Meter γ Factor	1.005	1.005	1.002
γ Factor Deviation From Average	1.005	1.005	1.002

Average Gas Meter γ Factor

1.004

Measurement Uncertainty: Total measurement uncertainty +/- 0.748% RD, K=2

Calculations:

1. Deviation = |Average value for all runs - current run value|

2. $\gamma = [V_{std} \times (\gamma_{std}) \times (P_{bar} + P_{std}/13.6) \times (T_{DGM} + 460)] / [V_{DGM} \times (T_{std} + 460) \times (P_{bar} + P_{DGM}/13.6)]$

Dry Gas Meter Calibration

DUT

Manufacturer: APEX
 Model: XC-60
 Lab ID #: 54
 Serial #: 1902133
 Calibration Date: 2/1/2024
 Calibration Expiration: 8/1/2024
 Barometric Pressure: 29.34 in. Hg



Equipment Used:	Ref. Std. DGM	Thermometer	Barometer	Manometer
Manufacturer: Apex		NI	Aquatech	Dwyer
Model: SK25DA		NI-9213	DBX2	475
Lab ID#: 47		215	202	174
Calibration Expiration Date: 4/17/2024		2/28/2024	5/23/2024	4/21/2024
Calibration γ Factor: 0.9988				

Use in accordance with EPA Method 5, sections 10.3 and 16.1. Use only calibrated, NIST traceable reference standard DGM. Calibrate over expected operating flow range of DUT.

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	148.890	148.972	150.647
Standard DGM Temperature (°F)	75.0	75.0	75.0
Standard DGM Pressure (in H ₂ O)	0.00	0.00	0.0
DGM Initial Volume (ft ³)	0.000	0.000	0.000
DGM Final Volume (ft ³)	5.418	5.418	5.520
DGM Temperature (°F)	101.0	101.0	101.0
DGM Pressure (in H ₂ O)	3.96	4.95	2.02
Net Volume for Standard DGM (ft ³)	5.258	5.261	5.320
Net Volume for DGM (ft ³)	5.418	5.418	5.520
Dry Gas Meter γ Factor	1.006	1.005	1.004
γ Factor Deviation From Average	1.006	1.005	1.004

Average Gas Meter γ Factor

1.005

Measurement Uncertainty: Total measurement uncertainty +/- 0.748% RD, K=2

Calculations:

- Deviation = |Average value for all runs - current run value|
- $\gamma = [V_{std} \times (\gamma_{std}) \times (P_{bar} + P_{std}/13.6) \times (T_{DGM} + 460)] / [V_{DGM} \times (T_{std} + 460) \times (P_{bar} + P_{DGM}/13.6)]$

Report and Certificate of Calibration



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Toll Free
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Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 33086-203325-4525 **Customer PO#:** 1109
Customer Name: PFS TECO
Customer Address: 1507 Matt Pass
City: Cottage Grove **State:** WI **Zip:** 53527
Contact: Ethan Frederick
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Calibration Standards

10-01442 Compound Gauge Fluke SN: 4582643 Cal: 01/26/2024 Due: 01/31/2025 Vendor: Fluke Report #: EVL943251
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/24/2024 Due: 01/31/2025 Range: 122 °F 95 %RH Report #: 32568-205513-3646

Instrument Data

Calibration Date:	February 26, 2024	Reference:	ASME B40.100
Recommended Due Date:	February 26, 2025	Cal-Cert Procedure:	CP-003
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	Newport Industries	Temperature:	64 °F
Type:	Pressure Transducer	Humidity:	36% RH
Model Number:	Unknown	Cal Factor:	None
Serial #:	Unknown	Asset #:	54B
Capacity:	1 PSI	Service Location:	Service Address
Tolerance:	± 1.00% of Span	As Found:	Pass
Gauge Class:	A	As Left:	Pass

Instrument Range:		Range Resolution:		Mode Verified:		Pressure		
UUT Reading	Standard As Found	Standard Verification Reading #1	Error	Standard Verification Reading #2	Error	Tolerance	Expanded Uncertainty ±	
PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	
0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.005	
0.10	0.10	0.10	0.00	0.10	0.00	0.01	0.005	
0.25	0.25	0.25	0.00	0.25	0.00	0.01	0.006	
0.50	0.50	0.50	0.00	0.50	0.00	0.01	0.014	
0.75	0.75	0.75	0.00	0.74	-0.01	0.01	0.018	
1.00	1.00	1.00	0.00	0.99	-0.01	0.01	0.013	
0.75	0.76	0.76	0.01	0.76	0.01	0.01	0.005	
0.50	0.50	0.50	0.00	0.51	0.01	0.01	0.015	
0.25	0.25	0.25	0.00	0.26	0.01	0.01	0.017	
0.10	0.11	0.11	0.01	0.11	0.01	0.01	0.008	
0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.005	

Manufacturer: Newport Industries

Type: Pressure Transducer

Serial #: Unknown

Remarks:

**We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.**

**Cal-Cert is accredited by A2LA under Calibration Laboratory Code #4986.01.
A2LA is recognized under the ILAC mutual recognition agreement (MRA).**

This certificate is hereby issued that the above instrument was tested for accuracy with calibrated standards traceable to the National Institute of Standards and Technology (NIST). The information provided on this form complies with the data gathering and reporting requirements of ISO/IEC 17025 and ANSI/NCSL Z540.1, and meets the requirements of all applicable references and Cal-Cert procedures listed above. Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated.

All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer: Steven White

Date: February 26, 2024

Technical Manager: Marshall Doyle

Signature:



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Milwaukie, OR 97222

Local
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Report #: 33086-203326-4525 **Customer PO#:** 1109
Customer Name: PFS TECO
Customer Address: 1507 Matt Pass
City: Cottage Grove **State:** WI **Zip:** 53527
Contact: Ethan Frederick
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Calibration Standards

10-01442 Compound Gauge Fluke SN: 4582643 Cal: 01/26/2024 Due: 01/31/2025 Vendor: Fluke Report #: EVL943251
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/24/2024 Due: 01/31/2025 Range: 122 °F 95 %RH Report #: 32568-205513-3646

Instrument Data

Calibration Date:	February 26, 2024	Reference:	ASME B40.100
Recommended Due Date:	February 26, 2025	Cal-Cert Procedure:	CP-003
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	Newport Industries	Temperature:	64 °F
Type:	Pressure Transducer	Humidity:	36% RH
Model Number:	Unknown	Cal Factor:	None
Serial #:	Unknown	Asset #:	54C
Capacity:	5 In H2O	Service Location:	Service Address
Tolerance:	± 1.00% of Span	As Found:	Pass
Gauge Class:	A	As Left:	Pass

Instrument Range:		Range Resolution:		Mode Verified:		Pressure		
UUT Reading	Standard As Found	Standard Verification Reading #1	Error	Standard Verification Reading #2	Error	Tolerance	Expanded Uncertainty ±	
In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	
0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.005	
0.50	0.50	0.50	0.00	0.48	-0.02	0.05	0.045	
1.25	1.25	1.25	0.00	1.23	-0.02	0.05	0.036	
2.50	2.49	2.49	-0.01	2.49	-0.01	0.05	0.006	
3.75	3.74	3.74	-0.01	3.74	-0.01	0.05	0.007	
5.00	4.98	4.98	-0.02	4.99	-0.01	0.05	0.026	
3.75	3.74	3.74	-0.01	3.74	-0.01	0.05	0.023	
2.50	2.50	2.50	0.00	2.49	-0.01	0.05	0.014	
1.25	1.26	1.26	0.01	1.24	-0.01	0.05	0.042	
0.50	0.51	0.51	0.01	0.50	0.00	0.05	0.04	
0.00	0.00	0.00	0.00	0.01	0.01	0.05	0.005	

Manufacturer: Newport Industries

Type: Pressure Transducer

Serial #: Unknown

Remarks:

**We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
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Service Engineer:

Steven White

Date:

February 26, 2024

Technical Manager:

Marshall Doyle

Signature:

McDoyle

Dry Gas Meter Calibration

DUT

Manufacturer: APEX
 Model: XC-60
 Lab ID #: 55
 Serial #: 1902130
 Calibration Date: 2/5/2024
 Calibration Expiration: 8/5/2024
 Barometric Pressure: 29.39 in. Hg



Equipment Used:	Ref. Std. DGM	Thermometer	Barometer	Manometer
Manufacturer: Apex		NI	Aquatech	Dwyer
Model: SK25DA		NI-9213	DBX2	475
Lab ID#: 47		215	202	174
Calibration Expiration Date: 4/17/2024		2/28/2024	5/23/2024	4/21/2024
Calibration γ Factor: 0.9988				

Use in accordance with EPA Method 5, sections 10.3 and 16.1. Use only calibrated, NIST traceable reference standard DGM. Calibrate over expected operating flow range of DUT.

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	202.311	156.489	164.235
Standard DGM Temperature (°F)	72.0	72.0	74.0
Standard DGM Pressure (in H ₂ O)	0.00	0.00	0.0
DGM Initial Volume (ft ³)	0.000	0.000	0.000
DGM Final Volume (ft ³)	7.085	5.526	5.749
DGM Temperature (°F)	77.0	77.0	78.0
DGM Pressure (in H ₂ O)	0.00	0.00	0.0
Net Volume for Standard DGM (ft ³)	7.145	5.526	5.800
Net Volume for DGM (ft ³)	7.085	5.526	5.749
Dry Gas Meter γ Factor	1.017	1.008	1.015
γ Factor Deviation From Average	1.017	1.008	1.015

Average Gas Meter γ Factor

1.013

Measurement Uncertainty: Total measurement uncertainty +/- 0.748% RD, K=2

Calculations:

- Deviation = |Average value for all runs - current run value|
- $\gamma = [V_{std} \times (\gamma_{std}) \times (P_{bar} + P_{std}/13.6) \times (T_{DGM} + 460)] / [V_{DGM} \times (T_{std} + 460) \times (P_{bar} + P_{DGM}/13.6)]$

Technician:

Dry Gas Meter Calibration

DUT

Manufacturer: APEX
 Model: XC-50-DIR
 Lab ID #: 203
 Serial #: A2204292
 Calibration Date: 2/2/2024
 Calibration Expiration: 8/2/2024
 Barometric Pressure: 29.55 in. Hg



Equipment Used:	Ref. Std. DGM	Thermometer	Barometer	Manometer
Manufacturer: Apex		NI	Aquatech	Dwyer
Model: SK25DA		NI-9213	DBX2	475
Lab ID#: 47		215	202	174
Calibration Expiration Date: 4/17/2024		2/28/2024	5/23/2024	4/21/2024
Calibration γ Factor: 0.9988				

Use in accordance with EPA Method 5, sections 10.3 and 16.1. Use only calibrated, NIST traceable reference standard DGM. Calibrate over expected operating flow range of DUT.

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	137.050	146.311	151.880
Standard DGM Temperature (°F)	67.0	66.0	67.0
Standard DGM Pressure (in H ₂ O)	0.0	0.00	0.0
DGM Initial Volume (ft ³)	0.000	0.000	0.000
DGM Final Volume (ft ³)	5.006	5.317	5.489
DGM Temperature (°F)	88.0	86.0	88.0
DGM Pressure (in H ₂ O)	1.06	1.52	2.81
Net Volume for Standard DGM (ft ³)	4.840	5.167	5.364
Net Volume for DGM (ft ³)	5.006	5.317	5.489
Dry Gas Meter γ Factor	1.001	1.004	1.008
γ Factor Deviation From Average	1.001	1.004	1.008

Average Gas Meter γ Factor

1.004

Measurement Uncertainty: Total measurement uncertainty +/- 0.748% RD, K=2

Calculations:

- Deviation = |Average value for all runs - current run value|
- $\gamma = [V_{std} \times (\gamma_{std}) \times (P_{bar} + P_{std}/13.6) \times (T_{DGM} + 460)] / [V_{DGM} \times (T_{std} + 460) \times (P_{bar} + P_{DGM}/13.6)]$

Report and Certificate of Calibration



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Local
503-654-9620



Report #: 33086-203319-4525 **Customer PO#:** 1109
Customer Name: PFS TECO
Customer Address: 1507 Matt Pass
City: Cottage Grove **State:** WI **Zip:** 53527
Contact: Ethan Frederick
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Calibration Standards

10-01442 Compound Gauge Fluke SN: 4582643 Cal: 01/26/2024 Due: 01/31/2025 Vendor: Fluke Report #: EVL943251
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/24/2024 Due: 01/31/2025 Range: 122 °F 95 %RH Report #: 32568-205513-3646

Instrument Data

Calibration Date:	February 26, 2024	Reference:	ASME B40.100
Recommended Due Date:	February 26, 2025	Cal-Cert Procedure:	CP-003
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	Red Lion	Temperature:	65 °F
Type:	Pressure Transducer	Humidity:	36% RH
Model Number:	Unknown	Cal Factor:	None
Serial #:	Unknown	Asset #:	203B
Capacity:	1 In H2O	Service Location:	Service Address
Tolerance:	± 1.00% of Span	As Found:	Pass
Gauge Class:	A	As Left:	Pass

Instrument Range:		Range Resolution:		Mode Verified:		Pressure		
UUT Reading	Standard As Found	Standard Verification Reading #1	Error	Standard Verification Reading #2	Error	Tolerance	Expanded Uncertainty ±	
In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	
0.000	0.000	0.000	0.00	0.000	0.00	0.01	0.0005	
0.100	0.098	0.098	0.00	0.099	0.00	0.01	0.0036	
0.250	0.252	0.252	0.00	0.250	0.00	0.01	0.0055	
0.500	0.502	0.502	0.00	0.499	0.00	0.01	0.0065	
0.750	0.751	0.751	0.00	0.748	0.00	0.01	0.0086	
1.000	1.001	1.001	0.00	0.998	0.00	0.01	0.0068	
0.750	0.752	0.752	0.00	0.749	0.00	0.01	0.0073	
0.500	0.501	0.501	0.00	0.499	0.00	0.01	0.0065	
0.250	0.251	0.251	0.00	0.250	0.00	0.01	0.0024	
0.100	0.103	0.103	0.00	0.101	0.00	0.01	0.0057	
0.000	0.001	0.001	0.00	0.000	0.00	0.01	0.0005	

Manufacturer: Red Lion

Type: Pressure Transducer

Serial #: Unknown

Remarks:

**We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.**

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Service Engineer: Steven White

Date: February 26, 2024

Technical Manager: Marshall Doyle

Signature: 

Report and Certificate of Calibration



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Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 33086-203320-4525 **Customer PO#:** 1109
Customer Name: PFS TECO
Customer Address: 1507 Matt Pass
City: Cottage Grove **State:** WI **Zip:** 53527
Contact: Ethan Frederick
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Calibration Standards

10-01442 Compound Gauge Fluke SN: 4582643 Cal: 01/26/2024 Due: 01/31/2025 Vendor: Fluke Report #: EVL943251
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/24/2024 Due: 01/31/2025 Range: 122 °F 95 %RH Report #: 32568-205513-3646

Instrument Data

Calibration Date:	February 26, 2024	Reference:	ASME B40.100
Recommended Due Date:	February 26, 2025	Cal-Cert Procedure:	CP-003
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	Red Lion	Temperature:	66 °F
Type:	Pressure Transducer	Humidity:	38% RH
Model Number:	Unknown	Cal Factor:	None
Serial #:	Unknown	Asset #:	203C
Capacity:	5 In H2O	Service Location:	Service Address
Tolerance:	± 1.00% of Span	As Found:	Pass
Gauge Class:	A	As Left:	Pass

Instrument Range:		Range Resolution:		Mode Verified:		Pressure		
UUT Reading	Standard As Found	Standard Verification Reading #1	Error	Standard Verification Reading #2	Error	Tolerance	Expanded Uncertainty ±	
In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	In H2O	
0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.005	
0.50	0.50	0.50	0.00	0.49	-0.01	0.05	0.038	
1.25	1.25	1.25	0.00	1.22	-0.03	0.05	0.067	
2.50	2.48	2.48	-0.02	2.47	-0.03	0.05	0.021	
3.75	3.72	3.72	-0.03	3.71	-0.04	0.05	0.043	
5.00	5.00	5.00	0.00	4.99	-0.01	0.05	0.045	
3.75	3.72	3.72	-0.03	3.71	-0.04	0.05	0.034	
2.50	2.49	2.49	-0.01	2.47	-0.03	0.05	0.05	
1.25	1.23	1.23	-0.02	1.23	-0.02	0.05	0.008	
0.50	0.50	0.50	0.00	0.49	-0.01	0.05	0.018	
0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.005	

Manufacturer: Red Lion

Type: Pressure Transducer

Serial #: Unknown

Remarks:

**We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.**

**Cal-Cert is accredited by A2LA under Calibration Laboratory Code #4986.01.
A2LA is recognized under the ILAC mutual recognition agreement (MRA).**

This certificate is hereby issued that the above instrument was tested for accuracy with calibrated standards traceable to the National Institute of Standards and Technology (NIST). The information provided on this form complies with the data gathering and reporting requirements of ISO/IEC 17025 and ANSI/NCSL Z540.1, and meets the requirements of all applicable references and Cal-Cert procedures listed above. Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated.

All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer: Steven White

Date: February 26, 2024

Technical Manager: Marshall Doyle

Signature: 

Report and Certificate of Calibration



Portland Laboratory
5777 SE International Way
Milwaukie, OR 97222
800-356-4662
503-654-9620

Anaheim Laboratory
120 S. Chaparral Ct Suite 110
Anaheim Hills, CA 92808
888-700-4100
714-696-5300

www.Cal-Cert.com

Report #: 30452-28785-3646 **Customer PO#:** 1100
Customer Name: PFS TECO
Customer Address: 11785 SE Highway 212, Suite 305
City: Clackamas **State:** OR **Zip:** 97015
Contact: John Steinert
Service Address: 5777 SE International Way Milwaukie, OR 97222

Calibration Standards

LP-00051 Electrical Meter Fluke SN: 9663004 Cal: 01/10/2023 Due: 01/10/2024 Vendor: Fluke Report #: EVL861119
LP-01333 Electrical Meter IET Labs, Inc. SN: E3-1842499 Cal: 01/19/2023 Due: 01/31/2024 Vendor: Transcat Calibration Lab Report #: 5-G584Z-20-1
LP-01347 Thermo-Hygrometer Comark SN: 06210350163 Cal: 04/18/2023 Due: 04/30/2024 Vendor: Cal-Cert Range: 122 °F 95 %RH Report #: 28945-67214-3646

Instrument Data

Calibration Date:	August 9, 2023	Reference:	Manufactures Tolerances
Recommended Due Date:	August 9, 2024	Cal-Cert Procedure:	CP-080
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	Delmhorst	Temperature:	74 °F
Type:	Resistivity Meter	Humidity:	36% RH
Model Number:	MCS-1	Asset #:	#094
Serial #:	#094	Service Location:	Cal-Cert Lab
Capacity:	120 Megaohms	As Found:	Pass
Tolerance:	3.00 % of indication	As Left:	Pass

Instrument Range:		120 Megaohms		Resolution:	0.001	Mode Verified:	Resistance
Standard Reading	UUT As Found	UUT Reading #1	Error	UUT Reading #2	Error		
0.000	0.000	0.000	0.000	0.000	0.000		
1.100	1.095	1.095	-0.005	1.095	-0.005		
54.545	54.719	54.719	0.173	54.719	0.173		
0.000	0.000	0.000	0.000	0.000	0.000		

Expanded Uncertainty± 2.50 Megaohms

Remarks:

100Mohm std Parallel with 120Mohm UUT= 54.545Mohms

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Service Engineer: Brent Enbysk

Date: August 9, 2023

Technical Manager: Marshall Doyle

Signature:

Report and Certificate of Calibration



www.Cal-Cert.com

Toll Free
800-356-1662

Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 33086-206391-4525 **Customer PO#:** 1109
Customer Name: PFS TECO
Customer Address: 1507 Matt Pass
City: Cottage Grove **State:** WI **Zip:** 53527
Contact: Ethan Frederick
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Calibration Standards

13-01811 Thermocouple Meter/Calibrator Tegan SN: 2454186 Cal: 10/04/2023 Due: 02/28/2024 Range: 2400 °F Report #: 31363-217443-3646
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/24/2024 Due: 01/31/2025 Range: 122 °F 95 %RH Report #: 32568-205513-3646

Instrument Data

Calibration Date:	February 26, 2024	Reference:	Navair 17-20ST-95
Recommended Due Date:	February 26, 2025	Cal-Cert Procedure:	CP-013
Calibration Frequency:	12 Months	Indicating System:	Computer
Manufacturer:	National Instruments	Temperature:	64 °F
Type:	Data Logger	Humidity:	39% RH
Model Number:	NI 9213	Asset #:	215 Booth 1
Serial #:	1B182FB	Service Location:	Service Address
Resolution:	0.1 °F	As Found:	Pass
Capacity:	2,500 °F	As Left:	Pass
Tolerance:	± 3.0 °F		
Thermocouple Type:	K		

Thermocouple METER FUNCTION

Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Tunnel	0.00	1.10	1.10	1.10	1.10	0.346
	500.00	501.10	501.10	501.10	1.10	
	1000.00	1001.10	1001.10	1001.10	1.10	
	1500.00	1501.20	1501.20	1501.20	1.20	
	2000.00	2001.30	2001.30	2001.30	1.30	
	2400.00	2401.40	2401.40	2401.40	1.40	
	0.00	1.20	1.20	1.20	1.20	

Thermocouple LOGGING FUNCTION

Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Flue	0.00	0.80	0.80	0.80	0.80	0.346
	500.00	500.80	500.80	500.80	0.80	
	1000.00	1000.80	1000.80	1000.80	0.80	
	1500.00	1500.90	1500.90	1500.90	0.90	
	2000.00	2001.00	2001.00	2001.00	1.00	
	2400.00	2401.10	2401.10	2401.10	1.10	
	0.00	0.80	0.80	0.80	0.80	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Filter A	0.00	0.60	0.60	0.60	0.60	0.346
	500.00	500.60	500.60	500.60	0.60	
	1000.00	1000.70	1000.70	1000.70	0.70	
	1500.00	1500.70	1500.70	1500.70	0.70	
	2000.00	2000.80	2000.80	2000.80	0.80	
	2400.00	2400.00	2400.00	2400.00	0.00	
	0.00	0.60	0.60	0.60	0.60	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Back	0.00	0.40	0.40	0.40	0.40	0.346
	500.00	500.40	500.40	500.40	0.40	
	1000.00	1000.50	1000.50	1000.50	0.50	
	1500.00	1500.50	1500.50	1500.50	0.50	
	2000.00	2000.60	2000.60	2000.60	0.60	
	2400.00	2400.70	2400.70	2400.70	0.70	
	0.00	0.50	0.50	0.50	0.50	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Catalyst	0.00	0.30	0.30	0.30	0.30	0.346
	500.00	500.20	500.20	500.20	0.20	
	1000.00	1000.30	1000.30	1000.30	0.30	
	1500.00	1500.40	1500.40	1500.40	0.40	
	2000.00	2000.40	2000.40	2000.40	0.40	
	2400.00	2400.40	2400.40	2400.40	0.40	
	0.00	0.20	0.20	0.20	0.20	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Meter A	0.00	0.10	0.10	0.10	0.10	0.346
	500.00	500.10	500.10	500.10	0.10	
	1000.00	1000.20	1000.20	1000.20	0.20	
	1500.00	1500.20	1500.20	1500.20	0.20	
	2000.00	2000.30	2000.30	2000.30	0.30	
	2400.00	2400.30	2400.30	2400.30	0.30	
	0.00	0.10	0.10	0.10	0.10	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Left	0.00	0.10	0.10	0.10	0.10	0.346
	500.00	500.10	500.10	500.10	0.10	
	1000.00	1000.20	1000.20	1000.20	0.20	
	1500.00	1500.20	1500.20	1500.20	0.20	
	2000.00	2000.20	2000.20	2000.20	0.20	
	2400.00	2400.20	2400.20	2400.20	0.20	
	0.00	0.10	0.10	0.10	0.10	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Right	0.00	0.00	0.00	0.00	0.00	0.346
	500.00	500.00	500.00	500.00	0.00	
	1000.00	1000.10	1000.10	1000.10	0.10	
	1500.00	1500.10	1500.10	1500.10	0.10	
	2000.00	2000.20	2000.20	2000.20	0.20	
	2400.00	2400.20	2400.20	2400.20	0.20	
	0.00	0.00	0.00	0.00	0.00	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Filter B	0.00	0.00	0.00	0.00	0.00	0.346
	500.00	501.30	501.30	501.30	1.30	
	1000.00	1001.00	1001.00	1001.00	1.00	
	1500.00	1500.70	1500.70	1500.70	0.70	
	2000.00	2000.40	2000.40	2000.40	0.40	
	2400.00	2400.00	2400.00	2400.00	0.00	
	0.00	0.00	0.00	0.00	0.00	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Top	0.00	-0.10	-0.10	-0.10	0.10	0.346
	500.00	499.90	499.90	499.90	-0.10	
	1000.00	1000.10	1000.10	1000.10	0.10	
	1500.00	1500.10	1500.10	1500.10	0.10	
	2000.00	2000.10	2000.10	2000.10	0.10	
	2400.00	2400.10	2400.10	2400.10	0.10	
	0.00	-0.10	-0.10	-0.10	0.10	

Remarks:

We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
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Service Engineer: Steven White

Date: February 26, 2024

Technical Manager: Marshall Doyle

Signature:



Report and Certificate of Calibration



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Toll Free
800-356-4662

Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 33086-206391-4525-B **Customer PO#:** 1109
Customer Name: PFS TECO
Customer Address: 1507 Matt Pass
City: Cottage Grove **State:** WI **Zip:** 53527
Contact: Ethan Frederick
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Calibration Standards

13-01811 Thermocouple Meter/Calibrator Tegan SN: 2454186 Cal: 10/04/2023 Due: 02/28/2024 Range: 2400 °F Report #: 31363-217443-3646
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/24/2024 Due: 01/31/2025 Range: 122 °F 95 %RH Report #: 32568-205513-3646

Instrument Data

Calibration Date:	February 26, 2024	Reference:	Navair 17-20ST-95
Recommended Due Date:	February 26, 2025	Cal-Cert Procedure:	CP-013
Calibration Frequency:	12 Months	Indicating System:	Computer
Manufacturer:	National Instruments	Temperature:	66 °F
Type:	Data Logger	Humidity:	34% RH
Model Number:	NI 9213	Asset #:	215 Booth 1
Serial #:	1B182FB	Service Location:	Service Address
Resolution:	0.1 °F	As Found:	Pass
Capacity:	2,500 °F	As Left:	Pass
Tolerance:	± 3.0 °F		
Thermocouple Type:	K		

Thermocouple LOGGING FUNCTION

Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Bottom	0.00	-0.10	-0.10	-0.10	0.10	0.346
	500.00	499.90	499.90	499.90	-0.10	
	1000.00	1000.00	1000.00	1000.00	0.00	
	1500.00	1500.10	1500.10	1500.10	0.10	
	2000.00	2000.10	2000.10	2000.10	0.10	
	2400.00	2400.00	2400.00	2400.00	0.00	
	0.00	-0.10	-0.10	-0.10	0.10	

Thermocouple LOGGING FUNCTION

Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Meter B	0.00	-0.10	-0.10	-0.10	0.10	0.346
	500.00	499.90	499.90	499.90	-0.10	
	1000.00	1000.10	1000.10	1000.10	0.10	
	1500.00	1500.10	1500.10	1500.10	0.10	
	2000.00	2000.20	2000.20	2000.20	0.20	
	2400.00	2400.20	2400.20	2400.20	0.20	
	0.00	0.00	0.00	0.00	0.00	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Meter C	0.00	-0.20	-0.20	-0.20	0.20	0.346
	500.00	499.90	499.90	499.90	-0.10	
	1000.00	1000.00	1000.00	1000.00	0.00	
	1500.00	1500.00	1500.00	1500.00	0.00	
	2000.00	2000.10	2000.10	2000.10	0.10	
	2400.00	2400.10	2400.10	2400.10	0.10	
	0.00	-0.10	-0.10	-0.10	0.10	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Filter C	0.00	-0.20	-0.20	-0.20	0.20	0.346
	500.00	499.90	499.90	499.90	-0.10	
	1000.00	1000.00	1000.00	1000.00	0.00	
	1500.00	1500.10	1500.10	1500.10	0.10	
	2000.00	2000.10	2000.10	2000.10	0.10	
	2400.00	2400.10	2400.10	2400.10	0.10	
	0.00	-0.10	-0.10	-0.10	0.10	

Thermocouple LOGGING FUNCTION						
Channel	Calibration Standard	UUT As Found	UUT As Left Reading 1	UUT As Left Reading 2	As Left Error	Expanded Uncertainty±
Ambient	0.00	0.00	0.00	0.00	0.00	0.346
	20.00	18.70	18.70	18.70	-1.30	
	40.00	38.70	38.70	38.70	-1.30	
	60.00	58.90	58.90	58.90	-1.10	
	80.00	78.80	78.80	78.80	-1.20	
	100.00	98.80	98.80	98.80	-1.20	
	0.00	0.00	0.00	0.00	0.00	

Remarks:

15 Channels Tested, Ambient is Type T tested from 0-100°F per customer request.

We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
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Service Engineer: Steven White

Date: February 26, 2024

Technical Manager: Marshall Doyle

Signature:





CERTIFICATE OF CALIBRATION

CUSTOMER: PFS-TECO : CLACKAMAS, OR
PO NUMBER: 1097
INST. MANUFACTURER: DWYER
INST. DESCRIPTION: VELOMETER
MODEL NUMBER: 471
SERIAL NUMBER: CP288559 ID# 095
RATED ACCURACY: SEE NOTES BELOW.
UNCERTAINTY GIVEN: $\pm 0.43\%$ RD ; k=2
NOTES: $\pm 3.0\%$ FS (0-500 / 0-1500) ** $\pm 4.0\%$ F.S. (0-5000) ** $\pm 5.0\%$ F.S. (0-15000) ** $\pm 2^\circ\text{F}$

CALIBRATION DATE: 05/23/2023
CALIBRATION DUE: 05/23/2024
PROCEDURE: T.O.33K6-4-1769-1
CALIBRATION FLUID: AIR @ 14.7 PSIA 70°F
RECEIVED CONDITION: WITHIN MFG. SPECS.
LEFT CONDITION: WITHIN MFG. SPECS.
AMBIENT CONDITIONS: 763mm HGA 53% RH 71°F
CERTIFICATE FILE #: 490265.2023

Q.MANUAL IM 2.0 REV 2020.2 DATED 7-27-2020

DECISION RULE: SIMPLE ACCEPTANCE. MEASUREMENT UNCERTAINTIES NOT TAKEN INTO CONSIDERATION WHEN DETERMINING PASS/FAIL

UUT INDICATED FT/MIN	DM.STD. ACTUAL FT/MIN	UUT INDICATED DEG. F	DM STD. ACTUAL DEG. F
74	77	0 TO 200°F	0 TO 200°F
118	121	45.0	44.5
253	259	73.9	73.2
491	502	100.3	99.8
515	525		
1028	1049		
1492	1526		
502	514		
3145	3224		
4993	5135		
6892	7061		
14821	15229		

STANDARDS USED:

A310: TEMP. STANDARD $\pm 0.024^\circ\text{F}$ TRACE# 1649766843	DUE	02/09/2024
A800: FLOW-DYNE SONIC NOZZLE SYSTEM 0 - 1086 CFM $\pm 0.46\%$ RD. TRACE# 144613547, 1424683640, 1583314714	DUE	12/10/2023

All instruments used in the performance of the shown calibration have traceability to the National Institute of Standards and Technology (NIST). The uncertainty ratio between the calibration standards (DM.STD.) and the Unit Under Test (UUT) is a minimum of 4:1, unless otherwise noted. Calibration has been performed according to the shown procedure. The use of IAS/ILAC logo indicates calibrations are in accordance to ISO/IEC 17025:2017.

Dick Munns Company - 11133 Winners Circle, Los Alamitos, CA 90720
Phone: 714-827-1215 - www.dickmunns.com

This Calibration Certificate shall not be reproduced except, in full, without approval by Dick Munns Company. The data shown applies only to the instrument being calibrated and under the stated conditions of calibration.

Issuing Date:

Approved By:

Cal. Technician:

Calibrated at:

Lab

On-Site (Customer's)

5-23-2023

DC

Page 1 of 1

Report and Certificate of Calibration



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Toll Free
800-356-4662

Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 31538-218157-14
Customer Name: PFS TECO
Customer Address: 11785 SE Highway 212, Suite 305
City: Clackamas
Contact: Aaron Kravitz
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Customer PO#:
State: OR
Zip: 97015

Calibration Standards

10-00209 Weight Rice Lake SN: 43334 Cal: 02/02/2022 Due: 02/28/2024 Vendor: Oregon Dept of Ag Report #: 20220092
19-00269 Thermo-Hygrometer Comark SN: 6237360167 Cal: 08/14/2023 Due: 08/31/2024 Vendor: Cal-Cert Range: 122 °F 95 %RH Report #: 30530-30694-3646

Instrument Data

Calibration Date:	October 12, 2023	Reference:	ASTM E898-20, D4753-15
Calibration Due Date:	April 12, 2024	Cal-Cert Procedure:	CP-002
Calibration Frequency:	6 Months	Indicating System:	Digital
Manufacturer:	Sartorius	Temperature:	73 °F
Model Number:	ENTRIS224	Humidity:	52% RH
Type:	Digital Balance	Asset #:	107
Serial #:	34307497	Service Location:	Service Address
Scale Capacity:	200 grams	As Found:	PASS
		As Left:	PASS

Scale Linear Test								
Instrument Range:			Resolution:			0.0001 grams		
Calibration Standard	As Found UUT	As Found Error	As Left UUT	As Left Error	As Left % of Error	Tolerance (As Left) Allowable Error		
grams	grams	grams	grams	grams		Error	Condition	Expanded Unc. (grams)
0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	PASS	0.00000
20.0000	19.9998	-0.0002	19.9998	-0.0002	0.00	0.0200	PASS	0.00463
40.0000	39.9997	-0.0003	40.0000	0.0000	0.00	0.0400	PASS	0.00924
60.0000	59.9996	-0.0004	60.0001	0.0001	0.00	0.0600	PASS	0.01386
80.0000	79.9995	-0.0005	80.0001	0.0001	0.00	0.0800	PASS	0.01848
100.0000	99.9994	-0.0006	99.9999	-0.0001	0.00	0.1000	PASS	0.02310
120.0000	119.9993	-0.0007	119.9999	-0.0001	0.00	0.1200	PASS	0.02771
140.0000	139.9991	-0.0009	140.0000	0.0000	0.00	0.1400	PASS	0.03233
160.0000	159.9990	-0.0010	160.0001	0.0001	0.00	0.1600	PASS	0.03695
180.0000	179.9990	-0.0010	180.0000	0.0000	0.00	0.1800	PASS	0.03926
200.0000	199.9989	-0.0011	200.0000	0.0000	0.00	0.2000	PASS	0.04619
100.0000	99.9994	-0.0006	99.9999	-0.0001	0.00	0.1000	PASS	0.02310
0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	PASS	0.00000



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PFS Teco
11785 SE Hwy 212 STE#305
Clackamas, OR 97015

Report Number: DIRI01C101887027231228

A2LA ACCREDITED **CERTIFICATE OF CALIBRATION WITH DATA**

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Scale	Mettler	IND570 - 1000lxb0.	C101887027	#189	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
lbs	0.02	QC033	12/28/23	12/14/22	12/2024

FUNCTIONAL CHECKS

SHIFT TEST	LINEARITY	REPEATABILITY	ENVIRONMENTAL CONDITIONS
Test Wt: 400 Tol: 0.10 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Test Wt: HB44 Tol: HB44 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Test Wt: 200 Tol: 0.04 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Good Fair Poor Temperature: 18.2°C

CALIBRATION DATA

Standard	As-Found	As-Left	Expanded Uncertainty
1000	999.98	999.98	0.012
600	599.98	599.98	0.011
400	399.96	399.96	0.011
200	200.00	200.00	0.011
100	100.00	100.00	0.011
50	50.00	50.00	0.011

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Avoirdupois Cast W	Rice Lake	25 and 50lb	PWO990-CA	7/18/22	7/2024	20221688

Permanent Information Concerning this Equipment:

Comments/Information Concerning this Calibration

12/23 RH = 40.5%

Report prepared/reviewed by: R.B. Date: 12-28-23

Technician: R. Butcher
Signature: R. Butcher

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

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

Member: National Conference of Standards Laboratories and Weights & Measures

FUNCTIONAL CHECKS					
ECCENTRIC LOAD TEST:		HYSTERESIS: Load Increments		REPEATABILITY:	
Loading position	100.0000	Test Weight Applied. % of load	Readings	Test Weight Applied	100.0000
Right	99.9999	0%	0.0000	1st	99.9999
Left	99.9998	(R1) 50%	99.9999	2nd	100.0000
Front	99.9998	100%	200.0000	3rd	99.9999
Back	99.9999	(R2) 50%	99.9999	4th	100.0000
Center	99.9999	0%	0.0000	5th	100.0000
As Left	PASS	As Left	PASS	As Left	PASS
Tolerance: The maximum error of the eccentric loading must be less than .1% of center load value.		Tolerance: The Difference of R1 and R2 must be within 0.1%		Tolerance: Deviation of lowest and highest reading within 0.1%	

Remarks:

The scale was adjusted prior to taking the As Left readings.

We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.

Cal-Cert is accredited by A2LA under Calibration Laboratory Code #4986.01.
A2LA is recognized under the ILAC mutual recognition agreement (MRA).

This certificate is hereby issued that the above instrument was tested for accuracy with calibrated standards traceable to the National Institute of Standards and Technology (NIST). The information provided on this form complies with the data gathering and reporting requirements of ISO/IEC 17025 and ANSI/NCSL Z540.1, and meets the requirements of all applicable references and Cal-Cert procedures listed above.

Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated. All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer:

Jon Rau

Date:

October 12, 2023

Technical Manager:

Marshall Doyle

Signature:

REPORT#: 31538-218157-14

Report and Certificate of Calibration



www.Cal-Cert.com

Toll Free
800-356-4662

Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 31538-218157-14
Customer Name: PFS TECO
Customer Address: 11785 SE Highway 212, Suite 305
City: Clackamas
Contact: Aaron Kravitz
Service Address: 11785 SE Highway 212, Suite 305 Clackamas, OR 97015

Customer PO#:
State: OR
Zip: 97015

Calibration Standards

10-00209 Weight Rice Lake SN: 43334 Cal: 02/02/2022 Due: 02/28/2024 Vendor: Oregon Dept of Ag Report #: 20220092
19-00269 Thermo-Hygrometer Comark SN: 6237360167 Cal: 08/14/2023 Due: 08/31/2024 Vendor: Cal-Cert Range: 122 °F 95 %RH Report #: 30530-30694-3646

Instrument Data

Calibration Date:	October 12, 2023	Reference:	ASTM E898-20, D4753-15
Calibration Due Date:	April 12, 2024	Cal-Cert Procedure:	CP-002
Calibration Frequency:	6 Months	Indicating System:	Digital
Manufacturer:	Sartorius	Temperature:	73 °F
Model Number:	ENTRIS224	Humidity:	52% RH
Type:	Digital Balance	Asset #:	107
Serial #:	34307497	Service Location:	Service Address
Scale Capacity:	200 grams	As Found:	PASS
		As Left:	PASS

Scale Linear Test								
Instrument Range:			Resolution:			0.0001 grams		
Calibration Standard	As Found UUT	As Found Error	As Left UUT	As Left Error	As Left % of Error	Tolerance (As Left) Allowable Error		
grams	grams	grams	grams	grams		Error	Condition	Expanded Unc. (grams)
0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	PASS	0.00000
20.0000	19.9998	-0.0002	19.9998	-0.0002	0.00	0.0200	PASS	0.00463
40.0000	39.9997	-0.0003	40.0000	0.0000	0.00	0.0400	PASS	0.00924
60.0000	59.9996	-0.0004	60.0001	0.0001	0.00	0.0600	PASS	0.01386
80.0000	79.9995	-0.0005	80.0001	0.0001	0.00	0.0800	PASS	0.01848
100.0000	99.9994	-0.0006	99.9999	-0.0001	0.00	0.1000	PASS	0.02310
120.0000	119.9993	-0.0007	119.9999	-0.0001	0.00	0.1200	PASS	0.02771
140.0000	139.9991	-0.0009	140.0000	0.0000	0.00	0.1400	PASS	0.03233
160.0000	159.9990	-0.0010	160.0001	0.0001	0.00	0.1600	PASS	0.03695
180.0000	179.9990	-0.0010	180.0000	0.0000	0.00	0.1800	PASS	0.03926
200.0000	199.9989	-0.0011	200.0000	0.0000	0.00	0.2000	PASS	0.04619
100.0000	99.9994	-0.0006	99.9999	-0.0001	0.00	0.1000	PASS	0.02310
0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	PASS	0.00000

FUNCTIONAL CHECKS					
ECCENTRIC LOAD TEST:		HYSTERESIS: Load Increments		REPEATABILITY:	
Loading position	100.0000	Test Weight Applied. % of load	Readings	Test Weight Applied	100.0000
Right	99.9999	0%	0.0000	1st	99.9999
Left	99.9998	(R1) 50%	99.9999	2nd	100.0000
Front	99.9998	100%	200.0000	3rd	99.9999
Back	99.9999	(R2) 50%	99.9999	4th	100.0000
Center	99.9999	0%	0.0000	5th	100.0000
As Left	PASS	As Left	PASS	As Left	PASS
Tolerance: The maximum error of the eccentric loading must be less than .1% of center load value.		Tolerance: The Difference of R1 and R2 must be within 0.1%		Tolerance: Deviation of lowest and highest reading within 0.1%	

Remarks:

The scale was adjusted prior to taking the As Left readings.

We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.

Cal-Cert is accredited by A2LA under Calibration Laboratory Code #4986.01.
A2LA is recognized under the ILAC mutual recognition agreement (MRA).

This certificate is hereby issued that the above instrument was tested for accuracy with calibrated standards traceable to the National Institute of Standards and Technology (NIST). The information provided on this form complies with the data gathering and reporting requirements of ISO/IEC 17025 and ANSI/NCSL Z540.1, and meets the requirements of all applicable references and Cal-Cert procedures listed above.

Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated. All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

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Service Engineer:

Jon Rau

Date:

October 12, 2023

Technical Manager:

Marshall Doyle

Signature:

REPORT#: 31538-218157-14



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Report of Calibration

Firm: PFS-TECO
Address: 11785 SE Hwy 212, Ste 305
City/State/Zip: Clackamas, OR 97015

Test Completed: 05/09/22
Purchase Order: 1067
Traceable Number: 20220682

Test Item: 200 mg and 100 mg Individual Weights
Serial No.: Listed in Table

Manufacturer: Troemner
Customer ID: Listed in Table

<u>Material</u>	<u>Assumed Density</u>	<u>Range</u>	<u>Tolerance Class</u>
Stainless Steel	7.95 g/cm ³	200 mg & 100 mg	ASTM Class 1

Method and Traceability

The procedure used for this calibration is NIST IR 6969 SOP 4 Double Substitution Weighing Design. Standards used for comparison are traceable to the National Institute of Standards and Technology (reports on file) and are part of a comprehensive measurement assurance program for ensuring continued accuracy and traceability within the level of uncertainty reported. The Traceable Number listed above is Traceable to National Standards through an unbroken chain of comparison each having stated uncertainties.

Standards Used:

100 g to 1 mg Working Standards Were Calibrated: 07/02/21 Due: 07/31/22 Standards ID: 723318
Mass Comparators Used: MET-05 Tested by: D. Thompson

Conventional Mass: “The conventional value of the result of weighing a body in air is equal to the mass of a standard, of conventionally chosen density, at a conventionally chosen temperature, which balances this body at this reference temperature in air of conventionally chosen density. International Recommendation 33 (OIML IR 33 1973, 1979). “Conventional Value of the Result of Weighing in Air” (Previously known as “Apparent Mass vs. 8.0 g/cm³).


Uncertainty Statement: The uncertainty conforms to the ISO Guide to the Expressions of Uncertainty in Measurement. Uncertainty as reported is based on a coverage factor $k=2$ for an approximate 95 percent level of uncertainty. Uncertainty components include the standard deviation of the process, the uncertainty of the standard used, an uncertainty component associated with the potential drift of the standard used, and the estimated uncertainty related to measuring and determining the air buoyancy effect.

Conventional Mass Values are listed on page 2 of this report.

page 1 of 2

Quality Control Services, Inc.
Metrology Laboratory Manager
E-mail dthompson@qc-services.com

Date: 05/09/22


Signature David S. Thompson

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Report of Calibration

Firm: PFS-TECO
Address: 11785 SE Hwy 212, Ste 305
City/State/Zip: Clackamas, OR 97015

Test Completed: 05/09/22
Purchase Order: 1067
Traceable Number: 20220682

Test Item: 200 mg and 100 mg Individual Weights
Serial No.: Listed in Table

Manufacturer: Troemner
Customer ID: Listed in Table

Laboratory Environment at time of test

Temperature °C	Pressure mmHg	Humidity %RH
21.93 to 21.94	760.7 to 760.8	47.8 to 47.9

Conventional Mass Value

Nominal Value	As Found Value (g)	As Found Correction* (mg)	As Left Value (g)	As Left Correction* (mg)	Uncertainty (mg)	Tolerance (mg)
200 mg, 1000101395, #109-B	0.2000082	0.0082	0.2000082	0.0082	0.0014	0.010
100 mg, 1000126267, #109-A	0.1000065	0.0065	0.1000065	0.0065	0.0014	0.010

*Correction is the difference between the conventional mass value of a weight and its nominal value.

Comments: These weights were received in good condition and were within ASTM Class 1 tolerances As Found.


Recalibration Due: The customer has requested a 5-year calibration cycle. The calibration due date for these weights is 05/09/27. The values listed above were found at the time of calibration. Any number of factors may cause these items to drift out of calibration before the calibration interval has expired.

Accredited by the American Association for Laboratory Accreditation (A2LA) under Calibration Laboratory Code 115953 and Certificate Number 1550.01. This laboratory meets the requirements of ISO/IEC 17025:2017 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration.

page 2 to 2

Quality Control Services, Inc.
Metrology Laboratory Manager
E-mail dthompson@qc-services.com

Date: 05/09/22


Signature David S. Thompson

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PFS Teco
11785 SE Hwy 212 STE#305
Clackamas, OR 97015

Report Number: DIRI01C101887027231228

A2LA ACCREDITED **CERTIFICATE OF CALIBRATION WITH DATA**

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Scale	Mettler	IND570 - 1000lxb0.	C101887027	#189	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
lbs	0.02	QC033	12/28/23	12/14/22	12/2024

FUNCTIONAL CHECKS

SHIFT TEST	LINEARITY	REPEATABILITY	ENVIRONMENTAL CONDITIONS
Test Wt: 400 Tol: 0.10 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Test Wt: HB44 Tol: HB44 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Test Wt: 200 Tol: 0.04 As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/> As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Good Fair Poor Temperature: 18.2°C

CALIBRATION DATA

Standard	As-Found	As-Left	Expanded Uncertainty
1000	999.98	999.98	0.012
600	599.98	599.98	0.011
400	399.96	399.96	0.011
200	200.00	200.00	0.011
100	100.00	100.00	0.011
50	50.00	50.00	0.011

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Avoirdupois Cast W	Rice Lake	25 and 50lb	PWO990-CA	7/18/22	7/2024	20221688

Permanent Information Concerning this Equipment:

Comments/Information Concerning this Calibration

12/23 RH = 40.5%

Report prepared/reviewed by: R.B. Date: 12-28-23

Technician: R. Butcher
Signature: R. Butcher

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

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

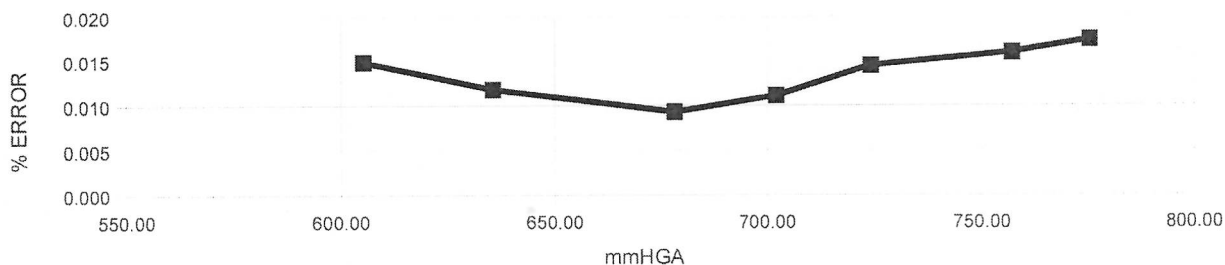
Member: National Conference of Standards Laboratories and Weights & Measures



CERTIFICATE OF CALIBRATION

CUSTOMER:	PFS-TECO; CLACKAMAS, OR	CALIBRATION DATE:	05/23/2023
PO NUMBER:	1096	CALIBRATION DUE:	05/23/2024
INST. MANUFACTURER:	AQUATECH SCIENTIFIC INSTRUMENTS	PROCEDURE:	NAVAIR-17-20MP-03
INST. DESCRIPTION:	DIGITAL BAROMETER	CALIBRATION FLUID:	AIR @ 70F
MODEL NUMBER:	DBX2	STANDARD(S) USED:	A321, A22 DUE 3-2024
SERIAL NUMBER:	118222	NIST TRACE # S:	1236086968,1583142077
RATED ACCURACY:	+/- .18 mmHGA	AMBIENT CONDITIONS:	757 mmHGA, 60% RH, 68F
UNCERTAINTY GIVEN:	+/- .03mmHGA.;k=2	CERTIFICATE FILE #:	533813
NOTES:	AS REC./AS LEFT WITHIN SPECS. ** DECISION RULE: PFA NOT USED TO DETERMINE CONFORMITY **		

TEST POINT NUMBER	UUT INDICATED mmHGA	DM.STD. ACTUAL mmHGA	% RD. ERROR
1	605.24	605.330	0.015
2	635.45	635.525	0.012
3	678.24	678.303	0.009
4	702.18	702.258	0.011
5	724.19	724.295	0.014
6	757.11	757.231	0.016
7	775.39	775.525	0.017



All instruments used in the performance of the shown calibration have traceability to the National Institute of Standards and Technology (NIST). The uncertainty ratio between the calibration standards (DM.STD.) and the Unit Under Test (UUT) is a minimum of 4:1, unless otherwise noted. Calibration has been performed according to the shown procedure. The use of IAS/ILAC logo indicates calibrations are in accordance to ISO/IEC 17025:2017.

Dick Munns Company • 11133 Winners Circle, Los Alamitos, CA 90720
Phone: 714-827-1215 • www.dickmunns.com

This Calibration Certificate shall not be reproduced except, in full, without approval by Dick Munns Company. The data shown applies only to the instrument being calibrated and under the stated conditions of calibration.

Issuing Date:

Approved By:

Cal. Technician:

Calibrated at: ☒ Lab

☐ On-Site (Customer's)

5-23-2023

Page 1 of 1

Report and Certificate of Calibration



www.Cal-Cert.com

Toll Free
800-356-4682

Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 32102-201251-4686 **Customer PO#:** 1102
Customer Name: PFS TECO
Customer Address: 11785 SE Highway 212, Suite 305
City: Clackamas **State:** OR **Zip:** 97015
Contact: Ethan Frederick
Service Address: 5777 SE International Way Milwaukie, OR 97222

Calibration Standards

10-00954 Gage Block Set Shars SN: 120018 Cal: 05/26/2023 Due: 05/26/2025 Vendor: American Gage Report #: 109141
LP-00397 Gage Block Set Mitutoyo SN: 509020 Cal: 12/28/2022 Due: 12/28/2024 Vendor: BHD Test and Measurement Report #: 99826
LP-01757 Thermo-Hygrometer Comark SN: 06257740560 Cal: 04/28/2023 Due: 04/28/2024 Report #: 29096-209333-4201

Instrument Data

Calibration Date:	December 6, 2023	Reference:	Manufacturer's Spec
Calibration Due Date:	December 6, 2024	Cal-Cert Procedure:	CP-115
Calibration Frequency:	12 Months	Indicating System:	Stamped
Manufacturer:	Starrett	Temperature:	69 °F
Type:	Tape Measure	Humidity:	51% RH
Model Number:	Exact	Asset #:	207
Serial #:	138054-2203-00002249	Service Location:	Cal-Cert Lab
Capacity:	192.00 Inches	As Found:	Pass
		As Left:	Pass

Instrument Range:	192.000 Inches	Range Resolution:	0.06250 Inches
	Calibration Standard	As Found Reading	Verification Reading #1
			Verification Reading #2
	0.2500	0.2500	0.2500
	1.0000	1.0000	1.0000
	6.0000	6.0000	6.0000
	12.0000	12.0000	12.0000
	64.0000	64.0000	64.0000
	128.0000	128.0000	128.0000
	192.0000	192.0000	192.0000

Expanded Uncertainty ± 0.07217 Inches

Remarks:

Metric scale not calibrated.

We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.

Cal-Cert is accredited by A2LA under Calibration Laboratory Code #4986.01.
A2LA is recognized under the ILAC mutual recognition agreement (MRA).

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Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated.

All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer: Scott McGuire **Date:** December 6, 2023

Technical Manager: Marshall Doyle

Signature:

Report and Certificate of Calibration



Toll Free
800-356-4662

www.Cal-Cert.com

Address
5777 SE International Way
Milwaukie, OR 97222

Local
503-654-9620



Report #: 31621-201253-5 **Customer PO#:** 1102
Customer Name: PFS TECO
Customer Address: 11785 SE Highway 212, Suite 305
City: Clackamas **State:** OR **Zip:** 97015
Contact: Ethan Frederick
Service Address: 5777 SE International Way Milwaukie, OR 97222

Calibration Standards

LP-00397 Gage Block Set Mitutoyo SN: 509020 Cal: 12/28/2022 Due: 12/28/2024 Vendor: BHD Test and Measurement Report #: 99826
LP-01782 Thermo-Hygrometer Comark SN: 06247790052 Cal: 01/30/2023 Due: 01/31/2024 Range: 122 °F 95 %RH Report #: 27747-205513-4239

Instrument Data

Calibration Date:	October 23, 2023	Reference:	ASME B89.1.14 2018
Calibration Due Date:	October 23, 2024	Cal-Cert Procedure:	CP-008
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	Mitutoyo	Temperature:	66 °F
Type:	Digital Caliper	Humidity:	51% RH
Model Number:	CD-P6"S	Asset #:	208
Serial #:	B22159310	Service Location:	Cal-Cert Lab
Capacity:	6 Inches	As Found:	PASS
Resolution:	0.0005 Inches	As Left:	PASS

Instrument Range:	6.0000 Inches	Range Resolution:	0.0005 Inches
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Outside Jaws / Linearity				
Calibration Standard Inches	As Found Inches	As Left Reading 1 Inches	As Left Reading 2 Inches	Tolerance ± Inches
0.0000	0.0000	0.0000	0.0000	0.0000
0.0500	0.0495	0.0495	0.0495	0.0010
0.3000	0.3000	0.3000	0.3000	0.0010
0.6000	0.6000	0.6000	0.6000	0.0010
1.2000	1.1995	1.1995	1.1995	0.0010
2.4000	2.4000	2.4000	2.4000	0.0010
3.5000	3.5000	3.5000	3.5000	0.0010
5.0000	5.0000	5.0000	5.0000	0.0010
6.0000	5.9995	5.9995	5.9995	0.0010

Expanded Uncertainty ± 0.00036 Inches

Scale Shift Verification			
	Target	Measured	Tolerance ±
Resolution Check	0.1005	0.10050	N/A
Depth	1.000	1.00000	0.001
Step	1.000	1.00000	0.001
Inside Jaws	1.000	0.99950	0.001
Inspections			
Jaws Parallel		Acceptable	

Remarks:

We sincerely thank you for your business. Please call us at 503-654-9620 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.

Cal-Cert is accredited by A2LA under Calibration Laboratory Code #4986.01.
A2LA is recognized under the ILAC mutual recognition agreement (MRA).

This certificate is hereby issued that the above instrument was tested for accuracy with calibrated standards traceable to the National Institute of Standards and Technology (NIST). The information provided on this form complies with the data gathering and reporting requirements of ISO/IEC 17025 and ANSI/NCSL Z540.1, and meets the requirements of all applicable references and Cal-Cert procedures listed above.
Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated.

All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer: Cameron Walling

Date: October 23, 2023

Technical Manager: Marshall Doyle

Signature: 

Caliper CF-008-01

Revision 17 6/30/2023



CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information

LGEPKG TUALATIN OR H
10450 SW TUALATIN SHERWOOD ROAD
TUALATIN OR 97062-9547

Certificate Issuance Date: 05/08/2023

Linde Order Number: 72422600

Part Number: NI CD17CO8E-AS

Customer PO Number: 80430965

Fill Date: 05/02/2023

Lot Number: 70086312207

Cylinder Style & Outlet: AS

CGA 590

Cylinder Pressure and Volume: 1290 psig 99 ft3

Certified Concentration

Expiration Date:	05/08/2031	NIST Traceable
Cylinder Number:	CC505834	Expanded Uncertainty
16.98 %	Carbon dioxide	± 0.13 %
4.30 %	Carbon monoxide	± 0.03 %
17.16 %	Oxygen	± 0.05 %
Balance	Nitrogen	

ProSpec EZ Cert



Certification Information:

Certification Date: 05/08/2023

Term: 96 Months

Expiration Date: 05/08/2031

This cylinder was certified according to the 2012 EPA Traceability Protocol, Document #EPA-600/R-12/531, using Procedure G1. Uncertainty above is expressed as absolute expanded uncertainty at a level of confidence of approximately 95% with a coverage factor $k = 2$. Do Not Use this Standard if Pressure is less than 100 PSIG.

CO2 responses have been corrected for Oxygen IR Broadening effect. O2 responses have been corrected for CO2 interference.

Analytical Data:

(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)

1. Component: Carbon dioxide

Requested Concentration: 17 %
Certified Concentration: 16.98 %
Instrument Used: Horiba VIA-510 S/N 20C194WK
Analytical Method: NDIR
Last Multipoint Calibration: 04/25/2023

First Analysis Data:				Date	05/08/2023
Z: 0	R: 19.34	C: 16.98	Conc: 16.97		
R: 19.36	Z: 0	C: 16.99	Conc: 16.98		
Z: 0	C: 17	R: 19.35	Conc: 16.99		
UOM: %	Mean Test Assay:			16.98	%

Reference Standard: Type / Cylinder #: NTRM / CC725981

Concentration / Uncertainty: 19.34 % ± 0.03 %

Expiration Date: 01/12/2027

Traceable to: SRM # / Sample # / Cylinder #: NTRM / 190701 / CC725973

SRM Concentration / Uncertainty: 19.34 % / ± 0.031 %

SRM Expiration Date: 01/12/2027

Second Analysis Data:				Date	
Z: 0	R: 0	C: 0	Conc: 0		
R: 0	Z: 0	C: 0	Conc: 0		
Z: 0	C: 0	R: 0	Conc: 0		
UOM: %	Mean Test Assay:				%

2. Component: Carbon monoxide

Requested Concentration: 4.25 %
Certified Concentration: 4.30 %
Instrument Used: Horiba VIA-510 S/N UB9UCSYX
Analytical Method: NDIR
Last Multipoint Calibration: 04/25/2023

First Analysis Data:				Date	05/08/2023
Z: 0	R: 7.81	C: 4.29	Conc: 4.3		
R: 7.77	Z: 0	C: 4.28	Conc: 4.29		
Z: 0	C: 4.3	R: 7.82	Conc: 4.31		
UOM: %	Mean Test Assay:			4.3	%

Reference Standard: Type / Cylinder #: GMIS / CC187322

Concentration / Uncertainty: 7.81 % ± 0.04 %

Expiration Date: 04/03/2025

Traceable to: SRM # / Sample # / Cylinder #: SRM 2642a / 51-D-23 / FF23106

SRM Concentration / Uncertainty: 7.859 % / ± 0.039 %

SRM Expiration Date: 07/15/2019

Second Analysis Data:				Date	
Z: 0	R: 0	C: 0	Conc: 0		
R: 0	Z: 0	C: 0	Conc: 0		
Z: 0	C: 0	R: 0	Conc: 0		
UOM: %	Mean Test Assay:				%

3. Component: Oxygen

Requested Concentration: 17 %
Certified Concentration: 17.16 %
Instrument Used: Siemens Oxymat 6E S/N 7MB20211AA000CA1
Analytical Method: Paramagnetic
Last Multipoint Calibration: 04/25/2023

First Analysis Data:				Date	05/08/2023
Z: 0	R: 20.9	C: 17.17	Conc: 17.17		
R: 20.87	Z: 0	C: 17.14	Conc: 17.14		
Z: 0	C: 17.15	R: 20.92	Conc: 17.15		
UOM: %	Mean Test Assay:			17.16	%

Reference Standard: Type / Cylinder #: GMIS / ND29287

Concentration / Uncertainty: 20.90 % ± 0.02 %

Expiration Date: 09/01/2028

Traceable to: SRM # / Sample # / Cylinder #: SRM 2659a / 71-E-19 / FF22331

SRM Concentration / Uncertainty: 20.863 % / ± 0.021 %

SRM Expiration Date: 08/23/2021

Second Analysis Data:				Date	
Z: 0	R: 0	C: 0	Conc: 0		
R: 0	Z: 0	C: 0	Conc: 0		
Z: 0	C: 0	R: 0	Conc: 0		
UOM: %	Mean Test Assay:				%

Analyzed By

Courtney Zielke

Certified By

Nelson Ma

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E04NI77E15A0575	Reference Number:	48-402546585-1
Cylinder Number:	SG9199309	Cylinder Volume:	140.0 CF
Laboratory:	124 - Los Angeles (SAP) - CA	Cylinder Pressure:	2015 PSIG
PGVP Number:	B32022	Valve Outlet:	590
Gas Code:	CO,CO2,O2,BALN	Certification Date:	Sep 23, 2022

Expiration Date: Sep 23, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON MONOXIDE	2.500 %	2.538 %	G1	+/- 0.6% NIST Traceable	09/23/2022
CARBON DIOXIDE	10.00 %	10.06 %	G1	+/- 0.6% NIST Traceable	09/23/2022
OXYGEN	10.50 %	10.58 %	G1	+/- 0.8% NIST Traceable	09/23/2022
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	12061520	CC354777	19.87 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	Jan 11, 2024
NTRM	98051002	SG9150866BAL	12.05 % OXYGEN/NITROGEN	+/- 0.7%	Dec 14, 2023
NTRM	08061402	CC267714	1.959 %W CARBON MONOXIDE/NITROGEN	+/- 0.6%	Jul 02, 2024

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
SIEMENS 6E CO2	NDIR	Sep 16, 2022
SIEMENS 6E CO HIGH	NDIR	Sep 06, 2022
SIEMENS OXYMAT 6	PARAMAGNETIC	Sep 12, 2022

Triad Data Available Upon Request



[Handwritten Signature]

Approved for Release