
Hearth and Home Technologies

Project # 19-502

Model: Pioneer-II-C

AKA: Northstar-C, Constitution
(C40-C), WarmMajic-II

Type: Wood-Fired Room Heater

October 9, 2019

**ASTM E3053 Standard Test
Method for Determining
Particulate Matter Emissions from
Wood Heaters Using Cordwood
Test Fuel (EPA ALT-125)**

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Affidavit

PFS-TECO was contracted by Hearth & Home Technologies to provide testing services for the Pioneer II-C Wood-Fired Room Heater per ASTM E3053, *Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters Using Cordwood Test Fuel*, which was approved for use under EPA ALT-125. All testing and associated procedures were conducted at Hearth & Home's Mt. Pleasant IA facility beginning on 8/20/2019 and ending on 8/22/2019. The facility is located at 1915 W Saunders St, Mt Pleasant, IA 52641. Testing procedures followed ASTM E3053, with variances as described in EPA ALT-125. Particulate sampling was performed per ASTM E2515, *Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel*, with the exception of caveats described in EPA ALT-125. A copy of EPA ALT-125 is included in Appendix A for reference, as required by the approval letter.

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 17025:2005 "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

Hearth and Home Technologies of Mt. Pleasant, IA, contracted with PFS-TECO to perform EPA certification testing on Pioneer II-C Wood-Fired Room Heater. All testing was performed at Hearth & Home's Mt. Pleasant facility. All testing was performed by Aaron Kravitz.

Notes

- Prior to start of testing, 50 hours of conditioning was performed per ASTM E3053.
- Prior to start of testing, the dilution tunnel was cleaned with a steel brush.
- Front filters were changed on sample train A at one hour for all 4 test runs.
- A total of 4 test runs were completed. Test runs were performed in accordance with ASTM E3053. For the three test runs used in the weighted average, no anomalies occurred. See the Run Narrative section for further detail on each run.

Wood Heater Identification and Testing

- Appliance Tested: ***Pioneer II-C***
- Serial Number: ***Un-serialized Prototype – PFS Tracking Number 0037***
- Manufacturer: ***Hearth & Home Technologies***
- Catalyst: ***No***
- Heat exchange blower: ***Standard***
- Type: ***Fireplace***
- Style: ***Built-in Fireplace***
- Date Received: ***Tuesday, August 20, 2019***
- Testing Period – Start: ***Tuesday, August 20, 2019***
Finish: ***Thursday, August 22, 2019***
- Test Location: ***Hearth & Home Technologies***
1915 W Saunders St, Mt Pleasant, IA 5264
- Elevation: ***~715 Feet above sea level***
- Test Technician(s): ***Aaron Kravitz***
- Observers: ***Colin McCormick & Pie Hummel of Hearth & Home.***

Test Procedures and Equipment

All Sampling and analytical procedures were performed by Aaron Kravitz. All procedures used are directly from ASTM E3053 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
4030806GM	Mettler Toledo Platform Scale & Indicator
129	APEX XC-50 Digital Emissions Sampling Box A
130	APEX XC-50 Digital Emissions Sampling Box B
109A/B	Troemner 100mg/200mg Audit Weights
V3WN5LYV	Horiba CO/CO2 Gas Analyzer
064	Digital Barometer
107	Sartorius Analytical Balance
10744	5 lb audit weight
090	Dewalt Tape Measure
092	Digital Calipers
095	Anemometer
111	Microtector
115	Delmhorst Wood Moisture Meter
XC032449B	Gas Analyzer Calibration Span Gas

Results

The weighted average emissions rate for the 3 run test series was measured to be **1.84 g/hr** with a Higher Heating Value efficiency of **70.3%**. The average CO emission rate for the 3 tests was **3.33 g/min**. The Pioneer II-C Wood-Fired Room Heater meets the 2020 cordwood PM emission standard of ≤ 2.5 g/hr per CFR 40 part 60, §60.532 (c).

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

Summary Table

	High Fire Test	Low Fire Test 1 (Fire Out)*	Low Fire Test 2	Medium Fire Test
Date	8/20/2019	8/20/2019	8/21/2019	8/22/2019
Run Number	1	2	3	4
PM Emission Rate (g/hr)	4.78	N/A	1.59	0.62
Burn Rate (kg/hr)	3.52	N/A	1.29	1.72
Heat Output (BTU/hr)	48,212	N/A	17,632	24,005
HHV Efficiency (%)	68.6%	N/A	70.1%	71.5%
LHV Efficiency (%)	73.7%	N/A	75.3%	76.8%
CO Emissions (g/MJ output)	5.91	N/A	7.56	6.26
CO Emissions (g/kg dry fuel)	83.05	N/A	108.54	91.72
CO Emissions (g/min)	5.00	N/A	2.34	2.64
1 st Hour Emission Rate (g/hr)	8.54	N/A	11.47	1.56
Weighting Factor (%)	20%	0%	40%	40%
Weighted particulate emission average of 3 test runs: 1.84 grams per hour.				
Weighted average HHV efficiency of 3 test runs: 70.3%.				
Average CO emission rate for 3 test runs: 3.33 grams per minute				
*Run 2 is not included in the weighted average - it was not completed due to loss of combustion prior to test end criteria being met. Therefore, no results can be computed from this run.				

Test Run Narrative

Run 1

Run 1 was performed on 8/20/2019 as a high fire test run per ASTM E3053. Emissions sampling began from a cold start ignition of kindling and start-up fuel. The test fuel load was loaded 25 minutes into the test. Testing was completed when 90% of the test fuel load was consumed. Total test time was 180 minutes, main test fuel load burn time was 155 min. The particulate emissions rate from kindling ignition to test completion was 4.78 g/h r. The burn rate of the test fuel load was 3.52 kg/hr. The main test load portion of the run had an overall HHV efficiency of 68.6%. The train A front filter was changed at 1 hr. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

Run 2

Run 2 was performed on 8/20/2019 as a low fire test run per ASTM E3053. 230 minutes into this run, combustion ceased, as defined by ASTM E3053. Therefore, the run is invalid and sampling was halted. No results were computed for this run, and it is not included in the weighted average. All sampling data for this run can be found in Appendix A. The low burn test run was repeated as Run 3.

Run 3

Run 3 was performed on 8/21/2019 as a low fire test run per ASTM E3053. The overall test duration was 545 minutes. The burn rate for the test run was 1.29 kg/hr. The duration of the run was in excess of 8 hours, and the air control was set to fully closed for the test, therefore the run meets the low burn rate category requirements. The particulate emissions rate for the test run was 1.59 g/hr. The run had an overall HHV efficiency of 70.1%. The train A front filter was changed at 1 hr. There were no anomalies and all criteria were met.

Run 4

Run 4 was performed on 8/22/2019 as a medium fire test run per ASTM E3053. The overall test duration was 420 minutes. The burn rate for the test run was 1.72 kg/hr, therefore the medium fire category requirements were met, less than the mid-point of the high and low burn rates (2.40 kg/hr). The particulate emissions rate for the test run was 0.62 g/hr. The run had an overall HHV efficiency of 71.5%. The train A front filter was changed at 1 hr. There were no anomalies and all criteria were met.

Test Conditions Summary

Testing conditions for all runs fell within allowable specifications of ASTM E3053 and ASTM E2515. A summary of facility conditions, fuel burned, and run times is listed below.

Runs	Ambient (°F)		Relative Humidity (%)		Average Barometric Pressure (In. Hg.)	Test Fuel Weight (lbs)	Test Fuel Moisture (%DB)	Test Run Time (Min)
	Pre	Post	Pre	Post				
1	73	76	48.5	42.8	29.94	28.24	22.4%	180
2*	74	73	42.8	44.2	29.92	31.43	21.8%	N/A
3	78	74	44.2	26.4	30.00	31.50	21.6%	545
4	75	73	37.8	35.7	29.90	32.55	22.4%	420

*Fire out, run aborted at 230 min

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 – Cold Start Ignition	Air control set to startup and allowed to close automatically to high fire test setting. Fan on high throughout run.
Run 2*	Air control set to High Fire Setting in accordance with ASTM E3053	Air control set to startup for first 15 minutes, then set to low. Fan off for first 30 min, then set to low.
Run 3	Air control set to High Fire Setting in accordance with ASTM E3053	Air control set to startup for first 15 minutes, then set to low. Fan off for first 30 min, then set to low.
Run 4	Air control set to High Fire Setting in accordance with ASTM E3053	Air control set to startup for first 15 minutes, then set to medium. Fan off for first 30 min, then set to low.

*Fire out, run aborted at 230 min

Appliance Description

Model(s): Pioneer II-C

Additional Models Discussion: In addition to the tested model, this design is offered as the Northstar-C, Constitution (C40-C), and WarmMajic-II. All four designs are identical in all aspects that may impact emissions. The models are distinguished for branding purposes and differ only in the design and appearance on the decorative fascia on the front of the unit.

Appliance Type: Wood-Fired Fireplace

Firebox Volume: 2.7 ft³

Air Introduction System: Primary Air enters the firebox through the required outside air system located at the rear of the appliance. Air is channeled up the sides on the appliance and down through the air wash, as well as through a pilot air opening in the front of the firebox. Primary air is controlled via a damper arm located below the ashlip which moves left (closed) to right (open). Secondary air is pulled from the same outside air system and routed through 3 secondary air tubes. Dimensions on all these features can be found in Appendix D.

Baffles & Refractory: A 12.50" x 11.5" x 0.50" refractory panel rests on top of the secondary air tubes. This baffle is covered by a 1" thick insulation blanket. The firebox is lined with 1.25" thick firebrick

Insulation: All six sides of the firebox are insulated from the outer shell with 1"-1.5" thick fiberglass insulation.

Flue Outlet: 8-inch exhaust outlet designed for direct connection to chimney located on the top of the appliance.

Catalytic Combustor: N/A

Fan: The Pioneer II-C is equipped from the factory with a convection fan located behind the firebox.

Appliance Dimensions

Pioneer II-C Unit Dimensions

Height	Width	Depth	Firebox Volume
40.5"	40"	23.5"	2.7 ft ³

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

Appliance Front



Appliance Left



Appliance Right



Appliance Rear



Test Fuel Properties

Test fuel used was white oak cordwood, split and air-dried to the specified moisture content range. Typical fuel loads are pictured below:

Typical Kindling Load

Typical Startup Load



Typical High Fire Load

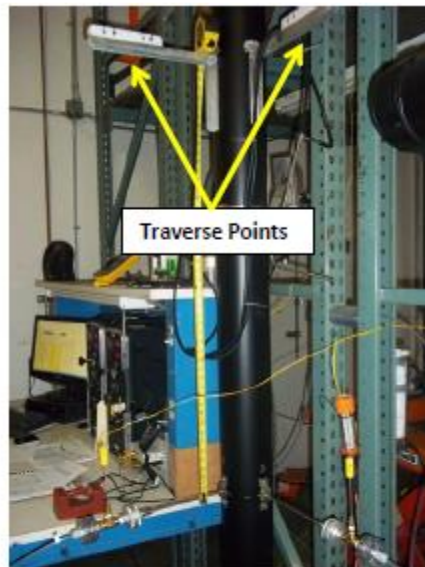
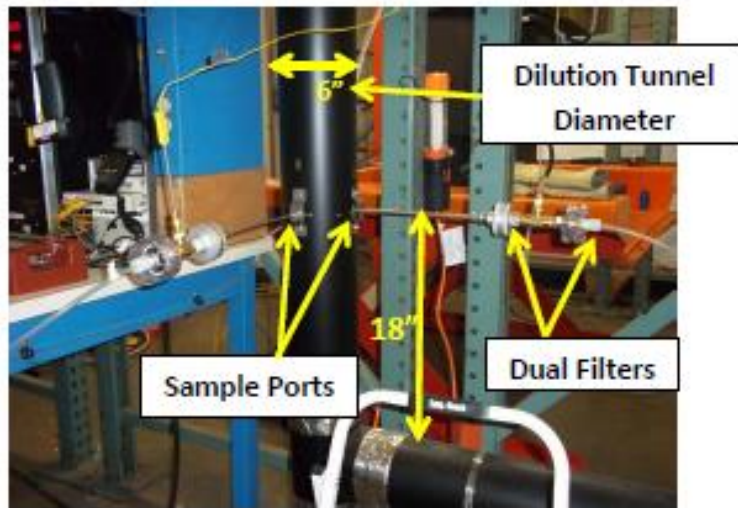
Typical Low Fire Load



Sampling Locations and Descriptions

Sample ports are located 16.5 feet downstream from any disturbances and 1 foot upstream from any disturbances. Flow rate traverse data was collected 12 feet downstream from any disturbances and 5.5 feet upstream from any disturbances. (See below).

Sample Points



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 with the exception of caveats described in ALT-125: Pall TX40 Emfab filters were used, filter temperatures were maintained between 80 and 90°F for all tests, filters were weighed in pairs where applicable, and no sampling intervals fell outside of proportional rates of +/- 10%.

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, dessicated 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, ASTM E2515-11 and ASTM E3053. Test method quality control procedures (leak checks, volume meter checks, stratification checks, proportionality results) followed the procedures outlined.

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 W Saunders St, 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 INACCORDANCE WITH REQUIREMNTS 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, Sample Analysis, and Alternate Test Method Approval

Appendix B – Labels and Manuals

Appendix C – Equipment Calibration Records

Appendix D – Design Drawings (CBI Report Only)

Appendix E – Manufacturer QAP (CBI Report Only)