TEST REPORT

TEST OF A NON CATALYTIC WOOD BURNING FIREPLACE FOR EMISSIONS AND EFFICIENCY

PER EPA METHODS 28R AND ASTM E2515 and ASTM E2780, MAY 2015

Client: Foyers Suprême
Model Name: Ambiance Elegance 36 (24SF model number)

Attention: Rafael Sanchez

TESTED BY:

Services Polytests inc.
695-B Gaudette
St-jean-sur-Richelieu, QC, J3B 7S7

TEST DATES: September 6th to 14th 2016
REPORT DATE: September 20th 2016
Revision 1: June 28th 2017
Project number: PI-20131

Tested: written by:

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Verified by third party certifier (Dirigo lab):

SUMMARY

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1 INTRODUCTION

1.1 GENERAL

Laboratory

- Location: Services Polytests Inc., 695-B Gaudette St-jean-sur-Richelieu QC, Canada J3B 7S7
- Elevation: 100 feet above sea level

Test program

- Purpose: unit qualification NSPS 2020
- Test dates: September 6th to 14th 2016
- Test methods used:
  - Particulate emissions: ASTM E2780-10 ; methods 28R and ASMT E2515 as referred into 40 CFR Part 60 Subpart AAA
  - Efficiency: CSA B415.1-10

1.2 TEST UNIT INFORMATION

General

- Manufacturer: Foyers Suprême inc.
- Product type: non-catalytic Wood burning Zero-Clearance fireplace
- Combustion system: non-catalytic
- Unit tested: Ambiance Elegance 36 (24SF model number)

Particularities

The engine will have the model number of 24SF, which comprises the standard components related to the combustion of the unit (such as the firebox, the controls, and the baffle system). The engine will be under the model name Ambiance Elegance 36. In addition, two other models (Novo and Lotus) will be derived from the Ambiance Elegance 36, which will differ in cosmetics/aesthetics and in marketing strategies; these models will not alter the performance of the engine and will respect all k-list components.

1.3 RESULTS

Emission results obtained

- Weighted average emission rate: 1.77 grams/hour
- Maximum rate cap: 4.3 grams/hour at run 6

Conformity: NSPS Phase 2020

1.4 PRETEST INFORMATION

Unit condition: The unit was received by carrier on September 1st 2016. The 50hrs of aging was made by the manufacturer during month of August 2016.

Set up

- Venting system type: 6 inch steel pipe and insulated chimney
- System height from floor: 15 feet
- Particularities: none

Break in period

- Duration: the unit was run for at least 50 hours at a category 2 burn rate with adequate documentation of fuel additions and flue and unit temperatures during month of August by the manufacturer.
- Fuel: cribwood

2 SUMMARY OF TEST RESULTS

2.1 EMISSIONS

Run Number	Test Date AAAA-MM-DD	Emission Rate (g/hr)	Burn Rate (kg/hr)	1st hour Emission Rate (g/hr)	CSA B415.1 CO emission (g/hr)	CO Emissions (g/Kg dry)	CO Emissions (g/MJ output)
1	2016-09-06	na	na	na	na	na	na
2	2016-09-07	1.16	0.81	7,46	71,86	89.16	6.577
3	2016-09-08	1.64	1.68	5.53	157.96	93.86	16.75
4	2016-09-09	1.73	2.134	4.49	142.83	66.91	12.13
5	2016-09-12	1.33	1.33	3.33	97.03	71.77	12.43
6	2016-09-13	4.3	0.804	24	98.65	122.7	21.47
7	2016-09-14	2.26	1.59	8,39	147,70	93.15	7.05

2.2 WEIGHTED AVERAGE CALCULATION

Test No.	Burn Rate Kg/hr	(E) Ave. Emission Rate g/hr	Overall Efficiency (%)	Heat Output (BTU/HR)	Prob.	(K) Weighting Factor
6	0,804	4,30	67,03	10125	0,2227	0,2241
2	0,806	1,20	68,43	10364	0,2241	0,3973
5	1,3	1,33	67,72	17203	0,6200	0,6099
3	1,68	1,60	65,73	20786	0,8340	0,3092
4	2,13	1,70	64,68	25944	0,9292	0,1660

Weighted Average Emissions Rate: 1.77g/hr
Weighted Average Overall Efficiency: 67.14%

2.3 TEST FACILITY CONDITIONS

Run Number	Room Temperature		Barometric pressure		Relative humidity		Air Velocity	
	Before (F)	After (F)	Before (in.Hg)	After (in.Hg)	Before (%)	After (%)	Before (ft/min)	After (ft/min)
1	na	na	na	na	na	na	na	na
2	80	81	30,032	29,914	66,5	47,4	19	18
3	81	84	29,766	29,766	65	60,5	18	22
4	80	84	29,766	29,855	65,5	48	24	21
5	76	81	30,150	30,121	48	35,9	22	18
6	78	85	30,091	29,914	48	43	12	15
7	79	81	29,914	30,062	58	38	17	19

2.4 FUEL QUALITIES

Run Number	Pre-test Load			Test Load						
	Loading Weight Wet Basis (lbs)	Moisture Content Dry Basis (%)	Coal bed Weight (lbs)	Weight Wet Basis (lbs)	Density Wet Basis (lbs/cuft)	Moisture Content Dry Basis (%)	Piece Length (in.)	Number of 2X4's	Number of 4x4's	Number of Spacers
1	na	na	na	na	na	na	na	na	na	na
2	17,95	21,20	3,3	16,44	7,341	21,81	22	2	2	12
3	18,02	20,28	3,3	16,16	7,216	20,50	22	2	2	12
4	19,87	20,49	3,2	15,79	7,048	21,30	22	2	2	12
5	18,52	19,70	3,5	16,16	7,216	21,24	22	2	2	12
6	17,97	20,32	3,4	16,27	7,262	20,80	22	2	2	12
7	20,24	20,33	3,5	15,79	7,050	19,98	22	2	2	12

2.5 DILUTION TUNNEL FLOW RATE MEASUREMENTS AND SAMPLING DATA (ASTM E2515)

Average dilution tunnel measurements				Sample Data			
Run Number	Burn Rate (Min)	Volumetric Flow Rate (dscf/min)	Total Temperatures (°R)	Volume sampled (DSCF)		Particulate catch (mg)	
				1	2	1	2
1	na	na	na	na	na	na	na
2	456	289,07	558,30	81,240	78,768	5,70	5,10
3	217	271,36	564,07	38,339	37,249	3,90	3,70
4	166	270,48	569,76	28,999	28,340	3,10	3,00
5	272	276,92	555,30	47,494	46,289	3,80	3,80
6	456	273,84	555,45	80,118	77,574	21,30	20,00
7	226	273,86	561,17	45,750	38,619	6,20	5,50

2.6 DILUTION TUNNEL DUAL TRAIN PRECISION

Run Number	Sample Ratio		Total Emission (g)		
	Train 1	Train 2	Train 1	Train 2	% Deviation
1	na	na	na	na	na
2	1622,57	1673,50	9,17	8,46	4,02%
3	1535,93	1580,88	5,99	5,85	1,19%
4	1548,33	1584,35	4,80	4,75	0,49%
5	1585,95	1627,23	5,96	6,13	1,33%
6	1558,57	1609,69	33,20	32,19	1,54%
7	1352,81	1602,61	8,31	8,76	2,65%

2.7 GENERAL SUMMARY OF RESULTS

Run Number	Burn Rate (kg/hr)	Average Surface Temperature (F)	Change in surface Temperature (F)	Initial Draft (in. H^2O)	static pressure tunnel (in. H^2O)	Primary Air Setting	Run Time (min)
1	na	na	na	na	na	na	na
2	0,806	296,13	-92,6	0,037	0,231	full close	456
3	1,682	417,56	41,0	0,042	0,215	Medium-high	217
4	2,134	485,51	64,4	0,038	0,218	Medium-high	166
5	1,334	391,23	26,4	0,037	0,224	fully close	272
6	0,804	306,66	-67,5	0,037	0,214	fully close	456
7	1,585	524,21	128,3	0,041	0,214	full close	226

3 PROCESS DESCRIPTION

3.1 DISCUSSION

At the reception of the unit we do preliminary test run to ensure the unit can reach the limit of the standard. We use those run for the aging of the unit

3.2 UNIT DIMENSIONS

Baffle

- Location: between top of combustion chamber and hearth
- Restriction: 1 3/4 in x 24 in. at the front of unit
- Dimensions: covers the hearth area minus the restriction at front
- Material: Stainless steel baffle

Bricks

- Inside Firebox refractory brick 1 ¼ inch. tick cover all the sides and the back of the combustion chamber

Flue gas exhaust

- Location: top flue located at the top,
- Dimensions: 6 in. diameter
- Material: Stainless

Gasket

The door of the unit consists of three sections of gaskets, where 2 of them are holding the glass (SGI-260-0230) and 1 is sealing around the door onto the firebox (SGI-265-0125). Please refer to page 47 of 24SF_TECH_DRAW.pdf for information on dimensions, materials, and assembly details. The ANPGA gasket is located at the top edge of the flue and is used to seal the anchor plate onto the unit. Please refer to page 2 of 24SF_TECH_DRAW.pdf (5) for information on dimensions, materials, and assembly.

Overall unit dimension

- Firebox dimensions : 24 in wide x 12 in. deep x 13 ½ in. high
- Usable volume : 2.24 cuft
- Overall fireplace dimension : 35 inch wide x 20 ¾ inch deep x 34 ½ high

Convection fan

- Optional blower supplied with unit see appendix 6 for all detail

Catalyst

- none

Bi-metallic combustion air control

The Primary Air Control is a patented mechanism (Patent No: US 7,325,541 B2) that regulates the air flow into the firebox based on the temperature of the unit. It is located on the top of the firebox, at the front center of the unit. The combustion air control of the 24SF has two components: the Activator and the Burn Rate Selector. The left combustion control lever is the Activator. When starting a fire or adding a new load of wood, the Activator must be pushed in to allow a primary source of air to enter the firebox. The Activator will retract automatically with heat. The right combustion control lever is the Burn Rate Selector. The Burn Rate Selector can slide sideways to achieve different burn rates. When the Burn Rate Selector is positioned to the left, a maximum burn rate is achieved and when it is positioned to the right, a minimum burn rate is set. Please refer to page 42 of 24SF_TECH_DRAW.pdf for details on the Primary Air Control assembly.

3.3 AIR SUPPLY SYSTEM

Description

- Primary air: window wash design with air intake on the top of unit
- Secondary air: secondary tube design with air intake on the top of unit

Characterization

The following table shows the inlet and outlet sections of each system. The air introduction system number is referred to on a set of drawings in Appendix 6.

AIR INTRODUCTION SYSTEM		INLET (1) sq. in.			OUTLET
Identification	Type	Imin	Imax	Controlled	(sq. in.)
A *	Primary	0.05	4.75	yes	28.27
B *	Secondary	1.77	1.77	No	-
C *	Pilot	none	none	No	-

* This section would be filled by measuring and comparing with the manufacturer's drawings included in the test report .

Legend

Identification: Tag name referred to on drawings in Appendix 14, section airflow pattern
Type: Characterization of air intake
Imin: Minimum air intake of a particular air channel
Imax: Maximum air intake of a particular air channel
Controlled: Determines if a provision for air control is present
Outlet: Total air outlet of a particular air channel

Note: surfaces are expressed in sq. Inches

3.4 OPERATION DURING TEST

Run #1

This run was performed on September 6th 2016. Following the load insertion the bi-metallic control, jammed in intermediate position. The test is stop and control operation fixation is modified to allowed free movement of the bi-metallic slider. As the unit is modified, test series will begin with the next test.

Run #2

This run was performed on September 7th 2016. It lasted 456 minutes and a category 2 burn rate was obtained at 0.81 kg/hr & emission at 1.16gr/hr. the optional blower was at on position and combustion air control was fully closed.

Run #3

This run was performed on September 8th 2016. It lasted 217 minutes and a category 3 burn rate was obtained at 1.68 kg/hr & emission at 1.64gr/hr. the optional blower was at on position

Run #4

This run was performed on September 9th 2016. It lasted 166 minutes and a category 4 burn rate was obtained at 2.13 kg/hr & emission at 1.73gr/hr. the optional blower was at on position and combustion air control was fully opened.

Run #5

This run was performed on September 12th 2016. It lasted 272 minutes and a category 3 burn rate was obtained at 1.33 kg/hr & emission at 1.33gr/hr. the optional blower was at on position, the air inlet control was fully closed, we were aiming for a minimum burn rate, but the wood burn faster than it was supposed, probably due to hotter firebox.

Run #6

This run was performed on September 13th 2016. It lasted 456 minutes and a category 2 burn rate was obtained at 0.804 kg/hr & emission at 4.3gr/hr. the optional blower was at on position and combustion air inlet fully closed.

Run #7

This run was performed on September 14th 2016. It lasted 226 minutes and a medium burn rate was obtained at 1.58 kg/hr & emission at 2.26gr/hr. the optional blower was at off position, it was confirmation test without fan.

- Details: Refer to the front page of each test run data sheets found in appendix for the detailed test sequence showing air supply settings and adjustments, fuel bed adjustments and operational specifics of the test unit.

Test fuel cribs

- Type of wood: Douglas fir, grade c or better, 19 to 25% dry basis moisture content
- Description: for each test, description of the fuel crib is found on the front page of each test run data sheet together with photograph in appendix.

3.5 START-UP OPERATION

The complete manufacturer's firing procedure of each burn rate category is fully described in appendix 13.

3.6 SAMPLING LOCATIONS

Particulate samples are collected from the dilution tunnel at a point 15 feet from the tunnel entrance. The tunnel has two elbows and two mixing baffles in the system ahead of the sampling section. The sampling section is a continuous 10 foot section of 6 inch diameter pipe straight over its entire length. Tunnel velocity pressure is determined by a standard pitot tube located 48 inches from the beginning of the sampling section. Thermocouple is installed on the pitot tube to measure the dry bulb temperature. MC is assumed, as allowed, to be 4%. Tunnel samplers are located 56 inches downstream of the pitot tube and 16 inches upstream from the end of this section.

3.7 DRAWINGS

Various drawings of the stack gas sampling train and of dilution tunnel system are found in Appendix 1.

3.8 EMISSIONS EFFICIENCY TESTING EQUIPMENT LIST

The complete test equipment list together with all corresponding calibration data can be found in Appendix 3.

4 SAMPLING METHODS

4.1 PARTICULATE SAMPLING

Particulates were sampled in strict accordance with ASTM E2515. This method uses two identical sampling systems with Gelman A/E 61631 binder free (or equivalent), 47 mm diameter filters. The dryers used in the sample systems are filled with "Drierite" before each test run.

5 QUALITY ASSURANCE

5.1 INSTRUMENT CALIBRATION

5.1.1 GAS METERS

At the conclusion of each test program the gas meters are verified using the reference dry gas meter. This process involves sampling the train operation for 1 cubic foot of volume. With readings made to .01 fr', the resolution is 1 %, giving an accuracy higher than the 2% required by the standard.

5.1.2 SCALES

Before each test program, the different scales used are checked with traceable calibration weights to ensure their accuracy.

5.1.3 GAS ANALYZERS

The continuous analyzers are zeroed and spanned before each test with NBS traceable gases. A mid-scale multi-component calibration gas is then analyzed (values are recorded). At the conclusion of a test, the instruments are checked again with zero, span and calibration gases (values are recorded only). The drift in each meter is then calculated and must not exceed 5% of the scale used for the test.

5.2 TEST METHOD PROCEDURES

5.2.1 LEAK CHECK PROCEDURES

Before and after each test, each sample train is tested for leaks. Leakage rates are measured and must not exceed 0.02 CFM or 4% of the sampling rate. Leak checks are performed checking the entire sampling train. Pre-test and post-test leak checks are conducted with a vacuum of 5 inches of mercury. Vacuum is monitored during each test and the highest vacuum reached is then used for the post test vacuum value. If leakage limits are not met, the test run is rejected. During these tests, the vacuum is typically less than 2 inches of mercury. Thus, leakage rates reported are expected to be much higher than actual leakage during the tests.

5.2.2 TUNNEL VELOCITY FLOW MEASUREMENT

The tunnel velocity is calculated from a center point pitot tube signal multiplied by an adjustment factor. This factor is determined by a traverse of the tunnel as prescribed in EPA Method 1. Final tunnel velocities and flow rates are calculated from EPA Method 2, Equation 6.9 and 6.10. (Tunnel cross sectional area is the average from both lines of traverse.)

Pitot tubes are cleaned before each test and leak checks are conducted after each test.

5.2.3 PM SAMPLING PROPORTIONALITY (ASTM E2515)

Proportionalities were calculated in accordance with ASTM E2515. The data and results are found in appendix.