TEST REPORT

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

PER EPA METHODS 28 AND 5G-3, FEBRUARY 1988

Client: Hichanse
Model name : HCS-03

Attention: Rafaël Sanchez

TESTED BY:

Services Polytests
411 St-Jacques
Napierville, QC, J0J 1L0

TEST DATES :
REPORT DATE : January 16, 2014
Project number : P-1216

Tested: written by :

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Verified by :

Gaétan Piédalue, P.Eng

SUMMARY

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1 INTRODUCTION

1.1 GENERAL

Laboratory

- Location: Services Inc., 411 St-Jacques st, Napierville QC, Canada JOJ 1LO
- Elevation: 100 feet above see level

Test program

- Purpose: unit qualification E.P.A. Phase II
- Test dates: November 20th to 27th 2013
- Test methods used:
    - Particulate emissions: methods 28 and 5G-3 as referred into 40 CFR Part 60 Subpart AAA
    - Efficiency: CSA B415.1-10

1.2 TEST UNIT INFORMATION

General

- Manufacturer: Qingdao Hichanse Group Co., Ltd.
- Product type: non-catalytic freestanding wood stove
- Combustion system: primary air with secondary air tube
- Unit tested: HCS-03

Particularities

- Options:
- Optional blower, located at the back of the unit
- optional side heat shield

1.3 RESULTS

Emission results obtained

- Weighted average emission rate: 4.08 grams/hour
- Maximum rate cap: 5.2 grams/hour at run 3

Conformity: E.P.A. Phase II

1.4 PRETEST INFORMATION

Unit condition: The unit was received by carrier 2013 july 3rd . The 10hrs of aging is made in week of november 12th , 2013.

Set up

- Venting system type: steel pipe and insulated chimney
- System height from floor: 15 feet
- Particularities: The unit was tested with the top flue configuration

Break in period

- Duration: the unit received from the manufacturer and run for at least 10 hours at a category 2 burn rate with adequate documentation of fuel additions and flue and unit temperatures during the week of november 12th 2013.
- Fuel: cordwood

2 SUMMARY OF TEST RESULTS

2.1 EMISSIONS

Run Number	Test Date	Burn Rate (kg/hr)	Adjusted Emission Rate (g/hr)	Heating Efficiency (% Overall)
1	20-11-2013	1,050	2,81	70,4%
2	21-11-2013	0,989	4,85	70,0%
3	25-11-2013	1,306	5,22	74,6%
4	26-11-2013	2,392	2,44	69,3%
5	27-11-2013	1,059	3,17	63,5%

2.2 WEIGHTED AVERAGE CALCULATION

Test No.	Burn Rate	(E) Ave. Emission Rate g/hr	(OHE)	Heat Output (BTU/HR)	Prob.	(K) Weighting Factor
2	0,989	4,853	0,70	13011	0,3682	0,4069
1	1,050	2,814	0,70	13600	0,4069	0,2559
3	1,306	5,219	0,75	18322	0,6242	0,5483
4	2,392	2,440	0,69	30752	0,9552	0,3758
					sum	4.08

Weighted Average Emissions Rate: 4.08g/hr

Weighted Average Overall Efficiency: 71.5%

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	73	74	30,62	30,62	24,5	20,8	18	22
2	76	83	30,56	30,42	32	21	11	18
3	78	80	30,42	30,21	20,7	15,8	10	16
4	80	82	30,18	30,18	24,5	19	9	11
5	77	83	29,53	29,44	31,5	20,4	5	5

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
1	13,65	20,40	2,8	13,10	6,550	20,00	19,5	3	1
2	13,85	21,00	2,7	12,80	6,400	20,67	19,5	3	1
3	12,76	20,40	3,1	12,60	6,300	20,44	19,5	3	1
4	12,80	19,50	2,8	12,75	6,375	19,91	19,5	3	1
5	13,15	21,50	2,8	12,70	6,350	20,40	19,5	3	1

2.5 DILUTION TUNNEL FLOW RATE MEASUREMENTS AND SAMPLING DATA (5G-3)

Average dilution tunnel measurements				Sam pie Data			
Run Number	Burn Rate (Min)	Volumetrie Flow Rate (dscf/min)	Total Temperatures (°R)	Volume sampled (DSCF)		Particulate catch (mg)	
				1	2	1	2
1	283	148,92	549,33	53,045	52,138	9,80	10,10
2	292	145,25	554,01	53,6491	52,5004	19,60	20,10
3	218	149,03	557,98	40,565	39,602	16,10	15,80
4	121	134,64	598,83	22,707	22,126	3,90	4,00
5	271	138,66	557,23	49,965	48,810	12,20	11,00

2.6 DILUTION TUNNEL DUAL TRAIN PRECISION

Run Number	Sam pie Ratio		Total Emission (g)		
	Train 1	Train 2	Train 1	Train 2	% Deviation
1	794,52	808,34	7,79	8,16	2,37%
2	790,54	807,84	15,49	16,24	2,34%
3	800,92	820,40	12,89	12,96	0,26%
4	717,47	736,31	2,80	2,95	2,56%
5	752,04	769,84	9,18	8,47	4,01%

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	1,050	308,13	-123,8	0,067	0.27	Close	283
2	0,989	313,96	-58,8	0,065	0.28	Close	292
3	1,306	326,12	-50,2	0,065	0.26	1/16 drill bit	218
4	2,392	394,68	-33,4	0,081	0.28	Fully open	121
5	1,059	341,97	-98,1	0,047	0.28	Close	271

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 22 1/4 in. at the front of unit
- Dimensions: covers the hearth area minus the restriction at front
- Material: refractory brick and 1/2 rigid insulation (silicate board)

Bricks

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

Flue gas exhaust

- Location: top flue located at the top, or back flue located at the back
- Dimensions: 6 in. diameter
- Material: Steel

Gasket

- Location: door (1/2 round), window (3/8 round),Glass holder (1/8 X 1/2 flat), ash door (1/2 round).

Overall unit dimension

- Firebox dimensions : 22 1/4 in wide x 17 5/8 in. deep x 8 1/2 to 91/2 in. high
- Usable volume : 2 cuft

Convection fan

- Manufacturer : Optional blower supplied with unit
- Model : FZ6030
- Spec. : 110V / 60HZ ; 0.55Amps

Catalyst

- none

3.3 AIR SUPPLY SYSTEM

Description

- Primary air: window wash design with air intake at the back of unit
- Secondary air: secondary tube design with air intake at the back of unit

Characterization

The following table shows the inlet and outlet sections of each system. The air introduction system number is referred 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	0.785	4.95	Yes	5.25
B *	Secondary	0.75	2.125	Yes	1.2
C *	Pilot	0.25	0.25	None	0.027

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

Legend

Identification: Tag name referred 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 December 20th , 2013. It lasted 283 minutes and a category 2 burn rate was obtained at 1.05 kg/hr & emission at 2.8gr/hr. the optional blower was at on position and the side optional heat remove

Run #2
This run was performed on December 21st , 2013. It lasted 292 minutes and a category 2 burn rate was obtained at 0.989 kg/hr & emission at 4.9gr/hr. the optional blower was at on position and the side optional heat remove

Run #3
This run was performed on December 25th , 2013. It lasted 218 minutes and a category 3 burn rate was obtained at 1.31 kg/hr & emission at 5.22gr/hr. the optional blower was at on position and the side optional heat remove

Run #4
This run was performed on December 26th , 2013. It lasted 121 minutes and a category 4 burn rate was obtained at 2.39kg/hr & emission at 2.4gr/hr. the optional blower was at on position and the side optional heat remove

Run #5 (fan confirmation test)
This run was performed on December 27th , 2013. It lasted 271 minutes and a category 2 burn rate was obtained at 1.06 kg/hr & emission at 3.2gr/hr. the optional blower was at off position and the side optional heat remove This run doesn't count in the emission weighted average

- 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 STAR-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 EPA Method 5G-3. This method uses two identical sampling systems with Gelman AIE 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 C5G-3)

Proportionalities were calculated in accordance with EPA Method 5G-3. The data and results are found in appendix.

APPENDIX 1: Raw data, forms and results

APPENDIX 2: Proportionality results

APPENDIX 3: Calibration data

APPENDIX 4: Unit pre burn

APPENDIX 5: Participants

APPENDIX 6: Drawings and specifications

APPENDIX 7: Operator's manual

APPENDIX 8: Photographs of test set up

APPENDIX 9: Test load photographs

APPENDIX 10: Laboratory Operating Procedures

APPENDIX 11: Sample calculations

APPENDIX 12: Volume calculations

APPENDIX 13: Operating instruction

APPENDIX 14: Drawing Air flow pattern

APPENDIX 15: Application for wood stove program