TEST REPORT

REPORT NUMBER: 102067594MID-008aR1
REPORT DATE: April 4, 2016
REVISED REPORT DATE: May 4, 2016
REVISED REPORT DATE: April 20, 2017

EVALUATION CENTER
Intertek Testing Services NA Inc.
8431 Murphy Drive
Middleton, WI 53562

RENDERED TO

AC Component Specialists, Inc.
PO Box 500
899 South Prairie Lane
Marshfield, MO 65706

PRODUCT EVALUATED:

Model 620-10 Pellet Fuel Furnace

Report of Testing Model 620-10 Pellet-fueled hot aired furnace for compliance with the applicable requirements of the following criteria: CAN/CSA B415.1-2010 Performance Testing of Solid-Fuel-Burning Heating Appliances, ASTM E2515-11 Determination of Particulate Matter Emissions Collected by a Dilution Tunnel, and EPA 40 CFR Part 60 "Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces", March 16, 2015.

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APPENDICES

REVISION SUMMARY

DATE	SUMMARY
May 4, 2016	Changed from model 620-9 to 620-10 as the model tested. Added 1st hour emission data. Added CSA B415 test data.
April 20, 2017	Updated Table II.B to better define the Weighted Average results. Updated Table II.D to indicate CO emissions in g/min. Updated Section VII Conclusion to include details of the difference between the models 620-10 and 620-9.

I. INTRODUCTION

I.A. GENERAL

From January 12, 2016 through February 4, 2016 Intertek Testing Services NA Inc. (Intertek) conducted tests on the model 620-10 pellet-fired hot aired furnace to determine emission and efficiency results for AC Component Specialists, Inc.

Tests were conducted by Ken Slater at the Intertek Testing Services NA Inc. laboratory located at 8431 Murphy Drive, Middleton, Wisconsin. The laboratory elevation is 860 feet above sea level. Tests were evaluated to CAN/CSA B415.1-2010 Performance Testing of Solid-Fuel-Burning Heating Appliances, ASTM E2515-11 Determination of Particulate Matter Emissions Collected by a Dilution Tunnel, and EPA 40 CFR Part 60 “Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces”, March 16, 2015.

I.B. TEST UNIT DESCRIPTION

The model 620-10 is constructed of mild steel with a steel firebox and a round under-fed pellet burn pot. The unit weighs 670 lbs.

I.C. RESULTS

The unit as tested produced an average emissions rate of 0.197 grams/mega joule of total output (0.458 lbs/MMBtu Output).

I.D. PRETEST INFORMATION

The test unit was received at Intertek Testing Services NA Inc. in Middleton, Wisconsin on May 4, 2015. The unit was inspected upon receipt and found to be in good condition. The unit was set up following the manufacturer’s instructions without difficulty. Following assembly, the unit was placed on the test stand and instrumented with thermocouples in the specified locations.
The chimney system and laboratory dilution tunnel was cleaned using standard wire brush chimney cleaning equipment.

On May 6, 2015, the unit was ready for testing.

II. SUMMARY OF TEST RESULTS

II.A EPA Results

CAT	Load % Capacity	Tgt Load (Btu/hr)	Act Load (Btu/hr)	Test Duration (Hours)	WoodWt (Lb)	Q_{in} (Btu)	Q_{out} (Btu)	η_N (%)	E_T (g)	E (g/MJ)	E Output (lb/mmbtu)	E Input (lb/mmbtu)	E (g/hr)	E (g/Kg)
I	<35% of max	42,000	37,722	6.00	53.50	430,548	226,332	52.6%	57.45	0.24	0.56	0.29	9.58	2.51
II	35-53% of max	52,800	52,227	6.00	70.70	568,967	313,363	55.1%	60.65	0.18	0.43	0.24	10.11	2.00
III	53-76% of max	78,000	75,861	6.00	101.70	818,444	455,167	55.6%	87.25	0.18	0.42	0.24	14.54	2.00
IV	Max capacity	120,000	112,434	4.33	115.20	927,087	487,214	52.6%	93.09	0.18	0.42	0.22	21.48	1.89

II.B

Weighted Average

			Efficiency (HHV)	Emissions	Emissions	Emissions (Input)	Emissions (Output)	Emissions
Cat	**Run No.**	**Weighting Factor**	Efficiency x WF	**g/MJ x WF**	**g/kg x WF**	**Lb/MMBtu x WF**	**Lb/MMBtu x WF**	**g/hr x WF**
I	3	0.25	0.131	0.060	0.627	0.074	0.140	2.394
II	4	0.25	0.138	0.046	0.501	0.059	0.107	2.527
III	5	0.25	0.139	0.045	0.501	0.059	0.106	3.636
IV	2	0.25	0.131	0.045	0.472	0.055	0.105	5.371
Totals		1.000	0.540	0.197	2.101	0.246	0.458	13.927
			54.0%					

II.C 1st Hour Emissions Results

Run Number	Test Date	Output Category	1st Hour Emissions (g/hr)	1st Hour Emissions (lbs/MMBtu)	1st Hour Emissions (g/MJ)
2	**1/12/16**	**4**	**14.17**	**0.28**	**0.12**
3	**2/2/16**	**1**	**7.30**	**0.37**	**0.16**
4	**2/3/16**	**2**	**24.32**	**0.92**	**0.40**
5	**2/4/16**	**3**	**11.54**	**0.36**	**0.15**

II.D CSA B415.1

Run Number	Burn Rate (kg/hr)(Dry)	Output Category	CO Emissions (g/min)	Heating Efficiency (% HHV) (Stack loss)	Heat Output (Btu/hr)
2	**11.38**	**4**	**0.19**	**65.5**	**140,308**
3	**3.82**	**1**	**1.87**	**61.9**	**44,495**
4	**5.05**	**2**	**2.01**	**64.1**	**60,815**
5	**7.26**	**3**	**0.25**	**67.6**	**92,269**

II.E Summary of other Data

Category	**1**	**2**	**3**	**4**
Run Number	3	4	5	2
Test Date	2/2/2016	2/3/2016	2/4/2016	1/12/2016
Total Test Fuel Weight (lb)	53.50	70.70	101.70	115.20
Avg. Test Fuel Moisture (% dry)	5.97	5.97	5.97	5.97
Test Duration (min)	360.000	360.00	360.00	260.00
Burn Rate (kg/hr)	3.82	5.04	7.26	11.38
Emissions (g)	57.45	60.65	87.25	93.09
Average Barometric Pressure (“Hg)	28.81	28.47	29.13	28.93
Average Tunnel Delta p (inches of water)	0.05	0.05	0.05	0.04
Average Gas Velocity in Tunnel (feet/sec)	13.08	12.69	12.64	11.82
Average Gas Flow Rate in Dilution Tunnel (Qsd),(dscf/m)	616.45	597.91	595.82	557.13
Total Output Btu	226332	313363	455167	487214
Target Load High (Btu/h)	42000	63600	91200	132000
Target Load Low (Btu/h)	36000	42000	63600	108000
Actual Load (Btu/h)	37722	52227	75861	112434
Quercus Ruba L. Fuel Heating Value	8600	Btu/lb Higher Heating Value		

III. PROCESS DESCRIPTION

III.A. DISCUSSION

RUN #1 (January 8, 2016). The furnace was set for a category 4 output rate. The convection blower was left on to maintain the desired heat rate. At approximately 120 minutes into the test, the computer system malfunctioned and data was lost. The system was restarted, but the proportional flow rate on the sample filters could not be maintained. The test data indicated a non-valid test.

RUN #2 (January 12, 2016). The furnace was set for a category 4 output rate. The convection blower was left on to maintain the desired heat rate. Unit was started and operated for a minimum of 1 hour as a pretest. The emissions sampling system was then started at the beginning of the test. The unit consumed 115.20 lbs. during the 260 minute duration of the test with an average output of 112,434 Btu/hr. The burn rate was 11.38 kg/hr. The test data indicated a valid test. The particulate emissions were 0.181 g/mJ.

RUN #3 (February 2, 2016). The furnace was set for a category 1 output rate. The convection blower was turned on and off to maintain the desired heat rate. Unit was started and operated for a minimum of 1 hour as a pretest. The emissions sampling system was then started at the beginning of the test. The unit consumed 53.50 lbs. during the 360 minute duration of the test with an average output of 37,722 Btu/hr. The burn rate was 3.82 kg/hr. The test data indicated a valid test. The particulate emissions were 0.241 g/mJ.

RUN #4 (February 3, 2016). The furnace was set for a category 2 output rate. The convection blower was turned on and off to maintain the desired heat rate. Unit was started and operated for a minimum of 1 hour as a pretest. The emissions sampling system was then started at the beginning of the test. The unit consumed 70.70 lbs. during the 360 minute duration of the test with an average output of 52,227 Btu/hr. The burn rate was 5.04 kg/hr. The test data indicated a valid test. The particulate emissions were 0.184 g/mJ.

RUN #5 (February 4, 2016). The furnace was set for a category 3 output rate. The convection blower was turned on and off to maintain the desired heat rate. Unit was started and operated for a minimum of 1 hour as a pretest. The emissions sampling system was then started at the beginning of the test. The unit consumed 101.70 lbs. during the 360 minute duration of the test with an average output of 75,861 Btu/hr. The burn rate was 7.26 kg/hr. The test data indicated a valid test. The particulate emissions were 0.1 g/mJ.

III.B. UNIT DIMENSIONS

Overall dimensions are 47.75-in wide, 40.5-in deep, 51-in high.

III.C. AIR SUPPLY SYSTEM

Combustion air enters the unit in the side of the unit aided by a combustion air blower and is directed to the burn pot. Combustion products flow through a heat exchanger system. Combustion products exit through a 6-in flue collar located at the top rear of the outer enclosure.

III.D. OPERATION DURING TEST

The convection air outlet was adjusted for each of the heat loads by turning the convection air blower on and off to maintain the desired output. The inlet and outlet air temperatures on the furnace were monitored to determine the Delta-T.

III.E TEST FUEL PROPERTIES

The fuel used was Marth Pellets. The fuel moisture content 5.80% on a dry basis and 5.63 on a wet basis.

III.F. START-UP OPERATION

Each test was started with a clean firebox and the scale zeroed. A fire was started. During the pretest loads, the air flow was adjusted to establish target heat output. After verification the heat output could be consistently stable, the sampling system was started and was operated for the duration of the test run.

IV. SAMPLING SYSTEMS

The sampling procedure used was as specified in CAN/CSA B415.1-2010 and ASTM E2515-2011.

IV.A. SAMPLING LOCATIONS

Particulate samples are collected from the dilution tunnel at a point 16 feet from the tunnel entrance. The tunnel has two elbows ahead of the sampling section. (See Figure 3.) The sampling section is a continuous 14-foot section of 12-inch diameter pipe straight over its entire length. Tunnel velocity pressure is determined by a standard Pitot tube located 96 inches from the beginning of the sampling section. The dry bulb thermocouple is located six inches downstream from the Pitot tube. Tunnel samplers are located 36 inches downstream of the Pitot tube and 36 inches upstream from the end of this section. (See Figure 1.)

Stack gas samples are collected from the steel chimney section 8 feet ± 6 inches above the scale platform. (See Figure 2.)

IV.A.(1) DILUTION TUNNEL

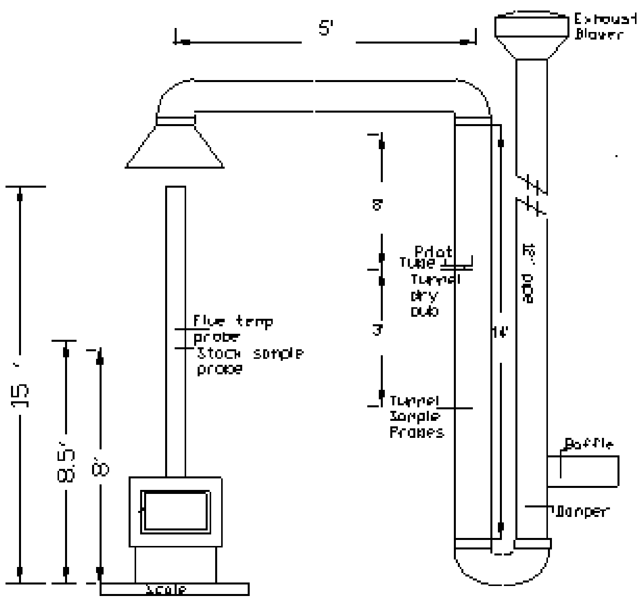
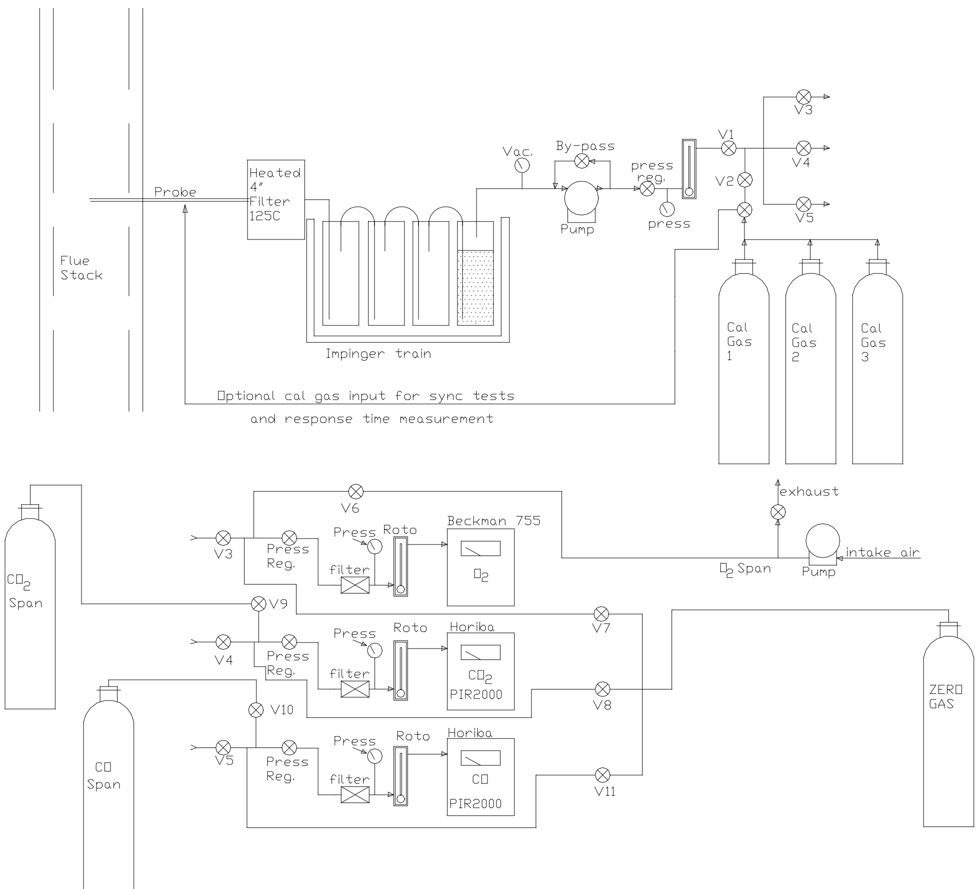


FIGURE 1

IV.B.OPERATIONAL DRAWINGS

IV.B.(1) STACK GAS SAMPLE TRAIN



ITS FLUE GAS SAMPLE TRAIN

FIGURE 2

IV.B.(2). DILUTION TUNNEL SAMPLE SYSTEMS

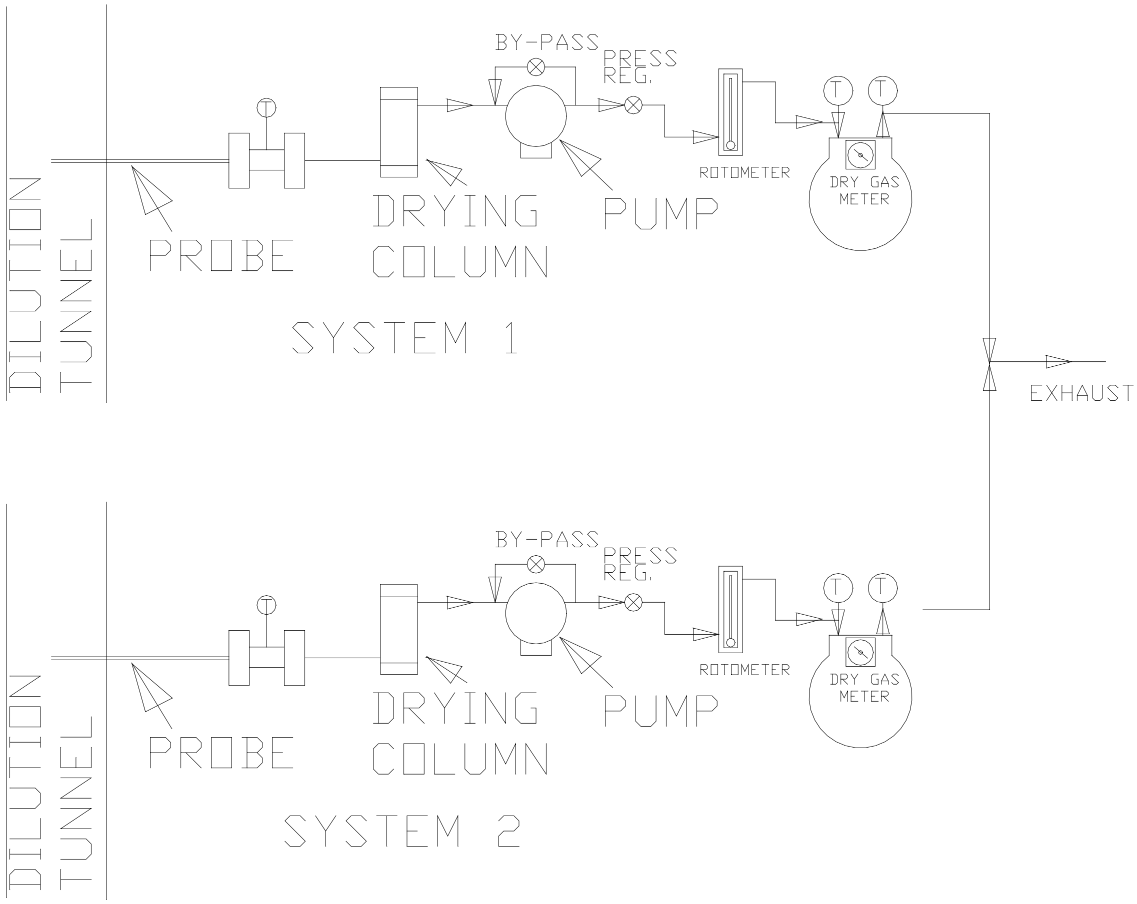


Figure 3

V. SAMPLING METHODS

V.A. PARTICULATE SAMPLING

Particulates were sampled in strict accordance with ASTM E2515-11. This method uses two identical sampling systems with Gelman A/E 61631 binder free, 47-mm diameter filters. The dryers used in the sample systems are filled with "Drierite" before each test run.

VI. QUALITY ASSURANCE

VI.A. INSTRUMENT CALIBRATION

VI.A. (1). DRY GAS METERS

At the conclusion of each test program the dry gas meters are checked against our standard dry gas meter. Three runs are made on each dry gas meter used during the test program. The average calibration factors obtained are then compared with the six-month calibration factor and, if within 5%, the six-month factor is used to calculate standard volumes. Results of this calibration are contained in Appendix D.

An integral part of the post test calibration procedure is a leak check of the pressure side by plugging the system exhaust and pressurizing the system to 10" W.C. The system is judged to be leak free if it retains the pressure for at least 10 minutes.

The standard dry gas meter is calibrated every 6 months using a Spirometer designed by the EPA Emissions Measurement Branch. The process involves sampling the train operation for 1 cubic foot of volume. With readings made to .001 ft^3, the resolution is .1%, giving an accuracy higher than the ±2% required by the standard.

VI.A.(2). STACK SAMPLE ROTOMETER

The stack sample rotometer is checked by running three tests at each flow rate used during the test program. The flow rate is checked by running the rotometer in series with one of the dry gas meters for 10 minutes with the rotometer at a constant setting. The dry gas meter volume measured is then corrected to standard temperature and pressure conditions. The flow rate determined is then used to calculate actual sampled volumes.

VI.A.(3). GAS ANALYZERS

The continuous analyzers are zeroed and spanned before each test with appropriate 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.

At the conclusion of each unit test program, a five-point calibration check is made. This calibration check must meet accuracy requirements of the applicable standards. Consistent deviations between analyzer readings and calibration gas concentrations are used to correct data before computer processing. Data is also corrected for interferences as prescribed by the instrument manufacturer's instructions.

VI.B. TEST METHOD PROCEDURES

VI.B.(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, not just the dry gas meters. Pre-test and post-test leak checks are conducted with a vacuum of 10 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 was typically less than 2 inches of mercury. Thus, leakage rates reported are expected to be much higher than actual leakage during the tests.

VI.B.(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.

VI.B.(3). PM SAMPLING PROPORTIONALITY (ASTM E2515-11)

Proportionality was calculated in accordance with ASTM E2515-11. The data and results are included in Appendix C.

VII RESULTS AND OBSERVATIONS

The AC Component Specialist, Inc. Model 620-10 has been found to be in compliance with the applicable performance requirements of the following criteria:

"**CSA B415.1-2011 – Performance Testing of Solid-Fuel-Burning Heating Appliances**".

This standard requires that the weighted emissions rate for indoor wood fired furnaces not exceed 0.40 g/MJ.

The average emission rate for the model 620-10 is 0.197 g/MJ (0.458 lbs/MMBtu Output).

Model 620-9 is a similar model to the model 620-10.
The 620-10 differs from the 620-9 in the following aspects:

1) The heat shield above the burn pot in the 620-10 is a welded stainless steel deflector as described in "620-10 DRAWINGS 7" as opposed to a flat plate in the 620-9.
2) The vent pipe in the cold air return cavity of the 620-10 contains cooling fins as described in "620-10 DRAWINGS 3" where there are none in the 620-9.
3) The sides of the 620-10 heat exchanger have more fins than the 620-9 as described in "620-10 DRAWINGS 4" and "620-10 DRAWINGS 6".

INTERTEK TESTING SERVICES NA

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