TEST REPORT

REPORT NUMBER: 101992844MID-001a
REPORT DATE: April 29, 2015
REVISED REPORT DATE: June 16, 2015

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

RENDERED TO
American Energy Systems, Inc.
150 Michigan Street, S.E.
Hutchinson, MN 55350

PRODUCT EVALUATED:

MODEL 3500P PELLET FUEL ROOM HEATER

Report of Testing Model 3500P Pellet Fuel Room Heater for compliance as an "Affected Wood Heater" with the applicable requirements of the following criteria: EPA 40 CFR Part 60 "Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces", March 16, 2015.

Contents

REVISION SUMMARY

DATE	SUMMARY
June 16, 2015	Added Table 6 for CSA B415.1 results.

I. INTRODUCTION

Intertek Testing Services NA (Intertek) has conducted testing for American Energy Systems, Inc., on model 3500P Pellet Burning Room Heater to evaluate all applicable performance requirements included in “Determination of particulate matter emissions from wood heaters.”

I.A PURPOSE OF TEST

The test was conducted to determine if the unit is in accordance with U.S EPA requirements under EPA 40 CFR Part 60 “Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces”. This evaluation was conducted on April 20, 2015. The following test methods were applicable:

ASTM E2515-11- Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel

ASTM E2779-10 - Standard Test Method for Determining Particulate Matter Emissions from Pellet Heaters

CSA B415.1-10 - Performance Testing of Solid-Fuel-Burning Heating Appliances

I.B LABORATORY

The tests on the model 3500P Pellet Burning Heater were conducted at the Intertek testing Services Laboratory located at 8431 Murphy Drive, Middleton, WI, 53562. The laboratory is accredited by the U.S. EPA, Certificate Number 3. The test was conducted by Ken Slater and observed by Mike Haefner of American Energy Systems, Inc.

I.C DESCRIPTION OF UNIT

The model 3500P Pellet Fuel Room Heater is constructed of sheet steel. The outer dimensions are 31-inches deep, 32.5-inches high, and 28-inches wide. The unit has a door located on the front with a viewing glass.

(See product drawings.)

Proprietary drawings and manufacturing methods are on file at Intertek in (Intertek location)

I.D REPORT ORGANIZATION

This report includes summaries of all data necessary to determine compliance with the regulations. Raw data, calibration records, intermediate calculations, drawings, specifications and other supporting information are contained in appendices to this report.

II. SUMMARY

II.A PRETEST INFORMATION

A sample was submitted to Intertek directly from the client. The sample was not independently selected for testing. The test unit was received at Intertek in Middleton, WI on April 10, 2015 and was shipped via the client. 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. Prior to beginning the emissions tests, the manufacturer operated the unit for a minimum of 50 hours at high-to-medium burn rates to break in the stove. This break-in period was witnessed by the American Energy Systems' staff and a signed document is included in the final report. The unit was found to be operating satisfactory during this break-in. The 50 plus hours of pre-burning were conducted from March 2, 2015 to March 4, 2015. The fuel used for the break-in process was wood pellets.

Following the pre-burn break-in process the unit was allowed to cool and ash and residue was removed from the firebox. The unit's chimney system and laboratory dilution tunnels were cleaned using standard wire brush chimney cleaning equipment. On April 17, 2015 the unit was set-up for testing.

II.B INFORMATION LOG

II.B(1) TEST STANDARD

On April 20, 2014, the unit was tested for EPA emissions. For pellet stoves, the test was conducted in accordance with ASTM E2779-10. The fuel used for the test run was premium-Grade Pellets (Marthwood).

The applicable EPA regulatory limits are:

Step 1 – 2015 – 4.5 grams per hour.

Step 2 – 2020 – 2.0 grams per hour.

II.B(2) Deviation from Standard Method

No deviations from the standards were performed, however, only the applicable sections from each standard were used during all testing.

II.C SUMMARY OF TEST RESULTS

The appliance tests resulted in the following performance:

Particulate Emissions: 1.007 g/hr

Carbon Monoxide Emissions: 13.53 g/hr

Heating Efficiency: 66.54% (Higher Heating Value Basis)

II.D DESCRIPTION OF TEST RUNS

RUN #1 (April 20, 2015): The test for pellet heaters is a continuous test with three separate burn rates. At 8:02 the unit was started and operated for a minimum of 1 hour for the pretest operation. At 9:52 the unit was set to the maximum feed rate (level 5) with a burn rate of 1.67 kg/hr and the inlet air shutter was set to 1 7/8-in to base of knob, the scale was tared and a 25-lb weight was added to the scale to determine feed rate of the fuel, and the sampling system was started. At 10:52, the system #2 sampling filter was changed out and the unit was set to ≤50% feed rate (level 2) with a burn rate of 0.75 kg/hr and the air shutter was maintained at 1 7/8-in to base of knob. At 12:52, the heater was changed to the minimum feed rate (level 1) with a burn rate of 0.47 kg/hr and the air shutter was maintained at 1 7/8-in to base of knob. At 15:52, testing was completed. The total burn time was 360 minutes.

II.D SUMMARY OF OTHER DATA

TABLE 1. - EMISSIONS

Run Number	Test Date	Burn Rates (kg/hr)(Dry)		Particulate Emission Rate (g/hr)	**1st Hour Emissions (g)**	CO Emissions (g/hr)	Heating Efficiency (% HHV)
1	**4/20/15**	**H***	**1.59**	**1.007**	**0.89**	**13.53**	**66.5**
		M*	**0.67**				
		L*	**0.42**				
		OA*	**0.73**				

*Notes: H= High burn rate, M= Medium burn rate, L= low burn rate, OA= overall burn rate.

TABLE 2. - TEST FACILITY CONDITIONS

Run	Room Temp. °F before	Room Temp °F after	Baro. Pres. In. Hg before	Baro. Pres. In. Hg after	R.H.% before	R.H.% after	Air Vel. Ft/min before	Air Vel. Ft/min after
1	**72**	**72**	**28.28**	**28.44**	**33.4**	**26.9**	**0**	**0**

TABLE 3. - DILUTION TUNNEL FLOW RATE MEASUREMENTS AND SAMPLING DATA

Run No.	Burn Time (min)	Velocity (ft/sec)	Volumetric Flow Rate (dscf/min)	Ave. Temp. (^oR)	Sample Volume (DSCF)		Particulate Catch (mg)	
					1	2	1	2
1	**360**	**18.24**	**193.42**	**544.46**	**80.33**	**79.86**	**6.30**	**7.60**

TABLE 4. - DILUTION TUNNEL DUAL TRAIN PRECISION

Run No.	Sample Ratios		Total Emissions (g)		% Deviation	g/kg Deviation
	Train 1	Train 2	Train 1	Train 2		
1	**866.78**	**871.95**	**5.46**	**6.63**	**9.65%**	**0.254**

TABLE 5. - GENERAL SUMMARY OF RESULTS

Run No.	Burn Rate (kg/hr)(Dry) (Overall)	Initial Draft (in/H_2O)	Run Time (min)	Average Draft (in/H_2O)
1	**0.73**	**0.027**	**360**	**0.024**

TABLE 6. – CSA B415.1 RESULTS

Burn Rate (kg/hr)(Dry)	CO Emissions (g/hr)	Heating Efficiency (% HHV)	Heat Output (Btu/hr)
High – 1.59	**15.64**	**68.7**	**20,607**
Medium – 0.67	**11.47**	**62.8**	**7,901**
Low – 0.42	**13.66**	**62.2**	**4,917**
Overall – 0.73	**13.53**	**66.5**	**9,110**

III. PROCESS DESCRIPTION

III.A TEST SET-UP DESCRIPTON

A 3” horizontal flue is connected by a 90° elbow and adapters to a standard 6” diameter vertical single wall pipe and insulated chimney system was installed to 15’ above floor level. The singe wall pipe extended to 8 feet above the floor and insulated chimney extended the remaining height.

III.B AIR SUPPLY SYSTEM

Combustion air enters a 2” inlet pipe located on the back of the heater, which is directed to the pellet burn pot. All gases exit through the 3” flue also located at the back of the heater. The exhaust gases are assisted by a combustion blower.

III.C TEST FUEL PROPERTIES

Wood pellets used for the testing were manufactured by Marthwood. The pellets have a measured heating value of 8528 Btu/hr (19836 kJ/kg) and a moisture content of 5.10% on a dry basis and 4.90% on a wet basis.

IV. SAMPLING SYSTEMS

IV.A. SAMPLING LOCATIONS

Particulate samples are collected from the dilution tunnel at a point 20 feet from the tunnel entrance. The tunnel has two elbows and two mixing baffles in the system ahead of the sampling section. (See Figure 3.) The sampling section is a continuous 13 foot section of 6 inch diameter pipe straight over its entire length. Tunnel velocity pressure is determined by a standard Pitot tube located 60 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 60 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

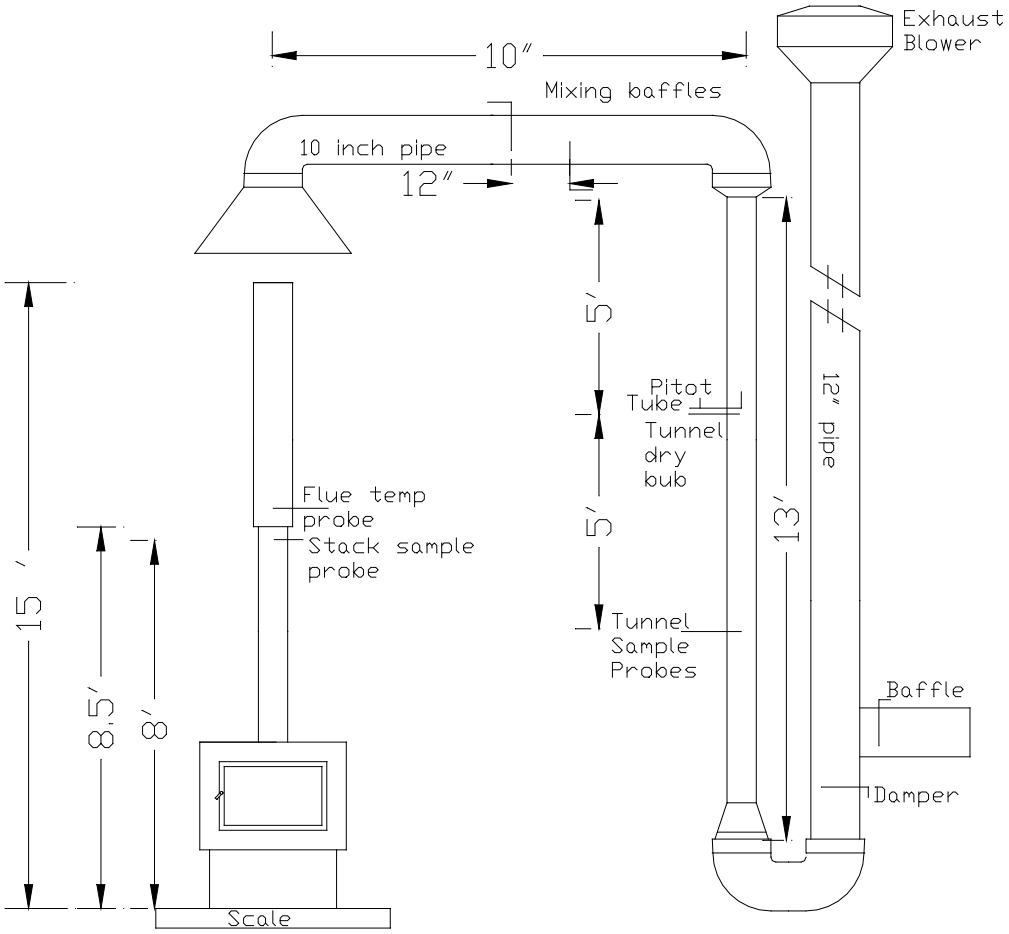
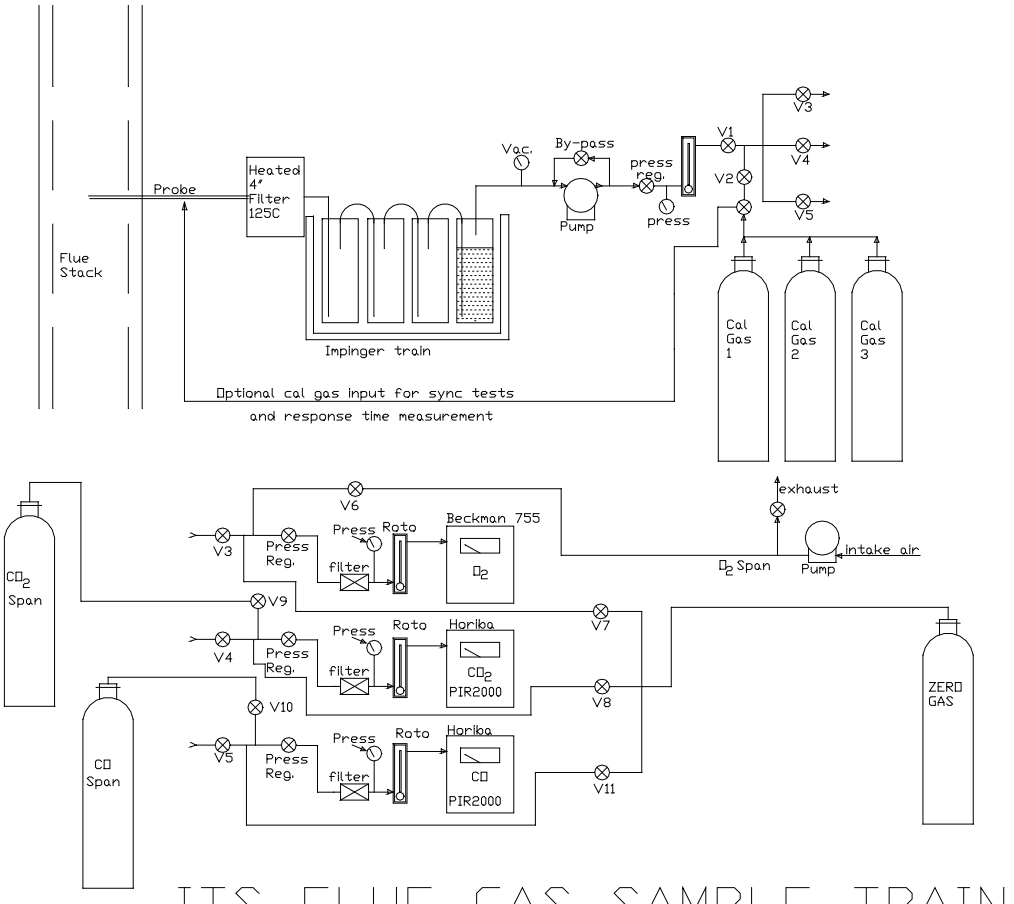


FIGURE 1

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

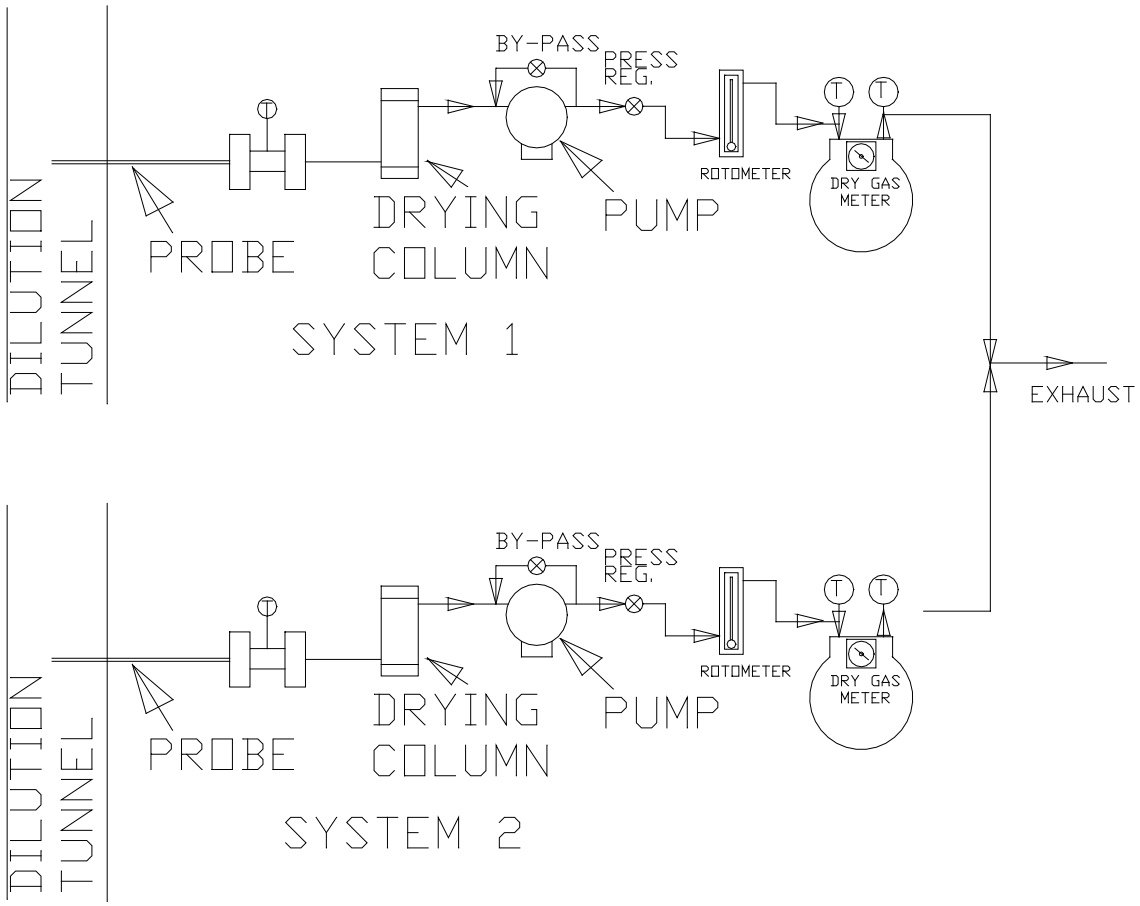


Figure 3

V. SAMPLING METHODS

V.A. PARTICULATE SAMPLING

Particulates were sampled in strict accordance with ASTM E2515-2011. 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. In order to measure first-hour emissions rates the a third filter set is prepared at one hour into the test run, the filter sets are changed in one of the two sample trains. The two filter sets used for this train are analyzed individually to determine the first hour and total emissions rate.

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 ROTAMETER

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 three-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

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

VII. CONCLUSION

This test demonstrates that this unit is an affected facility under the definition given in the regulation. The emission rate of 1.007 g/hr meets the EPA requirements for the Step 2 limits.

Model 3500P is a representative for similar models 3500L and 3502 fireplace insert. All models have the same internal design, electrical components, and controls. The only differences are external cosmetic designs.

INTERTEK TESTING SERVICES NA

Evaluated by: Ken Slater

Ken Slater
Associate Engineer - Hearth

Reviewed by:

Brian Ziegler
Lead Engineer - Hearth