Designation: E2515 – 11

Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel[1]

This standard is issued under the fixed designation E2515; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is applicable for the determination of particulate matter emissions from solid-fuel-burning appliances including woodstoves, pellet-burning appliances, factory-built fireplaces, masonry fireplaces, masonry heaters, indoor furnaces, and indoor and outdoor hydronic heaters within a laboratory environment.

1.2 Analytes will be a particulate matter (PM) with no CAS number assigned. For data quality objectives, see Appendix X1.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.4 *This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2986 Practice for Evaluation of Air Assay Media by the Monodisperse DOP (Dioctyl Phthalate) Smoke Test (Withdrawn 2004)[3]

E2558 Test Method for Determining Particulate Matter Emissions from Fires in Wood-Burning Fireplaces

E2618 Test Method for Measurement of Particulate Emissions and Heating Efficiency of Solid Fuel-Fired Hydronic Heating Appliances

E2779 Test Method for Determining Particulate Matter Emissions from Pellet Heaters

E2780 Test Method for Determining Particulate Matter Emissions from Wood Heaters

E2817 Test Method for Test Fueling Masonry Heaters

2.2 *AISI Documents:*[4]

AISI 316 Stainless Steel

2.3 *NIST Documents:*[5]

NIST Monograph 175 Standard Limits of Error

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *laboratory environment*—the area or room that is used for the storage, weighing, assembly, disassembly, and desiccation of filters and related equipment (sample recovery and analysis).

3.1.2 *particulate matter (PM)*—all gas-borne matter resulting from combustion of solid fuel, as specified in the appliance operation test method, that is collected and retained by the specified filter and probe system under the conditions of the test.

3.1.3 *test facility*—the area in which the tested appliance is installed, operated, and sampled for emissions.

4. Summary of Test Method

4.1 The total flue-gas exhaust from a solid fuel burning appliance is collected along with ambient dilution air with a collection hood. Duplicate sampling trains are used to extract gas samples from the dilution tunnel for determination of particulate matter concentrations. Each sample train has two glass fiber filters in series. The samples are withdrawn at a consistently proportional rate from sampling points located at the centroid of a sampling tunnel. During sampling, the filters are maintained at a temperature less than 32°C (90°F). The mass of the sampled particulate matter is determined gravimetrically after the removal of uncombined water. The total particulate matter mass collected on the filters and in the probe

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.54 on Solid Fuel Burning Appliances.

Current edition approved Nov. 1, 2011. Published December 2011. Originally approved in 2007. Last previous edition approved in 2010 as E2515 – 10. DOI: 10.1520/E2515-11.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American Iron and Steel Institute (AISI), 1140 Connecticut Ave., NW, Suite 705, Washington, DC 20036, http://www.steel.org.

[5] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

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and front filter housing are multiplied by the ratio of the dilution tunnel flow to sample flow to determine the total particulate emissions during a test.

4.2 The sampling system for this test method consists of duplicate dual-filter dry sampling trains. Both of the particulate sampling trains are operated simultaneously at a sample flow rate not to exceed 0.007 m^3/min (0.25 cfm/min). The total particulate results obtained from the two sampling trains are averaged to determine the particulate emissions and are compared as a quality control check on the data validity.

4.3 The particulate concentration results for each sampling train is adjusted by the particulate concentration result from a single room air sample blank collected and processed the same as the dilution tunnel particulate sampling trains described in 4.2, except that only one filter is used in the sampling train. A metering system as described in 6.1.1.4 shall be used to determine the volume of room air collected. The sample flow rate shall not exceed 0.007 m^3/min (0.25 cfm).

4.4 Appliances tested by this test method are to be fueled and operated as specified in appliance-specific test methods such as, but not limited to, Test Methods E2558, E2618, E2779, E2780, or E2817.

5. Safety

5.1 *Disclaimer*—This test method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6. Equipment and Supplies

6.1 *Sample Collection*—The following equipment is required for sample collection:

6.1.1 *Particulate Sampling Train*—Two separate, complete particulate sampling trains (also referred to as "sampling trains") are required for each test run. The filter face velocity shall not exceed 150 mm/sec (30 ft/min) during the test run. The dry gas meter shall be calibrated for the same flow rate range as encountered during the test runs. The sampling train configuration is shown in Fig. 1 and consists of the following components.

6.1.1.1 *Filter Holder Assembly*—The filter holder assembly is shown in Fig. 2 and consists of the following components:

(1) Filter Holders—The primary (front) filter holder shall be aluminum or PTFE.[6] The backup (rear) filter holder may be made of materials such as polycarbonate.[7] With such plastic materials, it is recommended not to use solvents when cleaning the filter holder parts. Mild soap and distilled water can be used for cleaning plastic filter holder parts. The two filter holders shall be placed in series with the backup filter holder located 25 to 100 mm (1 to 4 in.) downstream from the primary filter holder. The filter holders shall be capable of holding a filter with 47 mm diameter. The holder design shall provide a positive seal against leakage from the outside or around the filters. The use of a porous glass or ceramic frit to support the first (front) filter is not allowed. Any type of filter support is allowed for the second (rear) filter.

(2) Probe Assemblies—Probe assemblies shall consist of the following components assembled to provide a leak-tight seal:

(a) Front half of front filter holder as specified in 6.1.1.1(*1*).

[6] The Pall (Gelman) 1235 filter holder has been found suitable for this purpose. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[7] The Pall (Gelman) 1119 filter holder has been found suitable for this purpose. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

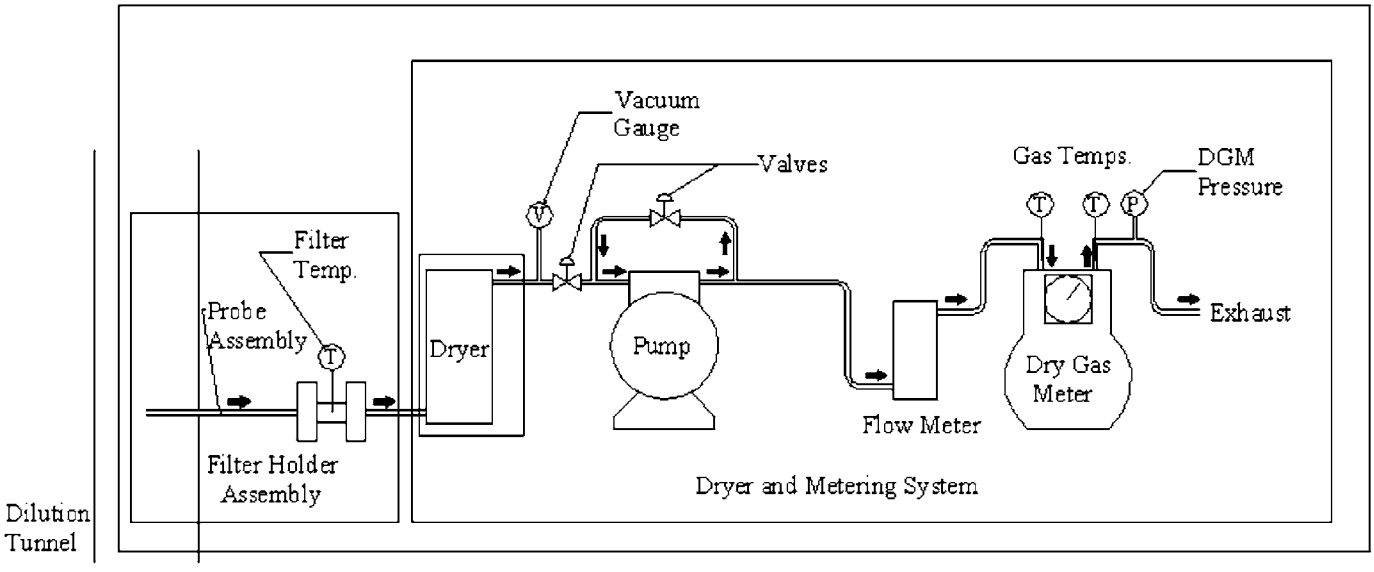

FIG. 1 Particulate Sampling Train

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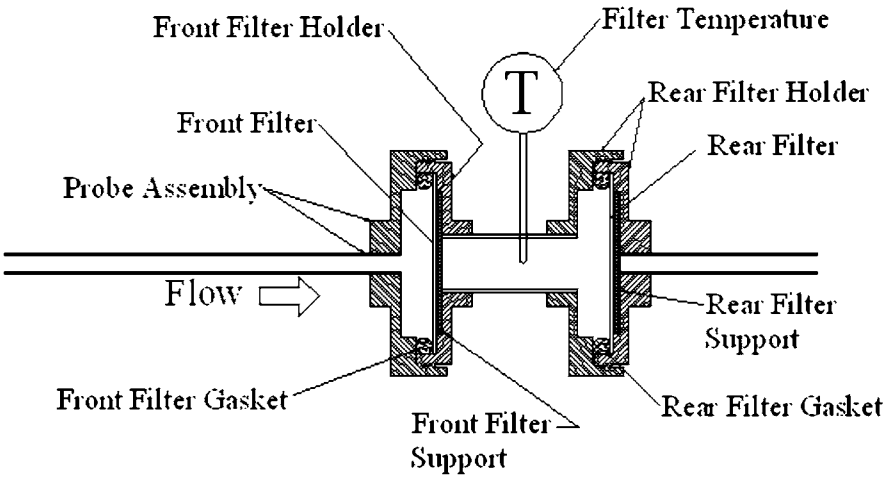

FIG. 2 Filter Holder Assembly

(b) Probe—The probe shall be constructed from seamless stainless steel (that is, AISI 316 or grade more corrosion resistant) 6.35 mm (¼ in.) outside diameter (O.D.) and 0.30 to 0.45 m (12 to 18 in.) in length, with a wall thickness such that the total weight of the probe and front filter housing can be weighed to an accuracy of 0.1 mg.

(3) Filters in accordance with 7.1.1.

(4) Filter Gaskets.

6.1.1.2 *Filter Temperature Monitoring System*—A temperature sensor capable of measuring with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, which ever is greater and meeting the calibration requirements specified in 8.2. The sensor shall be installed at the exit side of the front filter holder so that the sensing tip of the temperature sensor is in direct contact with the sample gas as shown in Fig. 2.

6.1.1.3 *Dryer*—Any system capable of removing water from the sample gas to less than 1.5 % moisture (volume percent) prior to the metering system. The system shall include a temperature sensor for demonstrating that sample gas temperature exiting the dryer is less than 27°C (80°F). See Fig. 1 for location of the dryer.

6.1.1.4 *Metering System*—The metering system shall include a vacuum gauge, leak-free pump, temperature sensors capable of measuring with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, which ever is greater and meeting the calibration requirements specified in 8.2, gas metering system capable of measuring the total volume sampled to within ± 2 % of the measured value, and related equipment, as shown in Fig. 1.

6.1.2 *Barometer*—Mercury, aneroid, or other barometer capable of measuring atmospheric pressure with an accuracy of ±2.5 mm Hg (0.1 in.). Must meet calibration requirements specified in 8.3.

NOTE 1—The barometric pressure reading may be obtained from a nearby National Weather Service station. In this case, the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be made at a rate of minus 2.5 mm Hg (0.1 in.) per 30 m (100 ft) elevation increase or plus 2.5 mm Hg (0.1 in) per 30 m (100 ft) elevation decrease.

6.1.3 *Dilution Tunnel Gas Temperature Measurement*—A temperature sensor capable of measuring with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, which ever is greater and meeting the calibration requirements specified in 8.2.

6.1.4 *Pitot Tube*—A standard Pitot tube designed according to the criteria given in 6.1.4.1 shall be used to measure flow in the dilution tunnel. Pitot tubes will have an assumed Pitot coefficient of 0.99 and be designed according to these specifications:

6.1.4.1 Standard Pitot design (see Appendix X2 for an example);

6.1.4.2 Hemispherical, ellipsoidal, or conical tip;

6.1.4.3 A minimum of six diameters straight run (based upon D, the external diameter of the tube) between the tip and the static pressure holes;

6.1.4.4 A minimum of eight diameters straight run between the static pressure holes and the centerline of the external tube, following the 90° bend;

6.1.4.5 Static pressure holes of equal size (approximately 0.1 D), equally spaced in a piezometer ring configuration; and

6.1.4.6 90° bend, with curved or mitered junction.

6.1.5 *Differential Pressure Gauge*—An inclined manometer or equivalent shall be readable to the nearest 0.127 mm (0.005 in.) water for Δp values greater than 2.54 mm (0.10 in.) water, and to the nearest 0.025 mm (0.001 in.) water for Δp values less than 2.54 mm (0.10 in.) water.

6.1.6 *Dilution Tunnel*—The dilution tunnel apparatus is shown in Fig. 3 and Fig. 4 and consists of the following components:

6.1.6.1 *Hood*—Constructed of steel. Hood shall be large enough to capture all of the flue-gas flow exiting the top of the appliance chimney. The dilution tunnel hood shall be conical with a minimum diameter at the entrance of at least four times the tunnel diameter. The height of the conical section shall be at least three tunnel diameters. A skirt can be used around the inlet to the conical section to insure capture of the flue-gas exhaust as shown in 9.2.4 as long as the requirements of 9.2.3

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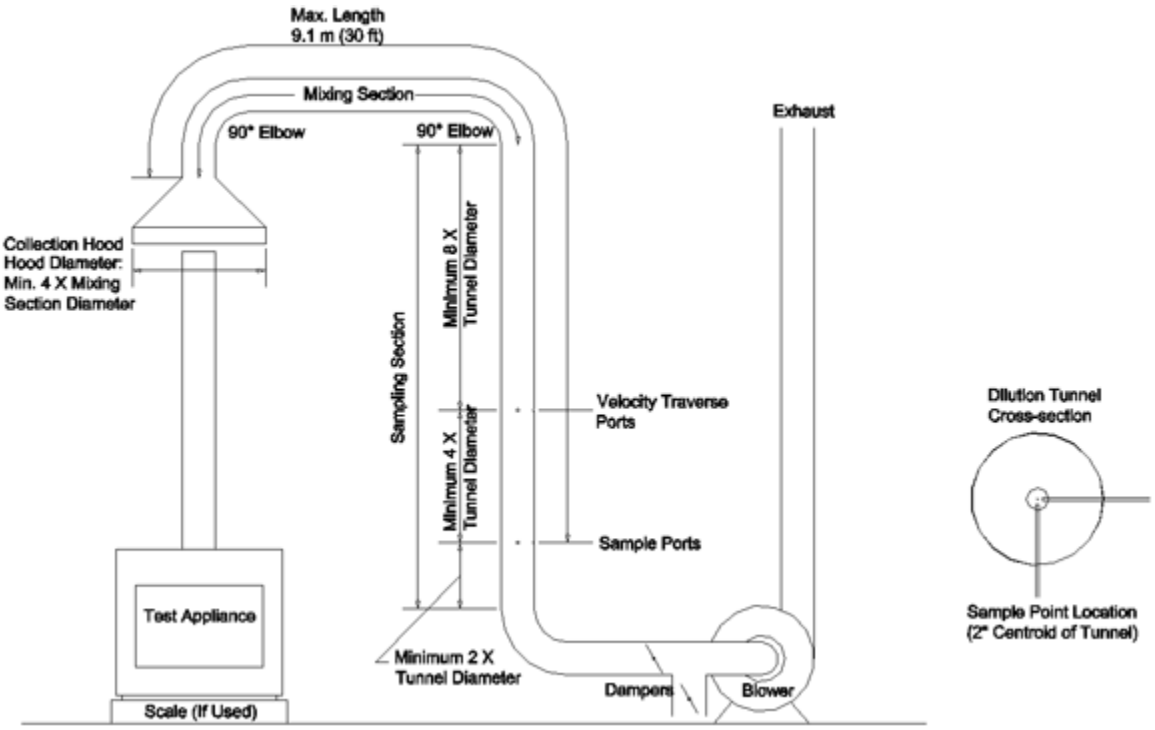

FIG. 3 Steel-Constructed Dilution Tunnel Apparatus

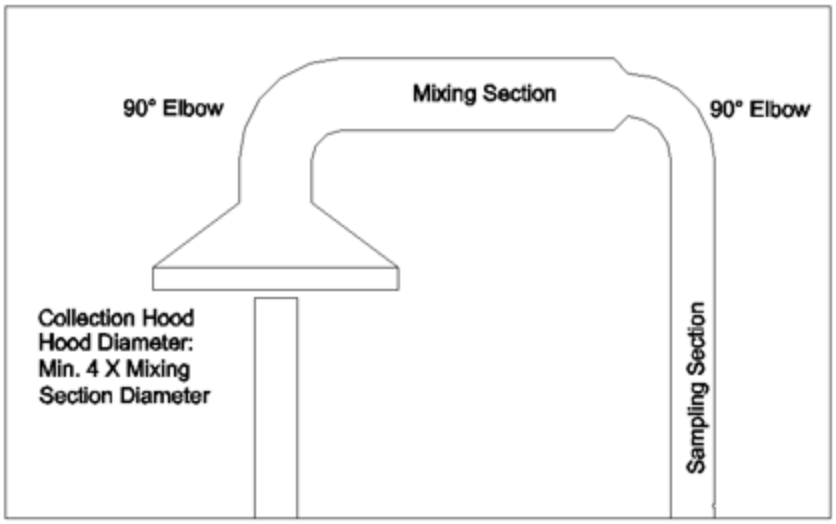

FIG. 4 Mixing Section and Sampling Section with Different Diameters

are met. The outlet of the conical section shall be sized to mate with the mixing section of the dilution tunnel. (See Fig. 3 and Fig. 4.)

6.1.6.2 *90° Elbows*—Steel 90° elbows should be used for connecting mixing section, the sampling section, and the optional damper assembly. There shall be at least two 90° elbows upstream of the sampling section. (See Fig. 3 and Fig. 4.) The last elbow before the sampling section begins shall be of the same diameter as the sampling section straight ducting.

6.1.6.3 *Straight Duct*—Straight sections of steel ducting shall be used to construct both the mixing section and sampling section of the dilution tunnel apparatus. The mixing section is considered to be the ducting that is upstream of the last elbow before the sampling section begins. The mixing section and sampling section may be different diameters, but the sampling section shall have a consistent diameter over the its full length. (See Fig. 4.) Two velocity traverse ports shall be located at least eight tunnel diameters downstream of the last flow disturbance (for example, a 90° elbow) and positioned at 90° to each other in the dilution tunnel sampling section. These velocity traverse points shall be of sufficient size to allow entry of the standard Pitot tube but shall not exceed 12.7 mm (0.5 in.) diameter. Two particulate sample extraction ports shall be located at least four tunnel diameters downstream of the velocity traverse ports and at least two tunnel diameters upstream from the next downstream flow disturbance. These

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sample extraction ports shall be of sufficient size to allow entry of the sampling probes. The total length of duct from the center of the outlet of the hood to the sampling ports shall not exceed 9.1 m (30 ft). (See Fig. 3.)

6.1.6.4 *Blower*—Squirrel cage or other type of fan capable of gathering and moving all flue-gases and entrained dilution air from the dilution tunnel extraction hood to the dilution tunnel exhaust having sufficient flow to maintain dilution rate specifications in Section 9. (See 9.2.)

6.1.7 *Test Facility Temperature Monitor*—A thermocouple capable of measuring with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, which ever is greater, located centrally in a vertically oriented 150 mm (6 in.) long, 50 mm (2 in.) diameter pipe shield that is open at both ends. Must meet the calibration requirements specified in 8.2.

6.1.8 *Anemometer*—Device capable of detecting air velocities less than 0.10 m/sec (20 ft/min) and used for measuring air velocities in the test facility near the test appliance.

6.2 *Sample Analysis*—The following items are required for sample analysis:

6.2.1 *Desiccator*—Any airtight cabinet or other container containing desiccant to remove moisture from the probes, front filter housings, filters, and filter gaskets prior to and after testing;

6.2.2 *Analytical Balance*—With a resolution 0.1 mg or better. Must meet the calibration requirements specified in 8.4;

6.2.3 *Hygrometer or Sling Psychrometer*—To measure the relative humidity of the laboratory environment with a resolution of 2 % RH or better; and

6.2.4 *Temperature Sensor*—To measure the temperature of the laboratory environment with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, which ever is greater. and meeting the calibration requirements specified in 8.2.

7. Reagents and Standards

7.1 *Sample Collection*—The following reagents are required for sample collection:

7.1.1 *Filters*—Glass fiber filters with a diameter of 47 mm without organic binder, exhibiting at least 99.95 % efficiency (<0.05 % penetration) on 0.3-micron dioctyl phthalate smoke particles in accordance with Practice D2986. Manufacturer's quality control test data are sufficient for validation of efficiency.[8]

7.2 *Sample Analysis*—One reagent is required for the sample analysis:

7.2.1 *Desiccant*—Desiccant shall be capable of drying air to a moisture content of 0.005 g/L or less. Calcium sulfate ($CaSO_4$) and molecular sieve desiccants are suitable.

7.3 *Probe Assembly Cleaning*—Acetone is used to clean and remove moisture from the probe assembly before pretest desiccation and to remove particulate material that has accumulated on the outside of the probe during the test run prior to post-test desiccation.

8. Calibration and Standardization

NOTE 2—Maintain a laboratory record of all calibrations.

8.1 *Volume Metering System:*

8.1.1 Sampling system volume metering equipment shall be calibrated before initial use and at least semi-annually thereafter. Calibration shall be traceable to NIST and demonstrate a maximum uncertainty of ±1.0 % of measured volume at the operating conditions (flow rate and total volume) used in the test.

8.2 *Temperature Sensors*—Temperature measuring equipment shall be calibrated before initial use and at least semiannually thereafter. Calibrations shall be in compliance with NIST Monograph 175.

8.3 *Barometer*—Calibrate against a mercury barometer before the first certification test and at least semi-annually, thereafter. If a mercury barometer is used, no calibration is necessary. Follow the manufacturer's instructions for operation. Barometers shall have an uncertainty of ±1.27 mm (0.05 in.) of mercury or better.

8.4 *Analytical Balance*—Perform a multipoint NIST traceable calibration (at least five points spanning the operational range) of the analytical balance before the first test and semiannually, thereafter. Before each test, audit the balance by weighing at least one calibration weight that corresponds to 50 to 150 % of the weight of one filter. If the scale cannot reproduce the value of the calibration weight to within 0.1 mg, conduct the multipoint calibration before use.

9. Procedures

9.1 *Dilution Tunnel Assembly and Cleaning*—A schematic of a dilution tunnel is shown in Fig. 3. The dilution tunnel requirements and other features are described in 6.1.6. Assemble the dilution tunnel, sealing joints, and seams to prevent air leakage. Clean the dilution tunnel with an appropriately sized wire chimney brush before each test run.

9.2 *Dilution Tunnel:*

9.2.1 *Size*—The dilution tunnel diameter shall be sized such that the flow velocity as measured as shown in 9.3 and as established in 9.2.2 shall result in a minimum of 4.1 m/sec (800 ft/min) when the velocity pressure is measured to an accuracy of ±0.025 mm (0.001 in.) water or a minimum of 7.6 m/sec (1500 ft/min) when the velocity pressure is measured to an accuracy of ±0.127 mm (0.005 in.) water.

9.2.2 *Flow Rate*—The dilution tunnel flow rate shall be selected to provide sufficient flow to collect and fully entrain all flue products during the test and provide sufficient velocity for accurate flow measurement. For closed combustion appliances tunnel flow rates in the range of 0.07 to 0.24 scm/sec (150 to 500 SCFM) have been found to be acceptable. For open combustion appliances, such as fireplaces, tunnel flow rates in the range of 0.24 to 0.71 scm/sec (500 to 1500 SCFM) have been found to be acceptable. The maximum tunnel flow rate shall not exceed five times the minimum flow rate determined as shown in 9.2.4.

[8] Gelman A/E 61631 and Whatman 1841-047 fllters have been found acceptable for this purpose. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

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NOTE 3—Optimum accuracy is achieved when the dilution tunnel flow rate is set so that the ratio of sample flow to tunnel flow is maximized.

9.2.3 *Induced Draft Determination*—Prepare the test appliance in accordance with appropriate test method. Locate the dilution tunnel collection hood over the appliance chimney exhaust. Operate the dilution tunnel blower at the flow rate to be used during the test run. Measure the static pressure imposed on the appliance by the dilution tunnel (that is, the difference in static pressure measured with and without the dilution tunnel operating) at a location no greater than 0.3 m (1 ft) above the flue connector. Adjust the distance between the top of the test appliance chimney and the dilution tunnel hood so that the dilution tunnel induced static pressure is less than 1.25 Pa (0.005 in. water). Have no fire in the appliance, open and close any doors, and open fully the flue damper if applicable during this check and adjustment.

9.2.4 *Smoke Capture*—Prior to any test run, burn the appliance at a high burn rate using a kindling fuel load and specified test load, operate the dilution tunnel, and visually monitor the appliance chimney exhaust. Determine the minimum dilution tunnel flow rate needed to insure that 100 % of the chimney effluent is collected by the dilution tunnel collection hood. If the appliance has doors, operate the appliance with the doors in all positions specified in the appliance owner's manual. It may be necessary to artificially inject smoke (using smoke pellets or smoke generator) into the area around dilution tunnel collection hood to provide a better visual check that no exhaust gases are escaping. If less than 100 % of the chimney effluent is collected, adjust the distance between the test appliance chimney outlet and the dilution tunnel hood or increase the dilution tunnel flow rate just to the point where no visible effluent is escaping, or both. With the Pitot tube located at the center of the dilution tunnel, record this dilution tunnel velocity head (D_p), temperature and static pressure.

9.3 *Velocity Measurements*—Prior to ignition, conduct a velocity traverse in the dilution tunnel to determine the Pitot Factor (F_p). The Pitot tube shall be placed at the center of the tunnel during the test run.

9.3.1 *Velocity Traverse*—Measure the diameter of the dilution tunnel at the velocity traverse port location through both ports. Calculate the dilution tunnel area using the average of the two diameters. Place the standard Pitot tube at the center of the dilution tunnel in either of the velocity traverse ports. Seal any gap between the velocity traverse port in the dilution tunnel and the Pitot tube and seal the unused velocity traverse port to prevent any air leakage into the dilution tunnel. Adjust the damper or similar device on the blower inlet until the velocity indicated by the Pitot tube indicates that a dilution tunnel flow rate within the allowable range as shown in 9.2 has been achieved. Continue to read the velocity head (D_p) and temperature until the velocity has remained constant (less than 5 % change) for 1 min. Once a constant velocity is obtained at the center of the dilution tunnel, perform a velocity traverse as specified in 9.3.2. Seal any gap between the velocity traverse port in the dilution tunnel and the Pitot tube and seal the unused velocity traverse port to prevent any air leakage into the dilution tunnel.

9.3.1.1 Ensure that the proper differential pressure gauge is being used for the range of Δp values encountered (see Section 6.1.5). If it is necessary to change to a more sensitive gauge, do so, and re-measure the Δp and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in 9.6.5, to validate the traverse. Measure the Δp and tunnel temperature at each traverse point and record the readings.

9.3.1.2 Calculate the total gas flow rate using calculations contained in Section 11, using the velocity traverse points in accordance with 9.3.2, excluding the center readings. Verify that the flow rate is equal to the target flow; if not, readjust the damper, and repeat the velocity traverse.

9.3.2 *Velocity Traverse Measurements*—Measure and record the velocity head and temperature at the traverse points specified as follows:

9.3.2.1 For dilution tunnel diameters equal to or greater than 0.3 m (12 in.) locate the traverse points on two perpendicular diameters according to the table in and the example shown in Fig. 5. For dilution tunnel diameters less than 0.3 m (12 in.) locate the traverse points on two perpendicular diameters according to the table and example shown in Fig. 6.

9.3.2.2 For dilution tunnel diameters equal to or less than 0.61 m (24 in.), no traverse points shall be located within 1.3 cm (0.50 in.) of the tunnel walls.

9.4 *Pretest Preparation*—The sampling equipment should be maintained according to good laboratory practices and manufacturer's instructions where applicable.

9.4.1 Check filters visually against light for irregularities, flaws, or pinhole leaks. Label the filters on the back side near the edge using numbering machine ink.

9.4.2 Rinse the probe assemblies with acetone to clean and remove moisture before desiccating.

9.4.3 Mark the probe assemblies in such a way that each can be identified during use.

9.4.4 Desiccate the filters, filter gaskets, and the probe assemblies at 20 ± 5.6°C (68 ± 10°F) and ambient pressure for at least 24 h. Weigh each component at intervals of not less than 6 h until a constant weight is achieved. Record results to the nearest 0.1 mg. During each weighing, the period for which the components are exposed to the laboratory environment shall be less than 2 min. The filter gaskets can be weighed in sets to be used in each filter holder and kept in an identified container at all times except during sampling and weighing. The filter holder assembly after the front filter need not be desiccated or weighed.

NOTE 4—For the purposes of this section, the term constant weight means a difference of no more than 0.2 mg between two consecutive weighings, with not less than 6 h of desiccation time between weighings.

9.5 *Preparation of the Filter Holder Assemblies*—During preparation and assembly of the filter holder assemblies, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin.

9.5.1 *Assemble the Filter Holder Assemblies*—Using tweezers or clean disposable surgical gloves, place one labeled and weighed filter in each of the front and back filter holders. Be sure that each filter is properly centered and that the identified filter gasket is properly placed so as to prevent the sample gas

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Taverse Point	% of Diameter
1	4.4
2	14.6
3	29.6
Center	50.0
4	70.4
5	85.4
6	95.6

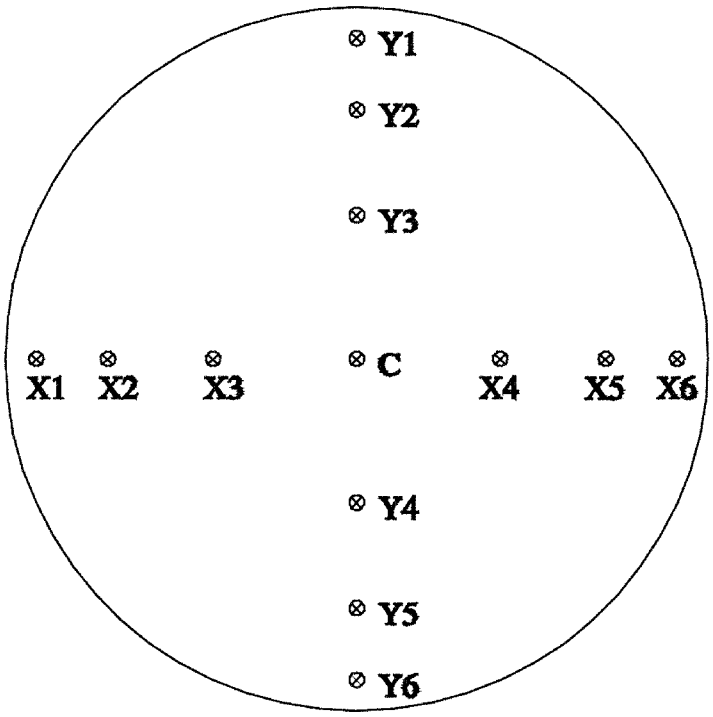

FIG. 5 Dilution Tunnel Diameter Equal To or Greater Than 0.3 m (12 in.) Traverse Point Table

Taverse Point	% of Diameter
1	6.7 *
2	25.0
Center	50.0
3	75.0
4	93.3 *

* No closer than 12.7 mm (0.50 in.) to tunnel wall.

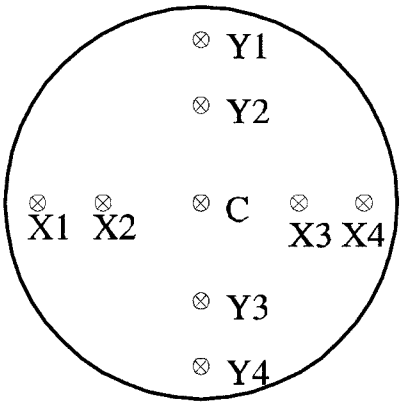

FIG. 6 Dilution Tunnel Diameter Less Than 0.3 m (12 in.) Traverse Point Table

stream from circumventing the filter. Mark the probes by a method that will not affect the tare weight to denote the proper distance for insertion into the tunnel. Set up the filter holder assemblies as shown in Fig. 2 and the sampling trains as shown in Fig. 1.

9.5.2 *Assemble the Room Air Blank Filter Holder Assembly*—Using tweezers or clean disposable surgical gloves, place one labeled and weighed filter in the single filter holder. Be sure that the filter is properly centered and that the identified filter gasket is properly placed so as to prevent the sample gas stream from circumventing the filter. Set up the room air blank filter holder assembly as shown in Fig. 7 and the dryer and metering system as shown in Fig. 1. The inlet to the room air blank filter holder assembly shall be located in the same space within the test facility as the test appliance and shall be within 3.1 m (10 ft) of the dilution tunnel hood entrance.

9.6 *Leak-Check Procedures:*

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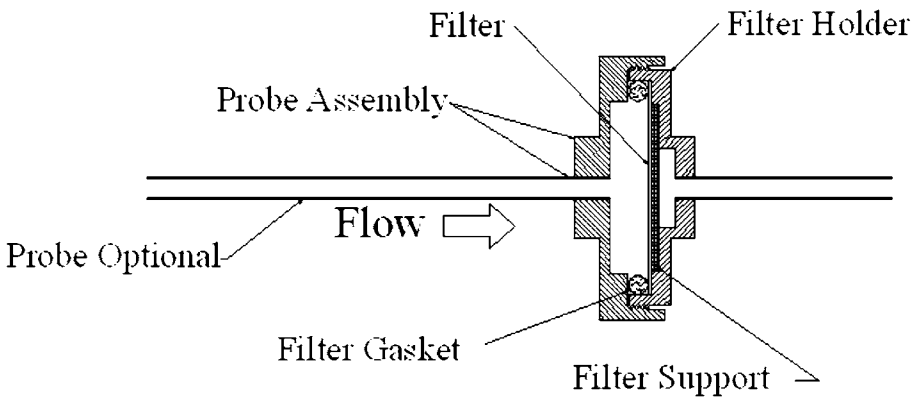

FIG. 7 Room Air Blank Filter Holder Assembly

9.6.1 *Leak-Check of Metering System Shown in* Fig. 1—That portion of the sampling train from the pump to the dry gas meter outlet (or orifice meter, if used) shall be leak-checked prior to initial use and at least semi-annually thereafter. Leakage after the pump will result in less volume being recorded than is actually sampled. The following procedure is suggested (see Fig. 1): Close the main valve before the pump. Attach a rubber tube to the dry gas meter outlet piping, downstream of the dry gas meter pressure gauge. Pressurize the system to 13 to 18 cm (5 to 7 in.) water column by blowing into the rubber tubing. Read the pressure on the dry gas meter pressure gauge. Pinch off the tubing, and observe the pressure gauge for 1 min.

9.6.2 If using an orifice meter, insert a one-hole rubber stopper with rubber tubing attached into the orifice exhaust pipe. Disconnect and vent the low side of the orifice manometer. Close off the low side orifice tap. Pressurize the system to 13 to 18 cm (5 to 7 in.) water column by blowing into the rubber tubing. Read the pressure on the orifice manometer. Pinch off the tubing, and observe the manometer for 1 min.

9.6.3 A loss of pressure on the dry gas meter pressure gauge or orifice manometer indicates a leak in the metering system; leaks, if present, must be corrected.

9.6.4 *Pretest Leak-Check:*

9.6.4.1 *Particulate Sampling Trains*—Pretest leak-checks of the sampling trains are required. Leakage in the sampling train results in less tunnel gas sample passing through the filters than is indicated by the metering system. The procedures outlined below should be used.

(1) After each sampling train has been assembled, plug the probe inlet and check for leaks by pulling a 380 mm (15 in.) Hg vacuum.

(2) Leakage rates in excess of 4 % of the average sampling rate or 0.0003 m^3/min (0.01 cfm), whichever is less, are unacceptable.

NOTE 5—A lower vacuum may be used, provided that it is not exceeded during the test. Start the pump with the bypass valve fully open and the coarse adjust valve completely closed. Partially open the coarse adjust valve, and slowly close the bypass valve until the desired vacuum is reached. If the desired vacuum is exceeded, either leak-check at this higher vacuum, or end the leak check and start over.

NOTE 6—If the leakage rate is above acceptable limit, find and repair the leakage source and leak test again. Repeat until the leakage rate is acceptable. When the leak check is completed, first slowly remove the plug from the inlet to the probe, and immediately turn off the vacuum pump.

9.6.4.2 *Pitot Tube Lines:*

(1) A pretest leak-check of Pitot lines using the following procedure is recommended: (*a*) blow through the Pitot impact opening until at least 7.6 cm (3.0 in.) water velocity head registers on the manometer; then, close off the impact opening. The pressure shall remain stable for at least 15 seconds; (*b*) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3.0 in.) water.

9.6.5 *Post-Test Leak Checks:*

9.6.5.1 *Sampling Train*—A leak check of the sampling train is mandatory at the conclusion of each sampling run before sample recovery. The leak check shall be performed in accordance with the procedures outlined in 9.6.4.1, except that it shall be conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.0003 m_3/min (0.01 cfm) or 4 % of the average sampling rate (whichever is less), the results are acceptable. If, however, a higher leakage rate is obtained, the test shall be considered void unless the total emissions measured by the dual sampling trains agree within the allowable limit as shown in 11.7 and one of the sampling trains is within the specified maximum post-test leakage limit.

9.6.5.2 *Pitot Tube Lines*—A leak test of the Pitot tube lines is mandatory at the conclusion of each sampling run before sample recovery. The leak test shall be conducted in accordance with the procedure outlined in 9.6.4.2. The lines must pass this leak-check in order to validate the velocity head data. The test run is invalid if this leak test is failed.

9.7 *Test Facility*—The test facility shall meet the following requirements during testing:

9.7.1 The test facility temperature shall be maintained between 13 and 32°C (55 and 90°F) during each test run. Locate the test facility temperature monitor on the horizontal plane that includes the primary air intake opening for the test appliance. Locate the temperature monitor 1 to 2 m (3.3 to 6.6 ft) from the front of the test appliance in the 90° sector in front of the test appliance (See Fig. 8.)

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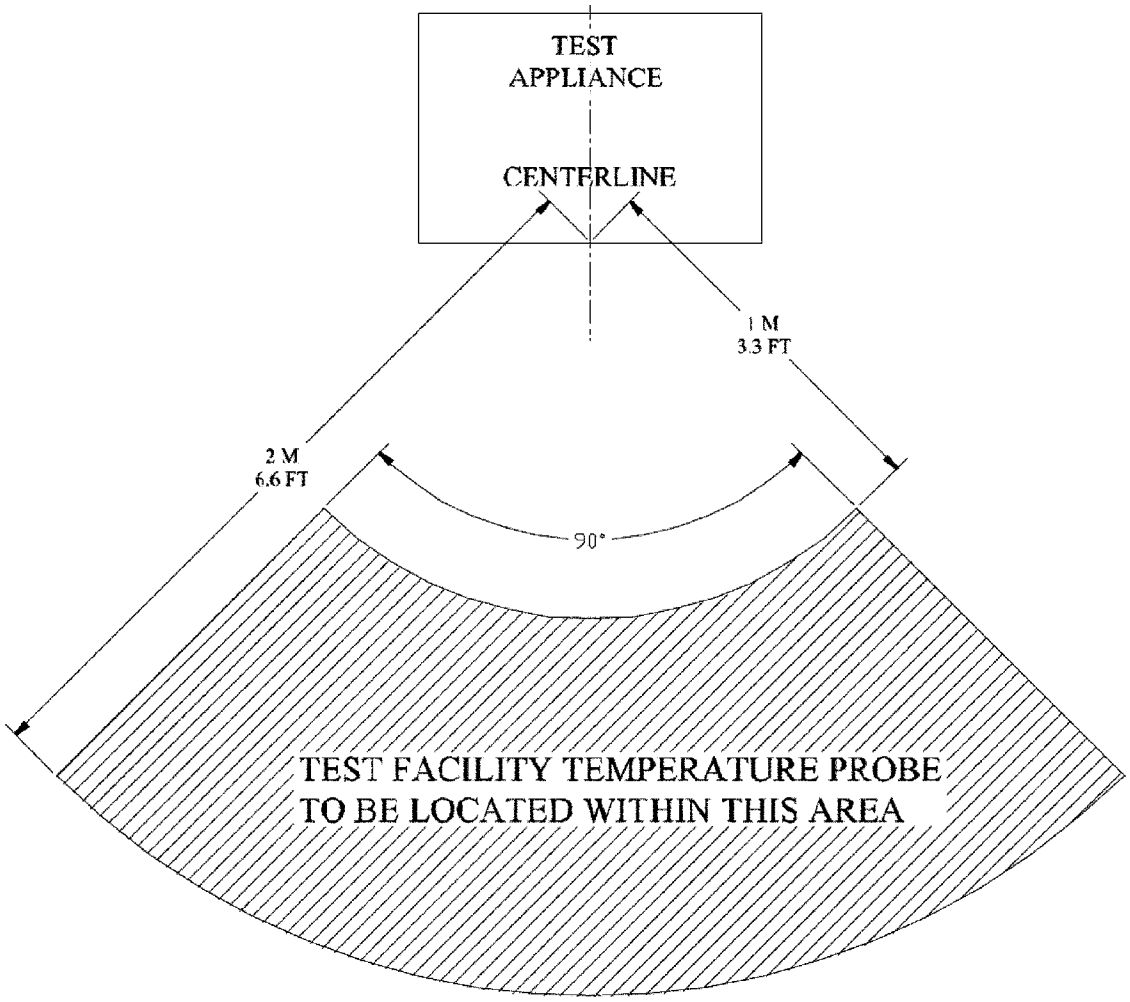

FIG. 8 Test Facility Temperature Monitor

9.7.2 Air velocities within 0.6 m (2 ft) of the test appliance shall be less than 0.25 m/sec (50 ft/min) without fire in the unit. Use an anemometer to measure the air velocity. Measure and record the room air velocity before starting a fire in the test appliance and once immediately following the test run completion.

9.7.3 Measure and record the test facility's ambient relative humidity, barometric pressure, and temperature before and after each test run.

9.8 *Sampling Train Operation*—Locate the probe inlets within the 50 mm (2 in.) diameter centroidal area of the dilution tunnel (see Fig. 3), no closer than 25 mm (1 in.) apart, and block off the openings around the probes to prevent unrepresentative dilution of the gas stream. Be careful not to bump the probes into the stack wall when removing or inserting the probe through the porthole; this minimizes the chance of extracting deposited material.

9.8.1 Begin sampling at the start of the test run as defined in the applicable test method. During the test run, maintain the sample flow rates for both tunnel particulate sampling trains proportional to the dilution tunnel flow rate (within 10 % of the initial proportionality ratio) and a filter holder temperature of no greater than 32°C (90°F). Begin room air sampling (background) at the same time as the tunnel particulate trains and maintain the room air sample flow rate with 20 % of the initial room air sample flow rate.

9.8.2 For each test run, record the required data. Be sure to record the starting dry gas meter readings for both tunnel particulate sampling trains and for the room air sampling train. Refer to Fig. 1 for a graphic description of the sampling trains. Record the dry gas meter readings for both tunnel particulate sampling trains at the beginning and end of each sampling time increment. It is not necessary to record dry gas meter readings for each sampling time increment for the room air sampling train. Recording flow meter readings is acceptable for the room air sampling train. Record the dry gas meter readings for both tunnel particulate sampling trains and the room air sampling train when sampling is halted. Take other needed readings at least once each 10 min during the test run. Since the manometer level and zero may drift because of vibrations and temperature changes, make periodic checks during the test run. Record tunnel gas static pressure at the beginning and end of each test run.

9.8.3 For the purposes of proportional sampling rate determinations, data from calibrated flow rate devices, such as glass rotameters, may be used in lieu of incremental dry gas

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meter readings. Proportional rate calculation procedures must be revised, but acceptability limits remain the same.

9.8.4 During the test run, make periodic adjustments to keep the temperature between the filters at the proper level. The probes may be cooled to help maintain filter temperature. Do not change sampling trains during the test run.

9.8.5 At the end of the test run as defined in the applicable test method, stop tunnel particulate sampling using the following procedure. Turn off both tunnel sampling train coarse adjust valves, remove the probe and filter assemblies from the dilution tunnel, turn off the sampling pumps, record the final dry gas meter readings, and conduct post-test leak-checks, as outlined in 9.6.5. Turn off the room air (background) sampling system at the same time as the tunnel particulate sampling trains. Record the final dry gas meter reading and conduct a post-test leak check as outlined in 9.6.5.

9.9 *Calculation of Proportional Sampling Rate*—Calculate percent proportionality (see Section 11) to determine whether the run was valid or another test run should be made.

9.10 *Sample Recovery*—After post test leak checking, disconnect the filter holder assembly from the dryer and metering system and carefully clean the outside of the probe with acetone, cap the ends of the filter holder assembly, identify (label) it, and transfer to the laboratory sample recovery area. Carefully disassemble the filter holder and remove the filters and the filter gaskets from the filter holders, and place them in identified containers. Use a pair of tweezers or clean disposable surgical gloves, or both, to handle the filters and filter gaskets. Reassemble the empty filter holder assemblies, cap the ends, identify (label), and transfer all the samples to the laboratory weighing area. Disassemble the filter holder assembly and remove the cap from the probe inlet. The probe assembly shall be weighed without sample recovery (use no solvents) in order to determine the sample weight gain. Requirements for filter holder reassembly, capping, and transport of sample containers are not applicable if sample recovery and weighing occur in the same laboratory environment.

10. Analytical Procedure

10.1 *Record the Data Required*—Use the same analytical balance for determining tare weights and final sample weights.

10.2 *Sample Weight Determination:*

10.2.1 Desiccate the filters and filter gaskets at 20 ± 5.6°C (68 ± 10°F) and ambient pressure for at least 24 h. Weigh each component at intervals of at least 6 h until a constant weight is achieved. Report the results to the nearest 0.1 mg. Filters and filter gaskets may be weighed directly without a Petri dish. They may be weighed in pairs (front and back filters and front and back filter gaskets from same filter train) to reduce handling and weighing errors. During each weighing, the components shall not be exposed to the laboratory atmosphere for longer than 2 min. For the room air background sample filter and filter gasket, treat negative particulate catch weights as "zero" when determining total room air particulate weight in accordance with 10.2.

10.2.2 Remove the probe assemblies from the filter holder assemblies and uncap the probe assemblies. Desiccate the probe assemblies at 20 ± 5.6°C (68 ± 10°F) and ambient pressure for at least 24 h. Weigh each probe assembly at intervals of at least 6 h until a constant weight is achieved. Report the results to the nearest 0.1 mg. During each weighing, the components shall not be exposed to the laboratory atmosphere for longer than 2 min. If the probe assemblies have reached constant weight and result in a negative particulate catch weight in the probe assembly:

10.2.2.1 Treat the negative sample probe catch as "zero" when determining total particulate catch weight in accordance with 10.2 if the negative value is equal to or less than 5 % of the total particulate catch (excluding the probe).

10.2.2.2 Treat the test run as invalid if the negative value is greater than 5 % of the total particulate catch weight (excluding the probe).

10.2.2.3 For the room air sample probe assembly, treat negative particulate catch weights as "zero" when determining total room air particulate weight in accordance with 10.2.

NOTE 7—For the purposes of 10.2, the term constant weight means a difference of no more than 0.2 mg or 1 % of total weight less tare weight (particulate catch), whichever is greater, between two consecutive weighings, with intervals of not less than 6 h of desiccation time between weighings.

11. Data Analysis and Calculations

11.1 Carry out calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after the final calculation. Other forms of the equations may be used as long as they give equivalent results.

11.2 *Nomenclature:*

A = Cross-sectional area of tunnel m^2 (ft^2).
B_{ws} = Water vapor in the gas stream, proportion by volume (assumed to be 0.02 (2.0 %)).
C_p = Pitot tube coefficient, dimensionless (assigned a value of 0.99).
c_r = Concentration of particulate matter room air, dry basis, corrected to standard conditions, g/dscm (gr/dscf) (mg/dscf).
c_s = Concentration of particulate matter in tunnel gas, dry basis, corrected to standard conditions, g/dscm (gr/dscf) (mg/dscf).
E_T = Total particulate emissions, g.
F_p = Adjustment factor for center of tunnel pitot tube placement.

$$F_p = \frac{V_{strav}}{V_{scent}} \quad (1)$$

$$K_p = \text{Pitot Tube Constant, } 34.97 \frac{\text{m}}{\text{sec}} \left[\frac{(\text{g/g•mole})(\text{mm Hg})}{(\text{K})\ (\text{mm water})} \right]^{\frac{1}{2}} \quad (2)$$

or

$$K_p = \text{Pitot Tube Constant, } 85.49 \frac{\text{ft}}{\text{sec}} \left[\frac{(\text{lb/lb} - \text{mole})(\text{in. Hg})}{(\text{R})(\text{in. } H_20)} \right]^{\frac{1}{2}}$$

L_a = Maximum acceptable leakage rate for either a pretest or post-test leak- check, equal to 0.0003 m^3/min (0.010 cfm) or 4 % of the average sampling rate, whichever is less.

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L_p = Leakage rate observed during the post-test leak-check, m^3/min (cfm).
m_p = mass of particulate from probe, mg.
m_f = mass of particulate from filters, mg.
m_g = mass of particulate from filter gaskets, mg.
m_r = mass of particulate from the filter, filter gasket, and probe assembly from the room air blank filter holder assembly, mg.
m_n = Total amount of particulate matter collected, mg.
M_s = the dilution tunnel dry gas molecular weight (may be assumed to be 29 g/g mole (lb/lb mole).
P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).
P_g = Static Pressure in the tunnel (in. water).
PR = Percent of proportional sampling rate.
P_s = Absolute average gas static pressure in dilution tunnel, mm Hg (in. Hg).
P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).
Q_{std} = Average gas flow rate in dilution tunnel.

$$Q_{std} = 60\,(1 - B_{ws})\,v_s\,A\left[\frac{T_{std}\,P_s}{T_s\,P_{std}}\right] \tag{3}$$

dscm/min (dscf/min).

T_m = Absolute average dry gas meter temperature, K (R).
T_{mi} = Absolute average dry gas meter temperature during each 10-min interval, i, of the test run.

$$T_{mi} = \frac{\left(T_{mi(b)} + T_{mi(e)}\right)}{2} \tag{4}$$

K (R).

where:

$T_{mi(b)}$ = Absolute dry gas meter temperature at the beginning of each 10-min test interval, i, of the test run, K (R), and
$T_{mi(e)}$ = Absolute dry gas meter temperature at the end of each 10-min test interval, i, of the test run, K (R).

T_s = Absolute average gas temperature in the dilution tunnel, K (R).
T_{si} = Absolute average gas temperature in the dilution tunnel during each 10-min interval, i, of the test run, K (R).

$$T_{si} = \frac{\left(T_{si(b)} + T_{m=si(e)}\right)}{2} \tag{5}$$

K (R).

where:

$T_{si(b)}$ = Absolute gas temperature in the dilution tunnel at the beginning of each 10-min test interval, i, of the test run, K (R), and
$T_{si(e)}$ = Absolute gas temperature in the dilution tunnel at the end of each 10-min test interval, i, of the test run, K (R).

T_{std} = Standard absolute temperature, 293K (528R).
V_m = Volume of gas sample as measured by dry gas meter, dcm (dcf).
V_{mc} = Volume of gas sampled corrected for the post test leak rate, dcm (dcf).
V_{mi} = Volume of gas sample as measured by dry gas meter during each 10-min interval, i, of the test run, dcm.
$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions.

$$V_{m(std)} = K_1\,V_m\,Y\,\frac{P_{bar} + \left(\frac{\Delta H}{13.6}\right)}{T_m} \tag{6}$$

dscm (dscf).

where:

K_1 = 0.3855 K/mm Hg for SI units and = 17.64 R/in. Hg for inch-pound units.

NOTE 8—Eq 6 can be used as written unless the leakage rate observed during the mandatory post test leak check exceeds L_a. If L_p exceeds L_a but the other requirements in accordance with 9.6.5.1 are met, Eq 6 must be modified as follows:

$$V_{m(std)} = K_1\,V_{mc}\,Y\,\frac{P_{bar} + \left(\frac{\Delta\,H}{13.6}\right)}{T_m} \tag{7}$$

where:

V_{mc} = $V_m - (L_p - L_a)\theta$
V_{mr} = Volume of room air sample as measured by dry gas meter, dcm (dcf), and
$V_{mr(std)}$ = Volume of room air sample measured by the dry gas meter, corrected to standard conditions.

$$V_{mr(std)} = K_1\,V_{mr}\,Y\,\frac{P_{bar} + \left(\frac{\Delta H}{13.6}\right)}{T_m} \tag{8}$$

dscm (dscf).

where:

K_1 = 0.3855 K/mm Hg for SI units and = 17.64 R/in. Hg for inch-pound units, and
V_s = Average gas velocity in the dilution tunnel.

$$v_s = F_p K_p\,C_p\,\sqrt{\Delta p_{avg}}\,\sqrt{\frac{T_s}{P_s M_s}} \tag{9}$$

m/sec (ft/sec).

V_{si} = Average gas velocity in dilution tunnel during each 10-min interval, i, of the test run.

$$v_{si} = F_p K_p\,C_p\,\sqrt{\Delta p_i}\,\sqrt{\frac{T_{si}}{P_s M_s}} \tag{10}$$

m/sec (ft/sec).

V_{scent} = Average gas velocity at the center of the dilution tunnel calculated after the Pitot tube traverse.
V_{strav} = Average gas velocity calculated after the multi-point Pitot traverse.
Y = Dry gas meter calibration factor.
ΔH = Average pressure at the outlet of the dry gas meter or the average differential pressure across the orifice meter, if used, mm water (in. water).

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Δp_{avg} = Average velocity pressure in the dilution tunnel, mm water (in. water).

Δp_i = Velocity pressure in the dilution tunnel as measured with the Pitot tube during each 10-min interval, *i*, of the test run.

$$\Delta p_i = \frac{\left(\Delta p_{i(b)} + \Delta p_{i(e)}\right)}{2} \quad (11)$$

mm water (in. water).

where:

$\Delta p_{i(b)}$ = Velocity pressure in the dilution tunnel as measured with the Pitot tube at the beginning of each 10-min interval, *i*, of the test run, mm water (in. water), and

$\Delta p_{i(e)}$ = Velocity pressure in the dilution tunnel as measured with the Pitot tube at the end of each 10-min interval, i, of the test run, mm water (in. water).

θ = Total sampling time, min.

10 = ten min, length of first sampling period.

13.6 = Specific gravity of mercury.

100 = Conversion to percent.

11.3 *Total Particulate Weight*—Determine the total particulate catch, mn, from the sum of the catches obtained from the filters, probe and filter housing and filter gaskets (O-rings).

$$m_n = m_p + m_f + m_g \quad (12)$$

grams.

11.4 *Particulate Concentration:*

11.4.1 *Particulate Concentration-Sample:*

$$c_s = K_2 \frac{m_n}{V_{m(std)}} \quad (13)$$

g/dscm (g/dscf).

where:

K_2 = 0.001 g/mg.

11.4.2 *Particulate Concentration-Room Air:*

$$c_r = K_2 \frac{m_r}{Vm_{r(std)}} \quad (14)$$

g/dscm (g/dscf).

where:

K_2 = 0.001 g/mg.

11.5 *Total Particulate Emissions:*

$$E_T = (c_s - c_r)\, Qstd\, \theta \quad (15)$$

(total emissions in grams.)

NOTE 9—See specific appliance operation and test procedures for appropriate emissions rate or factor for calculations for the appliance type. This involves dividing the total emissions determined by this test method by operational parameters such as total fuel load weight, heat output rate, test duration, or other factors.

11.6 *Proportional Rate Variation*—Calculate PR for each 10-min interval, *i*, of the test run.

reported as percentage.

11.6.1 Alternate calculation procedures for proportional rate variation may be used if other sample flow rate data (for example, orifice flow meters or rotameters) are monitored to maintain proportional sampling rates. The proportional rate variations shall be calculated for each 10-min interval by comparing the dilution tunnel to sample probe nozzle velocity ratio for each 10-min interval to the average dilution tunnel to sample probe nozzle velocity ratio for the entire test run. Proportional rate variation may be calculated for intervals shorter than 10 min with appropriate revisions to Eq 16. The results are acceptable if 90 % of the PR values calculated for all the sampling intervals are between 90 % and 110 % and if no PR value falls outside the range of 80 % to 120 %. If the PR values for the test run are determined to be unacceptable, repeat the test run.

11.7 *Dual Train Comparison*—Calculate the total emissions from each sampling train as shown in 11.5 separately and determine the average total emissions from the two values. Calculate the emissions factors for each sample train by dividing the total emissions by the weight of dry fuel burned. The total emissions values calculated for each sampling train shall not differ by more than 7.5 % from the average total emissions value or the difference between the emissions factors for the two trains shall not be greater than 0.5 grams per kilogram of dry fuel. If this specification is not met, the results are unacceptable.

12. Precision and Bias

12.1 *Precision*—It is not possible to specify the precision of the procedure in this test method for measuring solid fuel burning appliance emissions because the appliance operation and fueling protocols and the appliances themselves produce variable amounts of emissions and therefore the results cannot be used to determine reproducibility or repeatability of this measurement method.

12.2 *Bias*—No information can be presented on the bias of the procedure in this test method for measuring solid fuel burning appliance emissions because no material having an accepted reference value is available.

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APPENDIXES

(Nonmandatory Information)

X1. MEASUREMENT UNCERTAINTY

X1.1 Total Emissions Measurement Uncertainty

X1.2 *Introduction* —Solid fuel burning appliance particulate emissions measured by this test method are subject to both measurement uncertainty and variation due to uncontrolled random factors. The combustion process with wood fuels in particular results in variation in emissions measurements due to a large number of variables that cannot be precisely controlled. Fuel density, moisture content, piece size and placement, turbulent combustion air flow patterns and a number of other variables are known to have some effect on the total particulate emissions produced. There is insufficient data to determine just how significant the variation in results might be for particular appliances or appliance types. However, it is the consensus of experienced testers that these factors alone can account for variation in apparently identical test runs of at least ±10 % in total particulate emissions.

X1.2.1 One component of the variability in results is the Measurement Uncertainty (MU) of the actual particulate emissions measurement. This component of variability can be analyzed and estimated by standard MU analysis techniques. The purpose of Appendix X1 is to provide an outline of the process for determining MU with an example of the needed calculations for its application. However, performing this calculation is not a requirement of the test method.

X1.2.2 For the purposes of this appendix, uncertainties will be stated at a 95 % confidence level meaning that there is a 5 % or less probability that any measurement would deviate from the true value by more than the stated MU. To simplify the analysis it will be assumed that all uncertainties of individual measurements have the same distribution and coverage factor so that standard uncertainties do not need to be derived or stated.

X1.3 Measurement Uncertainty Analysis

X1.3.1 Every numerical physical measurement process is subject to a quantifiable level of uncertainty. This uncertainty is determined in the process of calibrating the measurement instrument. Therefore, the measurement uncertainty for each direct measurement required in a test method can be determined. When multiple measurements of specific quantities are combined into a final numerical measurement result, the combined uncertainty can be calculated by application of well defined and accepted procedures. These procedures are outlined fully in ISO "Guide to the Expression of Uncertainty in Measurement."

X1.3.2 Analysis of the MU for the total particulate emissions in this test method requires combining the uncertainty of the following individual measurements.

X1.3.2.1 Dilution tunnel volumetric flow rate.

X1.3.2.2 Sampling system volumetric flow rate.

X1.3.2.3 Filter and sample probe particulate gravimetric catch.

X1.3.2.4 Ambient particulate background concentration.

X1.3.3 *Component Measurement Uncertainties:*

X1.3.3.1 *Dilution Tunnel Flow Rate*—The dilution tunnel flow is measured by a standard Pitot tube and a differential pressure gauge. The direct measurement is of flow velocity at the operating temperature and pressure. Pitot tube measurements are considered a primary reference method and therefore the primary component of uncertainty in the velocity measurement is that of the differential pressure gauge. Conversion of the velocity measurement to flow rate at standard temperature and pressure conditions requires additional measurements of the tunnel cross sectional area, the temperature and the absolute pressure. An analysis of the overall uncertainty of the tunnel flow rate indicates that the measurements of tunnel cross sectional area, temperature and pressure have a relatively minor affect. The procedure in this standard has been specified such that the overall uncertainty of this parameter is about ±2 % of the flow rate.

X1.3.3.2 *Sampling Volumetric Flow Rate*—The equipment available to measure the sample flow rate has a high precision and can be calibrated such that the measurement uncertainty is ±1 % or better of the actual flow rate. For the purposes of this appendix a ±1 % uncertainty will be assumed. However, laboratories should use the actual MU of the metering equipment they use to estimate the MU of their test results.

X1.3.3.3 *Filter and Probe Particulate Catch*—The analytical balance specified has a measurement uncertainty of ±0.0001g (0.1 mg). A total of 4 to 6 weighings may be needed to determine the net catch depending on whether filters, o-rings and probes are weighed together or separately. Since each weighing is subject to the same uncertainty, the overall uncertainty of the weighing is:

$$MU_{weighing} = \sqrt{0.1^2 \bullet X} \qquad (X1.1)$$

where:

X = The total number of weight values actually used to calculate emissions. This does not include weighings during pretest or post-test drying.
= For a process that involves three pretest and three post-test weighings, this uncertainty is ±0.245 mg.

An additional component of the filter catch weight uncertainty is the potential for incomplete recovery of the filter material. There is no objective data to determine the magnitude of this factor, but laboratories familiar with the procedures report that they believe it to be less than 0.1 mg. Combining an additional ±0.1 mg with the weighing uncertainty results in an overall weighing uncertainty of ±0.27 mg.

X1.3.3.4 *Ambient Particulate Background Concentration* —This measurement uses the same measurement equipment

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and procedures as the sample system and is subject to a similar measurement uncertainty.

X1.3.4 *Combined Measurement Uncertainty*—This section shows an example calculation.

X1.3.4.1 Combined uncertainties are calculated by taking the square root of the sum of squares of the component uncertainties multiplied by a "sensitivity coefficient". The sensitivity coefficient is the partial derivative of the function used to calculate the result with respect to the specific measurement parameter. The general formula (law of propagation of uncertainty) is:

$$uY = \sqrt{((\delta Y/\delta\, x_1) \times u_1)^2 + \ldots + ((\delta Y/x_n) \times u_n)^2} \quad \text{(X1.2)}$$

where:

$\delta Y/\delta x_i$ = Partial derivative of the combining formula with respect to individual measurement x_i, and
u_i = is the uncertainty associated with that measurement.

The formula to calculate total particulate emissions is:

$$E_T = (c_s - c_r)\, Q_{std}\, \theta \quad \text{(X1.3)}$$

where:

c_s = sample filter catch/(sample flow rate x test duration), g/dscf,
c_r = room background filter catch/(sample flow x sampling time), g/dscf,
Q_{std} = average dilution tunnel flow rate, dscf/min, and
θ = sampling time, minutes.

X1.3.4.2 For the sake of example the following values will be used in an MU analysis of E_T.

Measurement	Measured Value	MU	Units
Sample Filter Catch (F_c)	0.025	±0.00027	g
Sample Flow Rate (Q_{sample})	0.25	±0.0025	dscfm
Sampling Duration (θ)	180	±0.1	minutes
Background Filter Catch (BG_c)	0.002	±0.00027	g
Background Filter Flow Rate (Q_{BG})	0.15	±0.0015	dscfm
Tunnel Flow Rate (Q_{std})	150	±3.0	dscfm

(1) Calculate the MU of c_s:

$$c_s = F_c/(Q_{sample}\, x\, \theta) = 0.025/(0.25 \times 180) = 0.0005555 \quad \text{(X1.4)}$$

$$\frac{\delta c_s}{\delta F_c} = \frac{1}{Q_{sample}\bullet\Theta} = \frac{1}{0.25\bullet 180} = 0.0222 \quad \text{(X1.5)}$$

$$\frac{\delta c_s}{\delta Q_{sample}} = \frac{-F_c}{Q^2_{sample}\bullet\Theta} = \frac{-0.025}{0.25^2\bullet 180} = -0.00222 \quad \text{(X1.6)}$$

$$\frac{\delta c_s}{\delta\Theta} = \frac{-F_c}{Q_{sample}\bullet\Theta^2} = \frac{-0.025}{0.25\bullet 180^2} = -0.000003 \quad \text{(X1.7)}$$

$$MUc_s = \sqrt{(0.00027\bullet 0.0222)^2 + (0.0025\bullet -0.00222)^2} \quad \text{(X1.8)}$$

$$\sqrt{+(0.1\bullet -0.000003)^2} = 0.0000081g$$

Thus, c_s would be 0.555 mg/dscf ± 0.0081 mg/dscf at 95 % confidence level.

(2) Calculate the MU of c_r:

$$c_r = BGc/(QBG \times 0) = 0.002/(0.15 \times 180) = 0.000074 \quad \text{(X1.9)}$$

$$\frac{\delta\, c_r}{\delta BG_c} = \frac{1}{Q_{BG}\bullet\Theta} = \frac{1}{0.15\bullet 180} = 0.03704 \quad \text{(X1.10)}$$

$$\frac{\delta c_r}{\delta Q_{BG}} = \frac{-BG_c}{Q^2_{BG}\bullet\Theta} = \frac{-0.002}{0.15^2\bullet 180} = -0.0004938 \quad \text{(X1.11)}$$

$$\frac{\delta c_r}{\delta\Theta} = \frac{-BG_c}{Q_{BG}\bullet\Theta^2} = \frac{-0.002}{0.15\bullet 180^2} = -0.0000004 \quad \text{(X1.12)}$$

$$MUc_r = \sqrt{(0.00027\bullet 0.03704)^2 + (0.0015\bullet -0.0004938)^2} \quad \text{(X1.13)}$$

$$\sqrt{+(0.1\bullet -0.0000004)^2} = 0.00001g$$

Thus, c_r would be 0.074 mg/dscf ± 0.01 mg/dscf at 95 % confidence level.

(3) Calculate E_T and MU_{ET}

$$E_T = (c_s - c_r)\, Q_{sd}\, \theta = (0.000555 - 0.000074) \times 150 \times 180 = 13.00\, g \quad \text{(X1.14)}$$

$$\frac{\delta\, E_T}{\delta c_s} = Q_{std}\bullet\Theta = 150\bullet 180 = 27{,}000 \quad \text{(X1.15)}$$

$$\frac{\delta E_T}{\delta c_r} = Q_{std}\bullet\Theta = 150\bullet 180 = 27{,}000 \quad \text{(X1.16)}$$

$$\frac{\delta E_T}{\delta Q_{std}} = c_s\bullet\Theta - c_r\bullet\Theta = 0.000555\bullet 180 - 0.000074\bullet 180 = 0.08667 \quad \text{(X1.17)}$$

$$\frac{\delta E_T}{\delta\Theta} = c_s\bullet Q_{std} - c_r\bullet Q_{std} = 0.000555\bullet 150 - 0.000074\bullet 150 = 0.07222 \quad \text{(X1.18)}$$

$$MU_{ET} = \sqrt{(27{,}000\bullet 0.0000081)^2 + (27{,}000\bullet 0.00001)^2\,(0.08667\bullet 3)^2} \quad \text{(X1.19)}$$

$$\sqrt{+(0.07222\bullet 0.1)^2} = 0.436$$

Thus the result in this example would be:
ET = 13.00 g ± 0.44 g at a 95 % confidence level.

X1.3.5 *Conclusion*—This example, which is representative of the measurement method as it is currently applied to woodstoves under the EPA NSPS, indicates that the uncertainty related to the dilution tunnel flow rate measurement and filter catch weights are the primary components of the overall uncertainty of the result. Tunnel flow rates may be much higher than necessary to capture all emissions. This can influence the uncertainty of the test method. For example, increasing the tunnel flow rate from 150 to 600 scfm in the above example increases the MU of the result to ±1.3 g or about ±10 % of the measured emissions. Therefore, keeping tunnel flow rates near the minimum necessary to reliably capture the exhaust stream, while keeping the tunnel velocity at a level that can be accurately measured during tests will minimize the uncertainty of the measurement.

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X2. STANDARD PITOT TUBE

X2.1 See Fig. X2.1.

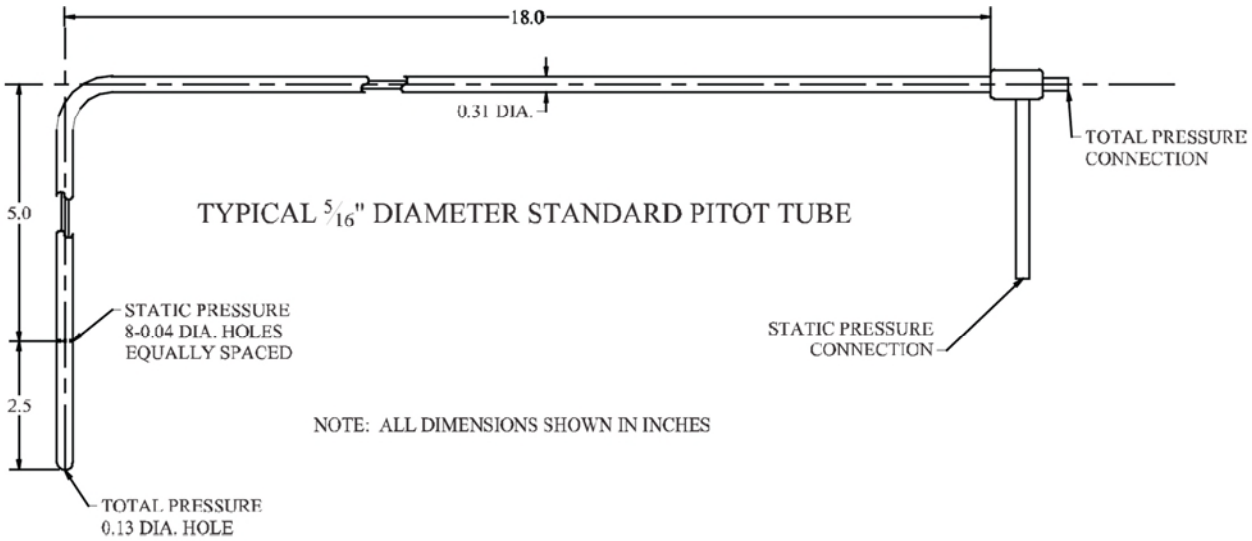

FIG. X2.1 Standard Pitot Tube

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Designation: E2780 – 10

Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters[1]

This standard is issued under the fixed designation E2780; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the fueling and operating protocol for determining particulate matter emissions from wood fires in wood-burning room heaters and fireplace inserts as well as determining heat output and efficiency.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E2515 Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel

2.2 *Other Standards:*

ANSI/UL-103 Standard for Chimneys, Factory-Built, Residential Type and Building Heating Appliance

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

3. Terminology

3.1 *Definitions*—Terms used in this test method are defined in Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *burn rate, n*—the rate at which test fuel is consumed in a wood heater. Measured in kilograms (lb) (dry basis) per hour.

3.2.2 *combustion air control, n*—an air control device that regulates air to the wood heater that is primarily intended promote pyrolysis of the fuel load.

3.2.3 *Douglas fir, n*—untreated, standard, or better grade Douglas fir lumber with agency grade stamp: D. Fir or Douglas Fir.

3.2.4 *firebox, n*—the chamber in the wood heater in which the test fuel charge is placed and combusted.

3.2.5 *fuel piece, n*—2 × 4 or 4 × 4 wood pieces used to construct test fuel cribs and referring to the nominal width and depth dimensions for commonly available dimensional lumber. The actual dimensions are 38 × 89 mm (1½ × 3½ in.) and 89 × 89 mm (3½ × 3½ in.).

3.2.6 *fuel piece length, n*—the length of fuel pieces used to construct the test fuel crib measured in mm (in.).

3.2.7 *firebox height, n*—unless otherwise specified in the manufacturer's written instructions included with the heater, firebox height is the vertical distance extending above the loading door, if fuel could reasonably occupy that space, but not more than 2 inches above the top (peak height) of the loading door, to the floor of the firebox (i.e., below a permanent grate) if the grate allows a 1-inch diameter piece of wood to pass through the grate, or, if not, to the top of the grate. Firebox height is not necessarily uniform but must account for variations caused by internal baffles, air channels, or other permanent obstructions. A visible indicator or landmark within the firebox that will provide a clear indication to the heater user of the maximum height that fuel should be loaded, and is specifically referenced in the manufacturer's written instructions, may be used to determine firebox height for the purposes of calculating usable firebox volume.

3.2.8 *firebox length, n*—the longest horizontal fire chamber dimension where fuel pieces might reasonably be expected to be placed in accordance with the manufacturer's written instructions that is parallel to a wall of the chamber.

3.2.9 *firebox width, n*—the shortest horizontal fire chamber dimension where fuel pieces might reasonably be expected to be placed in accordance with the manufacturer's written instructions that is parallel to a wall of the chamber.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.54 on Solid Fuel Burning Appliances.

Current edition approved Oct. 1, 2010. Published December 2010. DOI: 10.1520/E2780-10.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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3.2.10 *kindling, n*—wood pieces used to initiate combustion of the pre-burn fuel. Kindling may be ignited using crumpled newspaper.

3.2.11 *manufacturer's written instructions, n*—specific information regarding the fueling and operation procedures recommended by the heater manufacturer and included with the heater. These instructions must be consistent with information provided to the heater end-user in the owner's manual or equivalent.

3.2.12 *owner's manual, n*—written information provided to the heater end-user regarding the installation and recommended fueling and operating procedures that will help the heater user to achieve the best heater performance. It is also referred as the installation and operation guide or other equivalent title.

3.2.13 *particulate matter (PM), n*—all gas-borne matter resulting from combustion of solid fuel, as specified in this test method, which is collected in accordance with Test Method E2515.

3.2.14 *pre-burn fuel, n*—wood pieces used to pre-heat the wood heater and establish a charcoal bed prior to the test run.

3.2.15 *secondary combustion air control, n*—an air control device that regulates air to the wood heater that is primarily intended to provide the additional oxygen needed to promote secondary combustion of the combustible materials released during pyrolysis of the fuel load.

3.2.16 *test facility, n*—the area in which the wood heater is installed, operated, and sampled for emissions.

3.2.17 *test fuel crib, n*—the arrangement of the test fuel pieces and test fuel spacers.

3.2.18 *test fuel density, n*—the dry basis density of the test fuel pieces that comprise the test fuel crib.

3.2.19 *test fuel loading density, n*—the weight of the as-fired test fuel crib per unit volume of usable firebox.

3.2.20 *test fuel pieces, n*—the individual fuel pieces (nominal 2 × 4 and 4 × 4 dimensional lumber) that comprise the test fuel crib.

3.2.21 *test fuel spacers, n*—wood pieces used to space fuel pieces apart in the test fuel crib. Their function is to provide reproducible fuel crib geometry and air spaces between fuel pieces.

3.2.22 *test run, n*—an individual emission test which encompasses the time required to consume the mass of the test fuel crib.

3.2.23 *test series, n*—a group of test runs on the same wood heater.

3.2.24 *usable firebox volume, n*—the volume of the firebox determined using its height, length, and width as defined in this section.

3.2.25 *wood heater, n*—an enclosed, wood burning appliance capable of and intended for space heating and/or domestic water heating.

4. Summary of Test Method

4.1 This test method is used in conjunction with Test Method E2515. The wood heater under evaluation is fueled with kindling, pre-burn fuel and a test fuel load. Each test run is a hot-to-hot cycle. Individual test runs are conducted at burn rates ranging from low to maximum burn rates. The fuel load configuration is determined based on the usable firebox volume of the heater plus the firebox dimensions and geometry. Kindling and crumpled newspaper are used to ignite a pre-burn fuel load(s) that is burned to heat the wood heater to normal operating temperature and to establish a charcoal bed. The test fuel load is placed on the charcoal bed and given time to ignite before the air control(s) is (are) set to the test run condition. When the full weight of the test fuel load has been burned, the test run is terminated. Burn rate is determined based on the weight of the test fuel load divided by the length of test run and corrected to a dry fuel basis. Particulate sampling begins before the test fuel load is added and stops when the test run terminates. The total particulate emissions are determined over the test run length. The particulate emissions rate is then determined from the total particulate emissions divided by the length of the test run and is reported in grams of particulate per hour. The particulate emission factor may also be determined from the total particulate emissions divided by the dry basis weight of the test fuel load and is reported in grams of particulate per dry kilogram of fuel. This test method may also be used in conjunction with CSA B415.1 for determining heat output and efficiency. If heat output is determined, particulate emissions per unit of heat delivered may also be calculated and is reported in grams of particulate per megajoule.

5. Significance and Use

5.1 This test method is used for determining emission rates and emission factors for wood heaters.

5.1.1 The emission factor is useful for determining emission performance during product development.

5.1.2 The emission factor is useful for the air quality regulatory community for determining compliance with emission performance limits.

5.1.3 The emission rate may be useful for the air quality regulatory community for determining impacts on air quality from wood heaters.

5.2 The reporting units are grams of particulate per hour, grams of particulate per kilogram of dry fuel and grams of particulate per megajoule of heat output.

5.2.1 Appropriate reporting units for comparing emissions from all types of solid fuel fired appliances: g/kg.

5.2.2 Appropriate reporting units for predicting atmospheric emission impacts: g/h or g/MJ.

5.3 The fuel load specified in this test method is a lumber crib of uniform dimensions, identical to that specified in EPA Method 28. Cribs were specified in EPA Method 28 to provide a reproducible and repeatable test method. In normal operation the majority of fuel used by consumers is cordwood with irregular shapes and dimensions. Very little data exists to indicate whether or not the fuel cribs specified in this standard yield results that are predictive of performance using cordwood fuel. This standard, therefore, includes Annex A1 which provides a fueling procedure using cordwood. It is provided so that those interested in measuring emissions performance with

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cordwood will have a consistent method to follow. A comparative database using the two fueling procedures will provide data to determine whether test results using crib fuel correlate to test results using cordwood fuel.

6. Safety

6.1 *Disclaimer*—This test method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

7. Equipment and Supplies

7.1 *Wood Moisture Meter*—Calibrated electrical resistance meter capable of measuring test fuel moisture to within 1 % moisture content. Must meet the calibration requirements specified in 8.1.

7.2 *Test Fuel Scale*—A scale capable of weighing test fuel to within 0.005 kg (0.01 lb). Must meet the calibration requirements specified in 8.3.

7.3 *Platform Scale*—A scale capable of weighing the test wood heater and attached chimney, including the weight of the test fuel, to within 0.05 kg (0.1 lb). Must meet the calibration requirements specified in 8.2.

7.4 *Wood heater Flue Gas Temperature Measurement Device*—A 3.2 mm (0.125 in.) diameter sheathed, non-isolated junction Type K thermocouple capable of measuring flue gas temperature with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, whichever is greater. Must meet calibration requirements specified in 8.4.

7.5 *Wood Heater Surface Temperature Measuring Device*—A temperature sensor capable of measuring surface temperatures with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, whichever is greater. Must meet calibration requirements specified in 8.4.

7.6 *Catalytic Combustor Exit Temperature Measuring Device*—A temperature sensor capable of measuring the temperature of the gases exiting the catalytic combustor in a catalyst equipped heater with an accuracy of 2.2°C (4.0°F) or 0.75 % of the reading, whichever is greater. Must meet calibration requirements specified in 8.4.

7.7 *Insulated Solid Pack Chimney*—Chimney used for installation of wood heater in the test facility. Solid pack insulated chimneys shall have a minimum of 2.5 cm (1 in.) solid pack insulating material surrounding the entire flue and possess a label demonstrating conformance to ANSI/UL-103, Standard for Chimneys, Factory-Built, Residential Type and Building Heating Appliance.

8. Calibration and Standardization

8.1 *Wood Moisture Meter*—Calibrate as in accordance with the manufacturer's instructions before each certification test.

8.2 *Platform Scale*—Perform a multipoint calibration (at least five points spanning the operational range) of the platform scale before its initial use. The scale manufacturer's calibration results are sufficient for this purpose. Before each certification test, audit the scale with the test wood heater in place by weighing at least one calibration weight (ASTM Class F) that corresponds to between 20 and 80 % of the expected test fuel charge weight. If the scale cannot reproduce the value of the calibration weight within 0.05 kg (0.1 lb) or 1 % of the expected test fuel charge weight, whichever is greater, recalibrate the scale before use with at least five calibration weights spanning the operational range of the scale.

8.3 *Test Fuel Scale*—Perform a multipoint calibration (at least five points spanning the operational range) of the test fuel scale before its initial use. The scale manufacturer's calibration results are sufficient for this purpose. Before each certification test, audit the scale with the wood heater in place by weighing at least one calibration weight (ASTM Class F) that corresponds to between 20 and 80 % of the expected test fuel charge weight. If the scale cannot reproduce the value of the calibration weight within 0.005 kg (0.01 lb) or 1 % of the expected test fuel charge weight, whichever is greater, recalibrate the scale before use with at least five calibration weights spanning the operational range of the scale.

8.4 *Temperature Sensors*—Temperature measuring equipment shall be calibrated before initial use and at least semi-annually thereafter. Calibrations shall be in compliance with National Institute of Standards and Technology (NIST) Monograph 175, Standard Limits of Error.

9. Procedure

9.1 *Pre-conditioning of the Wood Heater*—The wood heater must be pre-conditioned before a test series begins.

9.1.1 Set up the wood heater in accordance with instructions provided by the manufacturer. The total height of chimney when measured from the floor or top of the platform scale shall be 4.6 ± 0.3 m (15 ± 1 ft).

9.1.2 Install a flue-gas temperature measurement device at the center of the flue, 2.6 ± 0.15 m (8.5 ± 0.5 ft) above the floor or top of the platform scale. For catalyst-equipped heaters, install a catalytic combustor exit temperature measurement device at the centroid of the catalytic combustor exit face and within 25 mm (1 in.) downstream of the catalytic combustor exit face.

9.1.3 Operate the wood heater for at least 48 hours at a medium burn rate as defined in 9.5.1 using fuel meeting the specifications in 9.4 or with any type of untreated wood with a moisture content between 15 and 25 % wet basis. The hours of operation do not need to be continuous.

9.1.4 Record the time and weight for all fuel added.

9.1.5 Record the flue-gas temperature at least once during each hour of operation.

9.1.6 For catalyst-equipped wood heaters, record the hourly catalytic combustor exit temperature.

9.1.7 Allow the wood heater to cool to room temperature and remove all unburned wood, charcoal, ash, or other debris from the firebox.

9.1.8 Clean the chimney using a standard chimney brush appropriately sized for the chimney.

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9.2 Install the wood heater in the test facility.

9.2.1 Set up the wood heater in accordance with instructions provided by the manufacturer. Place the wood heater centrally on the platform scale. The venting shall consist of single wall pipe extending to 2.4 ± 0.1 m (8 ± 0.3 ft) above the top of the platform scale, and above this level, insulated solid pack type chimney extending to 4.6 ± 0.3 m (15 ± 1 ft) above the platform scale, and of the size specified by the wood heater manufacturer. This applies to both freestanding and fireplace insert type wood heaters. Do not install a chimney cap.

9.2.1.1 Other chimney types (e.g., solid pack insulated pipe) may be used in place of the steel flue pipe if the wood heater manufacturer's written appliance specifications require such chimney for home installation.

NOTE 1—The chimney that is used for testing should be documented in the test data and test report.

9.2.2 Locate wood heater surface temperature measuring devices at five locations on the wood heater firebox exterior surface. Position the temperature monitors centrally on the top surface, on two sidewall surfaces, and on the bottom and back surfaces. Position the monitor sensing tip on the firebox exterior surface inside of any heat shield, air circulation walls, or other wall or shield separated from the firebox exterior surface.

9.2.3 Center the flue outlet (chimney) under the dilution tunnel hood. Refer to Test Method E2515 for specific requirements including positioning the flue outlet to meet induced draft and smoke capture requirements.

9.2.4 Install a flue-gas temperature measurement device at the center of the flue, 2.6 ± 0.15 m (8.5 ± 0.5 ft) above the top of the platform scale.

9.3 *Usable Firebox Volume Determination:*

9.3.1 Determine the firebox volume using the definitions for firebox height, width, and length in Section 3. Follow the manufacturer's written instructions that are included with the wood heater for specific recommendations to consumers for where fuel should or should not be placed in the firebox when determining usable firebox volume.

9.3.1.1 In the absence of specific written instructions regarding the placement of fuel in the firebox, take into account reasonable consumer loading practices. Guidelines for usable firebox volume adjustments due to the presence of firebrick and other permanent fixtures are as follows:

(1) Adjust width and length dimensions to extend to the metal wall of the wood heater above the firebrick or permanent obstruction if the firebrick or obstruction extending the length of the side(s) or back wall extends less than one third of the usable firebox height. Use the width or length dimensions inside the firebrick if the firebrick extends more than one third of the usable firebox height.

(2) If a log retainer or grate is a permanent fixture and the manufacturer recommends that no fuel be placed outside the retainer, the area outside of the retainer is excluded from the firebox volume calculations.

(3) Include areas adjacent to and above a baffle (up to two inches above the fuel loading opening) if four inches or more horizontal space exist between the edge of the baffle and a vertical obstruction (e.g., sidewalls or air channels).

9.4 *Fuel:*

9.4.1 *Fuel Properties:*

9.4.1.1 *Fuel Species*—The fuel is untreated, standard, or better grade certified Douglas fir lumber.

9.4.1.2 *Fuel Moisture*—The fuel moisture shall be measured using a fuel moisture meter as specified in 7.1. Moisture shall not be added to previously dried fuel pieces except by storage under high humidity conditions and temperature up to 100ºF. Fuel moisture shall be measured within four hours of using the fuel for a test.

NOTE 2—It has been found that to maintain fuel within the allowable moisture content range storage at a relative humidity of 95 % or higher and temperature of 90 to 100ºF is necessary. In addition, storage at these conditions for a period of several weeks results in relatively uniform moisture content throughout the fuel pieces and thus improves the accuracy of the moisture content measurement.

(1) Test Fuel Piece Moisture—The average fuel moisture for each test fuel piece used to construct the test fuel cribs (excluding test fuel spacers) shall be between 19 and 25 % dry basis. Kiln-dried lumber is not permitted. Determine the fuel moisture for each test fuel piece used for the test fuel crib by averaging at least three fuel moisture meter readings, one from each of three sides, measured parallel to the wood grain. If an electrical resistance type fuel moisture meter is used, penetration of insulated electrodes shall be ¼ the thickness of the fuel piece or 19 mm (¾ in.), whichever is greater.

(2) Test Fuel Spacer Moisture—Determine fuel moisture for each test fuel spacer. One moisture meter reading from each spacer, measured parallel to the wood grain is sufficient. If an electrical resistance type fuel moisture meter is used, penetration of insulated electrodes shall be ¼ the thickness of the spacers. Average all the readings for all the test fuel spacers to determine the average test fuel spacer moisture.

9.4.1.3 *Test Fuel Density*—The average test fuel density, dry basis, shall be in the range of 401 to 578 kg/m^3 (25 to 36 lb/ft^3) for the test fuel cribs. Nails and test fuel spacers are excluded from the density determinations. Determine the total volume of the fuel pieces that comprise the test fuel crib. Use the wet basis weight and the arithmetically averaged dry basis moisture content to determine the dry basis weight for the individual fuel pieces. Determine dry basis weight for the test fuel pieces that comprise the test fuel crib (excluding nails and spacers) by summing the dry basis weight of the individual fuel pieces that comprise the crib. Divide the dry basis weight by the volume to determine the density.

9.4.1.4 *Fuel Temperature*—The test fuel temperature shall be within the allowable test facility temperature range as in accordance with Test Method E2515. The fuel temperature may be determined by measuring the temperature of the room where the test fuel has been stored for at least 24 hours prior to the fuel moisture determination.

9.4.1.5 The test fuel crib loading density shall be 112 ± 11.2 kg/m^3 (7 ± 0.7 lb/ft^3) of usable firebox volume on a wet basis.

9.4.1.6 *Fuel Dimensions*—The cross-sectional dimensions of each test fuel piece shall conform to the nominal measurements of 2 × 4 and 4 × 4 lumber. Each test fuel piece (not including spacers) shall be of equal length, except as provided in 9.4.1.10, and shall closely approximate ⅚ the dimensions of the firebox length. Alternatively, the shape of the test fuel crib

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may be geometrically similar to the shape of the firebox volume without resorting to special angular or round cuts on the individual fuel pieces.

(1) The fuel piece composition of the test fuel crib shall be determined in relation to the appliance's firebox volume according to guidelines listed below:

(a) If the usable firebox volume is less than or equal to 0.043 m^3 (1.5 ft^3), use only 2 × 4 lumber.

(b) If the usable firebox volume is greater than 0.043 m^3 (1.5 ft^3) and less than or equal to 0.085 m^3 (3.0 ft^3), use 2 × 4 and 4 × 4 lumber. From 35 to 65 % of the weight of the test fuel crib including spacers shall be 2 × 4 lumber and the remainder shall be 4 × 4 lumber.

(c) If the usable firebox volume is greater than 0.085 m^3 (3.0 ft^3), use only 4 × 4 lumber.

(2) Test Fuel Spacer—The test fuel spacers shall be 130 × 40 × 20 mm (5 × 1.5 × 0.75 in.).

9.4.1.7 *Nails*—Use uncoated, un-galvanized nails for assembling the attaching test fuel spacers to the test fuel pieces. The number of nails used should be limited to the minimum number necessary to hold the test fuel spacers to the test fuel pieces.

9.4.1.8 *Test Fuel Crib Weight (dry basis)*—Determine the total dry basis fuel weight by summing the dry basis weight of the individual test fuel pieces and combined dry basis weight of the test fuel spacers that comprise the test fuel crib (without nails).

9.4.1.9 Attach the test fuel spacers to the test fuel pieces with nails in accordance with 9.4.1.7 as illustrated in Fig. 1. Attachment of test fuel spacers to the top of the test fuel piece(s) that comprise the top layer of the test fuel crib is optional.

9.4.1.10 To avoid stacking difficulties, or when a whole number of test fuel pieces does not result, all piece lengths shall be adjusted uniformly to remain within the specified loading density.

9.4.1.11 *Test Fuel Crib Weight (wet basis)*—Record the total weight (wet basis) of the test fuel crib after it is assembled (including nails and spacers) using the test fuel scale specified in 8.3. The weighed test fuel crib must be used within 3 h of being weighed.

9.5 *Burn Rates:*

9.5.1 *Burn Rate Categories*—One emission test run is required in each of the following burn rate categories:

TABLE 1 Burn Rate Categories

Average kg/h (lb/h), Dry Basis		
Low	Medium	Maximum
0.60[A] to 1.15 (1.32[A] to 2.54)	1.16 to 1.75 (2.55 to 3.86)	Maximum burn rate

[A] Burn rates < 0.6 kg/h (1.32 lb/h) are allowed but not required.

TABLE 2 Alternative Burn Rate Categories

% of Maximum Burn Rate		
Low	Medium	Maximum
18[A] to 35	36 to 53	100

[A] Burn rates < 18 % of maximum are allowed but not required.

9.5.1.1 *Maximum Burn Rate*—For the Maximum Category, the wood heater shall be operated with the combustion air control(s) set to achieve the maximum possible burn rate during the entire test run (or, if thermostatically controlled, the thermostat shall be set at maximum heat output setting at the start of the test run and shall be allowed to operate normally during the test run).

9.5.1.2 *Other Burn Rate Categories:*

(1) For burn rates in the low category, the combustion air control(s) or other mechanical control device shall be set at the minimum operating setting(s) other than fully off. The minimum operating setting(s) is the lowest possible operating

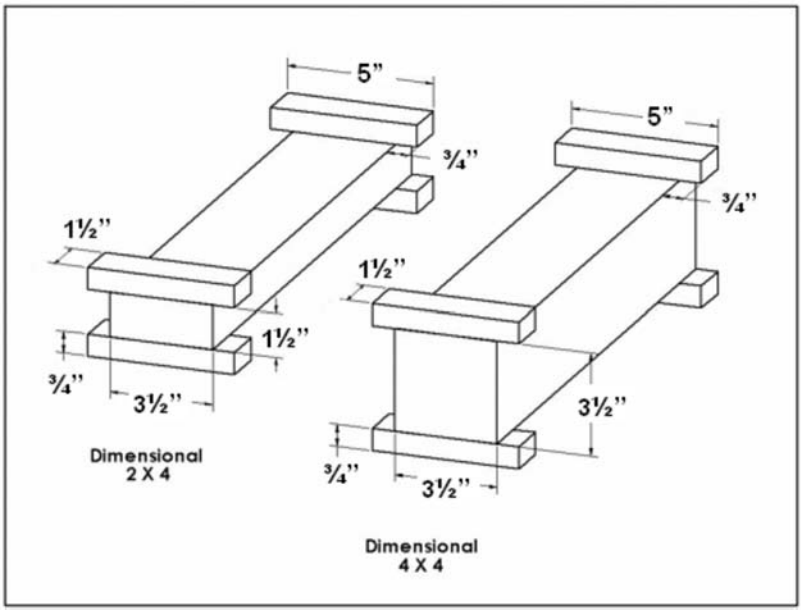

FIG. 1 Test Fuel Spacer Attachment

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position(s) or at the combustion air control stop, whichever is applicable. If the resultant burn rate is less than 0.6 kg/h (1.32 lb/h) when using Table 1 or less than 18 % of the maximum burn rate when using Table 2, the test run may be replaced with a test run with a burn rate that is less than or equal to 0.8 kg/h (1.76 lb/h) when using Table 1 or less than 24 % of the maximum burn rate when using Table 2. Results from any test run conducted at a burn rate below the minimum burn rate range as defined in Table 1 or Table 2, as applicable, shall be reported or but need not be included in the test run weighted average provided that such results are replaced with results from a test run meeting the criteria above.

(2) For test runs in the medium category, the wood heater shall be operated with the combustion air control(s), or other mechanical control device, set at a predetermined position necessary to obtain the average burn rate required for the category.

(3) For heaters with automatic controls, the controls may be allowed to function in a manner consistent with the owner's manual and with normal operation in a home as long as the required burn rate categories in accordance with 9.5.1 are achieved. The test laboratory shall document the procedures used to achieve the burn rates.

(4) The results from test runs that fall above the definition of the medium burn rate category in accordance with Table 1 or Table 2 shall be included with the medium category test results when determining the average emissions in accordance with Section 10.

9.5.1.3 If a wood heater tested using Table 1 cannot be operated at a burn rate below 1.15 kg/h (2.54 lb/h), the flue shall be dampered in order to achieve one average burn rate test run at or below 1.15 kg/h. Additionally, if flue dampering must be used to achieve a burn rate below 1.15 kg/h, results from any test run conducted at a burn rate below 1.00 kg/h need not be reported or included in the test run weighted average provided that such results are replaced with results from a test run meeting the criteria above.

(1) Evidence that a wood heater cannot be operated at a burn rate less than 1.15 kg/h shall include documentation of two or more test runs demonstrating that the burn rates were above 1.15 kg/h when the combustion air control(s) were adjusted to the lowest operating setting(s) in accordance with 9.5.1.2*(1)*.

9.5.1.4 If a wood heater tested using Table 2, cannot be operated at a burn rate below 35 % of the maximum burn rate, the flue shall be dampered in order to achieve one average burn rate test run at or below 35 % of the maximum burn rate. Additionally, if flue dampering must be used to achieve burn rates below 35 % of the maximum burn rate results from any test run conducted at a burn rate below 25 % of the maximum burn rate need not be reported or included in the test run weighted average provided that such results are replaced with results from a test run meeting the criteria above.

(1) Evidence that a wood heater cannot be operated at a burn rate less than 35 % of the maximum burn rate shall include documentation of two or more test runs demonstrating that the burn rates were above 35 % of the maximum burn when the combustion air control(s) were adjusted to the lowest possible operating setting(s) in accordance with 9.5.1.2*(1)*.

9.5.2 *Pre-burn Ignition*—Build a fire in the wood heater in accordance with the manufacturer's written instructions.

9.5.2.1 *Pre-burn Fuel Charge*—Crumpled newspaper and kindling may be used to help ignite the pre-burn fuel. The pre-burn fuel, used to sustain the fire and establish the pre-test run charcoal bed, shall meet the same fuel requirements prescribed in 9.4.

9.5.3 *Wood Heater Operation and Adjustments*—Set the combustion air control(s) at any position that will maintain combustion of the pre-burn fuel load. At least one hour before the start of the test run, set the combustion air control(s) at the approximate positions necessary to achieve the burn rate desired for the test run. Adjustment of the combustion air control(s), fuel addition or subtractions, and coal bed raking shall be kept to a minimum but are allowed up to 15 minutes prior to the start of the test run. For the purposes of this method, coal bed raking is the use of a metal tool (poker) to stir coals, break burning fuel pieces into smaller pieces, dislodge fuel pieces from positions of poor combustion, and check for the condition of uniform charcoalization. Record all adjustments made to the combustion air control(s), adjustments to and additions or subtractions of fuel, and any other changes to wood heater operations that occur during pre-burn ignition period. Record fuel weight data and wood heater temperature measurements at 10 minute intervals during the hour of the pre-burn ignition period preceding the start of the test run. During the 15-minute period prior to the start of the test run, the wood heater loading door shall not be open more than a total of 1 minute. Coal bed raking is the only adjustment allowed during this period.

NOTE 3—One purpose of the pre-burn ignition period is to achieve uniform charcoalization of the test fuel bed prior to loading the test fuel crib. Uniform charcoalization is a general condition of the test fuel bed evidenced by an absence of large pieces of burning wood in the coal bed and the remaining fuel pieces being brittle enough to be broken into smaller charcoal pieces with a metal poker. Manipulations to the fuel bed prior to the start of the test run should be done to achieve uniform charcoalization while maintaining the desired burn rate. In addition, some wood heaters (e.g., high mass units) may require extended pre-burn burn time and fuel additions to reach an initial average surface temperature sufficient to meet the thermal equilibrium criteria in 9.5.10.

9.5.4 The weight of pre-burn fuel remaining at the start of the test run is determined as the difference between the weight of the wood heater with the remaining pre-burn fuel and the tare weight of the cleaned, dry wood heater with or without dry ash or sand added consistent with the manufacturer's instructions and the owner's manual. The tare weight of the wood heater must be determined with the wood heater (and ash, if added) in a dry condition.

9.5.5 *Test Run Start:*

9.5.5.1 When the kindling and pretest fuel have been consumed to leave a pre-test charcoal bed weight between 20 and 25 % of the weight of the test fuel crib (wet basis), record the weight of the fuel remaining and start the test run. Record all wood heater individual surface temperatures, catalyst temperature if applicable, any initial sampling method measurement values, and begin the particulate emission sampling in

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accordance with Test Method E2515. Within 1 minute following the start of the test run, open the wood heater door, load the test fuel crib, and record the test fuel crib weight. Recording of the average, rather than individual, surface temperatures is acceptable.

9.5.5.2 Unless a different fuel loading orientation is recommended in the manufacturer's written instructions, position the fuel crib so that the spacers are parallel to the floor of the firebox, with the spacer edges abutting each other. If loading difficulties result, some fuel pieces may be placed on edge. If the usable firebox volume is between 0.043 and 0.085 m^3 (1.5 and 3.0 ft^3), alternate the piece sizes in vertical stacking layers to the extent possible. For example, place 2 × 4's on the bottom layer in direct contact with the coal bed and 4 × 4's on the next layer, etc. (see Fig. 1). Position the fuel pieces parallel to each other and parallel to the longest wall of the firebox to the extent possible within the specifications in 9.4.

9.5.5.3 Load the test fuel crib in appliances having unusual or unconventional firebox design maintaining air space intervals between the test fuel pieces and in conformance with the manufacturer's written instructions. For any appliance that will not accommodate the loading arrangement specified in the paragraph above, document the test fuel crib arrangement used including the rationale for the fuel piece placement.

9.5.5.4 *Load Time*—The maximum allowable time for loading the test fuel into the wood heater is equal to 1060 s/m^3 (30 s/ft^3) of usable firebox volume as determined in accordance with 9.3.

9.5.5.5 *Start-up Time*—The wood heater door may remain open and the combustion air control(s) adjusted for up to 5 minutes after the maximum load time in accordance with 9.5.5.4 has lapsed in order to make adjustments to the test fuel crib and to ensure ignition of the test fuel crib has occurred. Within the 5 minute start-up time, close the wood heater door(s) and adjust the combustion air control(s) to the position determined to produce the desired burn rate. No other adjustments to the combustion air control(s) or the test fuel crib are allowed (except as specified in 9.5.7 and 9.5.8) after the five minutes of start-up time has elapsed. Record the length of time the wood heater door remains open, the adjustments to the combustion air control(s), and any other operational adjustments.

9.5.6 *Data Recording*—Record all data at intervals no greater than 10 minutes, including fuel weight data, wood heater individual surface and catalyst temperature measurements, other wood heater operational data (e.g., draft), test facility temperature and Test Method E2515 data.

9.5.7 *Test Fuel Crib Adjustment*—The test fuel crib pieces may be adjusted (i.e., repositioned) once during a test run if more than 60 % of the initial test fuel crib weight has been consumed and more than 10 minutes have elapsed without a measurable (< 0.05 kg (0.1 lb) or 1.0 %, whichever is greater) weight change. The time used to make this adjustment shall be less than 15 seconds.

9.5.8 *Air Control(s) Adjustment*—Secondary combustion air control(s) may be adjusted once during the test run following the manufacturer's written instructions. No other air control(s) adjustments are allowed during the test run.

9.5.9 *Test Run Completion*—The test run is completed when the remaining weight of the test fuel charge is 0.00 kg (0.0 lb). End the test run when the scale has indicated a test fuel charge weight of 0.00 kg (0.0 lb) or less for 30 seconds. At the end of the test run, stop the particulate sampling, and record the final fuel weight, the run time, and all final measurement values.

9.5.10 *Wood Heater Thermal Equilibrium*—The average of the wood heater surface temperatures at the end of the test run shall agree with the average surface temperature at the start of the test run to within 70°C (126°F) or the test run is invalid. Alternatively, the wood heater thermal equilibrium criteria in 10.3 may be used to determine test validity.

9.5.11 *Auxiliary Wood Heater Equipment Operation*—Heat exchange blowers sold with the wood heater shall be operated during the test run following the manufacturer's written instructions. In the absence of manufacturer's written instructions, operate the heat exchange blower in the "high" position. (Automatically operated blowers shall be operated as designed.) Shaker grates, by pass controls, or other auxiliary equipment may be adjusted only one time during the test run following the manufacturer's written instructions. Record all adjustments on a wood heater operational written record.

NOTE 4—If the wood heater is sold with a heat exchange blower as an option, test the wood heater with the heat exchange blower operating as described in 9.5.1 through 9.5.10 and report the results. As an alternative to repeating all test runs without the heat exchange blower operating, one additional test run shall be conducted without the blower operating as described in 9.5.9 at a burn rate in the Medium Category (see 9.5.1). If the emission rate resulting from this test run without the blower operating is equal to or less than the emission rate plus 1.0 g/h (0.0022 lb/h) for the test run in the Medium burn rate Category with the blower operating, the wood heater may be considered to have the same average emission rate with or without the blower operating. Additional test runs without the blower operating are unnecessary.

9.5.12 *Consecutive Test Runs*—Test runs on a wood heater may be conducted consecutively provided that a minimum one hour interval occurs between test runs.

9.5.13 *Additional Test Runs*—The testing laboratory may conduct more than one test run in each of the burn rate categories specified in 9.5.1. If more than one test run is conducted at a specified burn rate, the results from at least two thirds of the test runs in that burn rate category shall be used in calculating the weighted average emission rate (see 10.2). The measurement data and results of all test runs shall be reported regardless of which values are used in calculating the weighted average emission rate.

10. Data Analysis and Calculations

10.1 Carry out calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after the final calculation. Other forms of the equations may be used as long as they give equivalent results.

10.2 *Nomenclature:*

$$M_{Sdb} = (M_{Swb})\,(100/(100+FM_S)) \quad (1)$$

where:

FM_S = average fuel moisture of all test fuel spacers, % dry basis,

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M_{Swb} = weight of all test fuel spacers, wet basis, kg (lb), and
M_{Sdb} = weight of all test fuel spacers, dry basis, kg (lb).

$$M_{Cdb} = \sum (M_{CPnwb})\,(100/(100+FM_{CPn})) \quad (2)$$

where:

M_{CPnwb} = weight of each test fuel piece n in fuel crib, excluding nails and spacers, wet basis, kg (lb),
M_{Cdb} = weight of fuel crib, excluding nails and spacers, dry basis, kg (lb),
FM_{CPn} = average fuel moisture of test fuel piece n in fuel crib, % dry basis, and
n = individual test fuel pieces that comprise the test fuel crib, as applicable.

$$D_{Cdb} = M_{Cdb}/V_C \quad (3)$$

where:

D_{Cdb} = density of fuel crib, excluding spacers and nails, dry basis, kg/m^3 (lb/ft^3), and
V_C = volume of fuel crib, m^3 (ft^3).

$$M_{FTAdb} = M_{Sdb} + M_{Cdb} \quad (4)$$

where:

M_{FTAdb} = total weight of fuel crib excluding nails, dry basis, kg (lb).

$$BR = \frac{60\,M_{FTAdb}}{\theta} \quad (5)$$

where:

BR = dry burn rate, kg/h (lb/h), and
θ = total length of test run, min.

$$PM_R = 60(E_T/\theta) \quad (6)$$

where:

E_T = total particulate emissions for test run from Test Method E2515, g (lb),
θ = total length of test run, min, and
PM_R = particulate emission rate for test run, g/h.

$$PM_F = E_T/M_{FTAdb} \quad (7)$$

where:

PM_F = particulate emission factor for test run, g/dry kg of fuel burned.

$$PM_H = E_T/E_O \quad (8)$$

where:

E_O = average measured overall heat output over the test run from Annex A2, MJ (MMBtu), and
PM_H = average particulate emissions per unit of average heat output over the test run, g/MJ (lb/MMBtu).

$$PM_{Rw} = 0.4(PM_{RLAve}) + 0.4(PM_{RMAve}) + 0.2(PM_{RHAve}) \quad (9)$$

where:

PM_{RLAve} = arithmetic average emission rate for all test runs (except in accordance with 9.5.13) that are included in the Low Burn Rate Category, g/h (lb/h),
PM_{RMAve} = arithmetic average emission rate for all test runs (except in accordance with 9.5.13) that are included in the Medium Burn Rate Category, g/h (lb/h),
PM_{RHAve} = arithmetic average emission rate for all test runs (except in accordance with 9.5.13) are included in the High Burn Rate Category, g/h (lb/h), and
PM_{Rw} = weighted average emission rate, g/h (lb/h).

$$PM_{Hw} = 0.4(PM_{HLAve}) + 0.4(PM_{HMAve}) + 0.2(PM_{HHAve}) \quad (10)$$

where:

PM_{HLAve} = arithmetic average emissions per heat output unit for all test runs (except in accordance with 9.5.13) that are included in the Low Burn Rate Category, g/MJ (lb/MMBtu),
PM_{HMAve} = arithmetic average emissions per heat output unit for all test runs (except in accordance with 9.5.13) that are included in the Medium Burn Rate Category, g/MJ (lb/MMBtu),
PM_{HHAve} = arithmetic average emissions per heat output unit for all test runs (except in accordance with 9.5.13) that are included in the High Burn Rate Category, g/MJ (lb/MMBtu), and
PM_{Hw} = weighted average emissions per heat output unit, g/MJ (lb/MMBtu).

$$\eta_{Ow} = 0.4(\eta_{OLAve}) + 0.4(\eta_{OMAve}) + 0.2(\eta_{OHAve}) \quad (11)$$

where:

η_{OLAve} = arithmetic average overall efficiency for all test runs (except in accordance with 9.5.13) that are included in the Low Burn Rate Category as determined in accordance with Annex A2, %,
η_{OMAve} = arithmetic average overall efficiency for all test runs (except in accordance with 9.5.13) that are included in the Medium Burn Rate Category as determined in accordance with Annex A2, %,
η_{OHAve} = arithmetic average overall efficiency for all test runs (except in accordance with 9.5.13) that are included in the High Burn Rate Category as determined in accordance with Annex A2, %, and
η_{Ow} = weighted average overall efficiency, %.

10.3 *Wood Heater Thermal Equilibrium:*

10.3.1 If the difference between the amount of heat stored in the mass of the test heater at the end of the test run versus the beginning of the test run (ΔQH) is greater than 8.5 % of the dry basis heat content of the test fuel crib (QFC), the test run shall be invalid. If $|\Delta Q_H| > 0.085(Q_{FC})$, the test run is invalid

$$\Delta Q_H = (0.5M_{Hm} + 0.83M_{Hr})\,(\Delta T_H) \quad (12)$$

where:

M_{Hm} = weight of the metallic portion of the heater assembly, kg,
M_{Hr} = weight of the refractory portion of the heater assembly, kg, and
ΔT_H = the difference in the average heater surface temperature from the start of the test run to the end of the test run, °C, and.

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ΔQ_H = the difference between the amount of heat stored in the mass of the test heater at the end of the test run versus the beginning of the test run, KJ.

$$\Delta Q_H = (0.1M_{Hm} + 0.2M_{Hr})(\Delta T_H) \quad (13)$$

where:

M_{Hm} = weight of the metallic portion of the heater assembly, lb,

M_{Hr} = weight of the refractory portion of the heater assembly, lb, and

ΔT_H = the difference in the average heater surface temperature from the start of the test run to the end of the test run, °F, and,

ΔQ_H = the difference between the amount of heat stored in the mass of the test heater at the end of the test run versus the beginning of the test run, BTU.

$$Q_{FC} = (M_{FTAdb})(H_{FC}), \quad (14)$$

where:

H_{FC} = heating value of fuel crib, dry basis, (BTU/lb) (refer to Annex A2 in this test method for additional information about heating value), and

Q_{FC} = the dry basis heat content of the test fuel crib KJ (BTU).

11. Precision and Bias

11.1 *Precision*—It is not possible to specify the precision of the procedure in this test method for measuring wood heater emissions because the appliance operation and fueling protocols and the appliances themselves produce variable amounts of emissions and, therefore, the results cannot be used to determine reproducibility or repeatability of this measurement method.

11.2 *Bias*—No information can be presented on the bias of the procedure in this test method for measuring woo heater emissions because no material having an accepted reference value is available.

12. Keywords

12.1 emissions; particulate; particulate matter; wood-burning; wood heater; wood stove

ANNEXES

(Mandatory Information)

A1. CORDWOOD FUELING AND OPERATION

A1.1 Scope

A1.1.1 This annex to the test method covers fueling and operating protocol for determining particulate matter emissions from wood heaters using cordwood test fuel. The annex provides substitute requirements for cordwood operation. This annex is used in conjunction with all other applicable requirements of the test method. This annex may also be used in conjunction with Annex A2 when determining wood heater efficiency.

A1.2 Terminology

A1.2.1 *Definitions of Terms Specific to this Annex:*

A1.2.1.1 *cordwood test fuel, n*—conventional firewood, often referred to as "round wood," although, in practice, it is usually round wood 300 to 600 mm (11.8 to 23.6 in.) long that has been split into segments. There is no equivalent SI term to the imperial volumetric measure of cord (4 ft × 4 ft × 8 ft = 128 ft^3), as piled, including air space; the SI conversion factor is 3.624 556 m^3/cord.

A1.2.1.2 *test run, n*—an individual emission test which encompasses the time required to consume the mass of the cordwood test fuel load.

A1.3 Equipment and Supplies A1.3 (Same as Test Method)

A1.4 Calibration and Standardization A1.4 (Same as Test Method)

A1.5 Cordwood Test Fuel

A1.5.1 *Fuel Properties:*

A1.5.1.1 *Fuel Species and Properties*—Test fuel charge fuel shall be species of cordwood with a specific gravity range of 0.60 to 0.73 (see Table A1.1 for examples of some fuel species that typically meet the specific gravity requirement. Other fuel

TABLE A1.1 Specific Gravity of Commercially Important Species of Wood Based on Oven-Dry Weight and Oven-Dry Volume

Species	Specific Gravity
Ash, white	0.63
Beech	0.67
Birch, sweet	0.71
Birch, yellow	0.65
Elm, rock	0.67
Maple, hard (black)	0.60
Maple, hard (sugar)	0.67
Oak, red	0.66
Oak, white	0.71
Pine, Southern, longleaf	0.64

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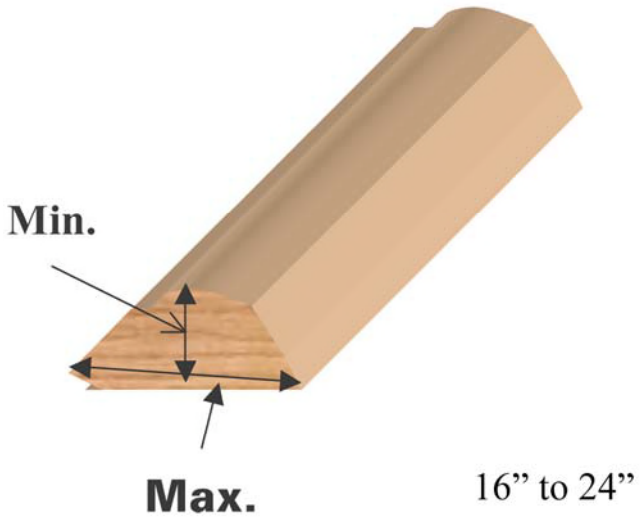

FIG. A1.1 Dimensions of Test Fuel Pieces

species may be used if they meet the specific gravity requirement). Only cordwood pieces that are free of decay, fungus and loose bark shall be used.

A1.5.1.2 *Cordwood Test Fuel Moisture*—The average cordwood test fuel piece moisture content shall be in the range of 18 to 28 % on a dry basis when tested in accordance with the following procedure.

NOTE A1.1—Once split cordwood pieces have dried to an average moisture content that is near the top of the allowable moisture content range, it has been found that to maintain the fuel pieces within the allowable moisture content range, storage at a relative humidity of 95 % or higher and temperature of 90 to 100ºF is necessary. In addition, storage at these conditions for a period of several months helps achieve a more uniform moisture content throughout the fuel pieces and thus improves the accuracy of the moisture content measurement.

(1) Using a fuel moisture meter as specified in 7.1 of the test method, determine the fuel moisture for each cordwood test fuel piece used for the cordwood test fuel load by averaging at least three fuel moisture meter readings, one from each of three sides, measured parallel to the wood grain. Penetration of the moisture meter insulated electrodes shall be ¼ the thickness of the fuel piece or 19 mm (¾ in.), whichever is greater. Moisture shall not be added to previously dried fuel pieces except by storage under high humidity conditions and temperature up to 100 ºF. Fuel moisture shall be measured within four hours of using the fuel for a test.

A1.5.1.3 *Cordwood Test Fuel Piece Length*—Piece length shall be 508 ± 102 mm (20 ± 4 in) (see Fig. A1.1).

A1.5.2 *Cordwood Test Fuel Loads*—Test fuel loads shall be determined by multiplying the firebox volume by 4.54 kg (10 lb), or a higher load density as recommended by the manufacturers printed operating instructions, of wood (as used wet weight) per cubic foot. Test fuel loads shall be made up of fuel pieces as specified in Table A1.2. Select the number of pieces of fuel that most nearly match this target weight. When the manufacturer’s written instructions specify fuel loading to a specific level, the firebox shall be loaded with fuel as specified in A1.5.5 to the level indicated and the weight of the fuel load recorded. This weight shall then be divided by the firebox volume as determined in 9.3 in the Test Method and the resulting loading density shall be reported. If this loading density is less than 162 kg/m^3 (10 lb/ft^3), all tests shall be run with fuel load densities of 162 kg/m^3 (10 lb/ft^3) even though this could require loading to a level higher than indicated in the manufacturer’s instructions.

A1.5.3 *Pre-burn Fuel*—The pre-burn fuel pieces shall be cordwood in approximately the same weight ratio as used for the test fuel load. Crumpled newspaper and kindling may be used to help ignite the pre-burn fuel.

A1.5.4 When the kindling and pre-burn fuel have been consumed to leave a pre-test fuel weight between 10 and 25 % of the weight of the test fuel load, record the weight of the fuel remaining and start the test run. Record all required data at the start of the test run. Load time and start-up time are as defined in 9.5.5.4 and 9.5.5.5 in the test method. Refer to other requirements in the test method as applicable and to the requirements of Test Method E2515.

A1.5.5 *Test Fuel Piece Placement*—Pieces are to be placed in the firebox parallel to the longest firebox dimension or in the direction specified in the manufacturer’s printed operating instructions. When loading test fuel loads, no effort shall be made to stack fuel pieces either tightly or loosely with respect to one another.

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TABLE A1.2 Correlation of Cordwood Wood Pieces with Appliance Firebox Volume[A]

Firebox Volume m^3 (ft^3)	Cross Section Min/Max mm (in.)	Piece Min Weight kg (lb)	Piece Max Weight kg (lb)	80% Piece Weight Range kg (lb)	Number of Pieces
<0.113 (4.0)	51 (2.0) / 152 (6.0)	1 (2.2)	6 (13.2)	1.5 (3.3) – 5 (11.0)	4 – 7
0.113 (4.0) – 0.283 (10.0)	64 (2.5) / 203 (8.0)	2 (4.4)	8 (17.6)	3 (6.6) – 7 (15.5)	5 – 10
0.283 (10.0) – 0.566 (20.0)	76 (3.0) / 254 (10.0)	3 (6.6)	10 (22.0)	4 (8.8) – 9 (19.8)	8 – 15
>0.566 (20.0)	76 (3.0) / 305 (12.0)	4 (8.8)	12 (26.4)	4 (8.8) – 10 (22.0)	>12

[A] Source: Wood Structural Design Data—National Forest Products Association

A2. WOOD HEATER THERMAL EFFICIENCY AND HEAT OUTPUT DETERMINATION

A2.1 Scope

A2.1.1 This annex to the test method covers the determination of overall efficiency and heat output for wood heaters.

A2.2 Referenced Documents

A2.2.1 *Other Documents:*

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

An Atlas of Thermal Data for Biomass and Other Fuels (NREL/TP-433-7965)

The Energy Research Center of the Netherlands "PHYLLIS" database

A2.3 Summary of Test Method

A2.3.1 The procedures in this annex may be used in conjunction with the test method to allow determination of the overall thermal efficiency and the heat output for each test run. Literature values, rather than measured values are used for the calorific value and ultimate analysis for the fuel species used for testing. This annex may be used with crib test fuel or cordwood test fuel. Additionally, in conjunction with the test method, the results determined by the procedures in the annex may be used to determine the integrated average particulate emissions per delivered heat output for each test run, expressed in g/MJ (lb/MMBtu).

A2.4 Significance and Use

A2.4.1 This annex is used for determining the average thermal efficiency and heat output for wood heaters.

A2.4.2 This annex is used to determine the particulate emission rate per unit of heat delivered. This is useful when comparing different types of heating equipment.

A2.4.3 Due to the variability from piece to piece within a given test fuel load, the uncertainty in whether fuel properties determined using ASTM sampling and test methods are actually representative of the average fuel properties of the entire test fuel load has resulted in the use of literature values for the properties (other than moisture content) of the fuel in the calculation of overall efficiency and heat output. The literature values are based on average values reported in scientific literature and in international data bases. Table A2.1 provides this data for some common fuel wood species. This data is taken from "An Atlas of Thermal Data for Biomass and Other Fuels" (NREL/TP-433-7965) and the Energy Research Center of the Netherlands "PHYLLIS" database. If species not listed in Table A2.1 are used for testing, average values for the fuel properties (other than moisture content) reported in scientific literature or in international databases should be used.

A2.5 Procedure

A2.5.1 The procedures used in the annex shall be in accordance with Clauses 6.2.1, 6.2.2, 6.3, 10.4.3 (a), 10.4.3(f-j), and 13.7 of CSA B415.1, 3rd Edition, 2010.

A2.5.1.1 Measure and record the test room air temperature in accordance with the requirements of CSA B415.1, Clauses 6.2.1 and 10.4.3 (g).

TABLE A2.1 Fuel Properties by Fuel Species

Species	%C	%H	%O	%Ash	HHV MJ/kg	HHV Btu/lb
Ash, white	49.7	6.9	43	0.3	20.75	8927
Beech	48.7	5.8	44.7	0.6	18.8	8088
Birch	49.8	6.5	43.4	0.3	20.12	8656
Elm, rock	50.4	6.6	42.3	0.7	20.49	8815
Maple, hard (black)	50.64	6.02	41.74	1.35	19.96	8587
Maple, hard (sugar)	50.64	6.02	41.74	1.35	19.96	8587
Oak, red	49.5	6.62	43.7	0.2	20.2	8690
Oak, white	50.4	6.59	42.7	0.2	20.5	8819
Pine, Southern, longleaf	52.6	7.02	40.1	1.3	22.3	9594
Douglas Fir	48.73	6.87	43.9	0.5	19.81	8522

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A2.5.1.2 Measure and record the flue gas temperature in accordance with the requirements of CSA B415.1, Clauses 6.2.2 and 10.4.3 (f).

A2.5.1.3 Determine and record the Carbon Monoxide (CO) and Carbon Dioxide (CO_2) concentrations in the flue gas in accordance with CSA B415.1, Clauses 6.3 and 10.4.3 (i) and (j).

A2.5.1.4 Measure and record the test fuel weight in accordance with the requirements of CSA B415.1, Clause 10.4.3 (h).

A2.5.1.5 Record the test run time in accordance with the requirements of CSA B415.1, Clause 10.4.3 (a).

A2.6 Data Analysis and Calculations

A2.6.1 *Thermal Efficiency and Heat Output:*

A2.6.1.1 For determination of the average thermal efficiency and average heat output for the test run, use the data collected over the full test run and the calculations in accordance with CSA B415.1, Clause 13.7 except for 13.7.2 (d), (e), (f), and (g), use the fuel properties in accordance with Table A2.1 for the fuel species used for testing.

A2.6.2 *Nomenclature:*

E_O = average measured overall heat output over the test run, MJ (MMBtu/h), and

ηr = overall efficiency for the test run, %.

APPENDIX

(Nonmandatory Information)

X1. SINGLE BURN RATE APPLIANCE FUELING AND OPERATION

X1.1 Scope

X1.1.1 This annex to the test method covers fueling and operating protocol for determining particulate matter emissions from wood heaters that have non-adjustable combustion air control(s). This annex is used in conjunction with all other applicable requirements of the test method. This annex may also be used in conjunction with Annex A2 when determining wood heater efficiency.

X1.2 Terminology

X1.2.1 *Definitions of Terms Specific to this Annex:*

X1.2.1.1 *single burn rate appliance, n*—a wood heater with combustion air control(s) that is not adjustable by the heater user and that meets the requirements of X1.4.2.

X1.3 Summary of the Test Method

X1.3.1 The procedures in this annex allow the determination of performance for single burn rate appliances by addressing the differences in operation between heaters with adjustable combustion air controls and those with non-adjustable combustion air control(s). The difference in the procedure for testing single burn rate appliances involves how the heater is operated, the number of test runs required and the determination of average emissions.

X1.4 Procedure

X1.4.1 Other than the requirements for testing at low, medium and maximum burn rates in 9.5.1 in the test method, all other test method test procedure requirements must be met.

X1.4.2 Conduct at least two test runs following the manufacturer's written instructions for operation of the heater. The heater shall be considered to have a single burn rate if the burn rate for any individual test run is within 10 % of the average burn rate for all test runs.

X1.4.3 For heaters with automatic controls, the controls may be allowed to function in a manner consistent with the owner's manual and with normal operation in a home as long as the requirements of X1.4.2 are met.

X1.5 Data Analysis and Calculations

X1.5.1 *Nomenclature:*

$$PM_{RA} = (PM_{R1} + PM_{R2} + \ldots PM_{Rn})/n \quad \text{(X1.1)}$$

where:

PM_{RA} = the average emission rate, g/h (lb/h),
PM_{R1} = the emission rate for test run 1, g/h (lb/h),
PM_{R2} = the emission rate for test run 2, g/h (lb/h),
PM_{Rn} = the emission rate for each additional valid test run, g/h (lb/h), and
n = number of valid test runs.

$$PM_{FA} = (PM_{F1} + PM_{F2} + \ldots PM_{Fn})/n \quad \text{(X1.2)}$$

where:

PM_{FA} = the average emission factor, g/kg (lb/ton),
PM_{F1} = the emission factor for test run 1, g/kg (lb/ton),
PM_{F2} = the emission factor for test run 2, g/kg (lb/ton),
PM_{Fn} = the emission factor for each additional valid test run, g/kg (lb/ton), and
n = number of valid test runs.

$$PM_{AH} = (PM_{1H} + PM_{2H} + \ldots PM_{nH})/n \quad \text{(X1.3)}$$

where heat output is determined in accordance with Annex A2:

PM_{AH} = arithmetic average emissions per heat output unit for all test runs, g/MJ (lb/MMBtu),
PM_{1H} = average emissions per heat output unit for test run 1, g/MJ (lb/MMBtu),
PM_{2H} = average emissions per heat output unit for test run 2, g/MJ (lb/MMBtu), and
PM_{nH} = average emissions per heat output unit for each additional test run n, g/MJ (lb/MMBtu).

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$$\eta_A = (\eta_1 + \eta_2 + \ldots \eta_n)/n \quad \text{(X1.4)}$$

where:

η_A = arithmetic average overall efficiency for all test runs, %,

η_1 = average overall efficiency for test run 1 as determined in accordance with Annex A2, %,

η_2 = average overall efficiency for test run 2 as determined in accordance with Annex A2, %, and

η_n = average overall efficiency for each additional test run n as determined in accordance with Annex A2, %.

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METHOD 28 - CERTIFICATION AND AUDITING OF WOOD HEATERS

Note: This method does not include all of the specifications (*e.g.,* equipment and supplies) and procedures (*e.g.,* sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 2, Method 3, Method 4, Method 5, Method 5G, Method 5H, Method 6, Method 6C, and Method 16A.

1.0 Scope and Application

1.1 Analyte. Particulate matter (PM). No CAS number assigned.

1.2 Applicability. This method is applicable for the certification and auditing of wood heaters, including pellet burning wood heaters.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 Particulate matter emissions are measured from a wood heater burning a prepared test fuel crib in a test facility maintained at a set of prescribed conditions. Procedures for determining burn rates and particulate emission rates and for reducing data are provided.

3.0 Definitions

3.1 *2 × 4 or 4 × 4* means two inches by four inches or four inches by four inches (50 mm by 100 mm or 100 mm by 100 mm), as nominal dimensions for lumber.

3.2 *Burn rate* means the rate at which test fuel is consumed in a wood heater. Measured in kilograms or lbs of wood (dry basis) per hour (kg/hr or lb/hr).

3.3 *Certification or audit test* means a series of at least four test runs conducted for certification or audit purposes that meets the burn rate specifications in Section 8.4.

3.4 *Firebox* means the chamber in the wood heater in which the test fuel charge is placed and combusted.

3.5 *Height* means the vertical distance extending above the loading door, if fuel could reasonably occupy that space, but not more than 2 inches above the top (peak height) of the loading door, to the floor of the firebox (*i.e.,* below a permanent grate) if the grate allows a 1-inch diameter piece of wood to pass through the grate, or, if not, to the top of the grate. Firebox height is not necessarily uniform but must account for variations caused by internal baffles, air channels, or other permanent obstructions.

3.6 *Length* means the longest horizontal fire chamber dimension that is parallel to a wall of the chamber.

3.7 *Pellet burning wood heater* means a wood heater which meets the following criteria: (1) The manufacturer makes no reference to burning cord wood in advertising or other literature, (2) the unit is safety listed for pellet fuel only, (3) the unit operating and instruction manual must state that the use of cordwood is prohibited by law, and (4) the unit must be manufactured and sold including the hopper and auger combination as integral parts.

3.8 *Secondary air supply* means an air supply that introduces air to the wood heater such that the burn rate is not altered by more than 25 percent when the secondary air supply is adjusted during the test run. The wood heater manufacturer can document this through design drawings that show the secondary air is introduced only into a mixing chamber or secondary chamber outside the firebox.

3.9 *Test facility* means the area in which the wood heater is installed, operated, and sampled for emissions.

3.10 *Test fuel charge* means the collection of test fuel pieces placed in the wood heater at the start of the emission test run.

3.11 *Test fuel crib* means the arrangement of the test fuel charge with the proper spacing requirements between adjacent fuel pieces.

3.12 *Test fuel loading density* means the weight of the as-fired test fuel charge per unit volume of usable firebox.

3.13 *Test fuel piece* means the 2 × 4 or 4 × 4 wood piece cut to the length required for the test fuel charge and used to construct the test fuel crib.

3.14 *Test run* means an individual emission test which encompasses the time required to consume the mass of the test fuel charge.

3.15 *Usable firebox volume* means the volume of the firebox determined using its height, length, and width as defined in this section.

3.16 *Width* means the shortest horizontal fire chamber dimension that is parallel to a wall of the chamber.

3.17 *Wood heater* means an enclosed, wood burning appliance capable of and intended for space heating or domestic water heating, as defined in the applicable regulation.

4.0 Interferences[Reserved]

5.0 Safety

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies

Same as Section 6.0 of either Method 5G or Method 5H, with the addition of the following:

6.1 Insulated Solid Pack Chimney. For installation of wood heaters. Solid pack insulated chimneys shall have a minimum of 2.5 cm (1 in.) solid pack insulating material surrounding the entire flue and possess a label demonstrating conformance to U.L. 103 (incorporated by reference—see §60.17).

6.2 Platform Scale and Monitor. For monitoring of fuel load weight change. The scale shall be capable of measuring weight to within 0.05 kg (0.1 lb) or 1 percent of the initial test fuel charge weight, whichever is greater.

6.3 Wood Heater Temperature Monitors. Seven, each capable of measuring temperature to within 1.5 percent of expected absolute temperatures.

6.4 Test Facility Temperature Monitor. A thermocouple located centrally in a vertically oriented 150 mm (6 in.) long, 50 mm (2 in.) diameter pipe shield that is open at both ends, capable of measuring temperature to within 1.5 percent of expected temperatures.

6.5 Balance (optional). Balance capable of weighing the test fuel charge to within 0.05 kg (0.1 lb).

6.6 Moisture Meter. Calibrated electrical resistance meter for measuring test fuel moisture to within 1 percent moisture content.

6.7 Anemometer. Device capable of detecting air velocities less than 0.10 m/sec (20 ft/min), for measuring air velocities near the test appliance.

6.8 Barometer. Mercury, aneroid or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg).

6.9 Draft Gauge. Electromanometer or other device for the determination of flue draft or static pressure readable to within 0.50 Pa (0.002 in. H_2O).

6.10 Humidity Gauge. Psychrometer or hygrometer for measuring room humidity.

6.11 Wood Heater Flue.

6.11.1 Steel flue pipe extending to 2.6 ±0.15 m (8.5 ±0.5 ft) above the top of the platform scale, and above this level, insulated solid pack type chimney extending to 4.6 ±0.3 m (15 ±1 ft) above the platform scale, and of the size specified by the wood heater manufacturer. This applies to both freestanding and insert type wood heaters.

6.11.2 Other chimney types (*e.g.,* solid pack insulated pipe) may be used in place of the steel flue pipe if the wood heater manufacturer's written appliance specifications require such chimney for home installation (*e.g.,* zero clearance wood heater inserts). Such alternative chimney or flue pipe must remain and be sealed with the wood heater following the certification test.

6.12 Test Facility. The test facility shall meet the following requirements during testing:

6.12.1 The test facility temperature shall be maintained between 18 and 32°C (65 and 90°F) during each test run.

6.12.2 Air velocities within 0.6 m (2 ft) of the test appliance and exhaust system shall be less than 0.25 m/sec (50 ft/min) without fire in the unit.

6.12.3 The flue shall discharge into the same space or into a space freely communicating with the test facility. Any hood or similar device used to vent combustion products shall not induce a draft greater than 1.25 Pa (0.005 in. H_2O) on the wood heater measured when the wood heater is not operating.

6.12.4 For test facilities with artificially induced barometric pressures (*e.g.*, pressurized chambers), the barometric pressure in the test facility shall not exceed 775 mm Hg (30.5 in. Hg) during any test run.

7.0 Reagents and Standards

Same as Section 6.0 of either Method 5G or Method 5H, with the addition of the following:

7.1 Test Fuel. The test fuel shall conform to the following requirements:

7.1.1 Fuel Species. Untreated, air-dried, Douglas fir lumber. Kiln-dried lumber is not permitted. The lumber shall be certified C grade (standard) or better Douglas fir by a lumber grader at the mill of origin as specified in the West Coast Lumber Inspection Bureau Standard No. 16 (incorporated by reference—see §60.17).

7.1.2 Fuel Moisture. The test fuel shall have a moisture content range between 16 to 20 percent on a wet basis (19 to 25 percent dry basis). Addition of moisture to previously dried wood is not allowed. It is recommended that the test fuel be stored in a temperature and humidity-controlled room.

7.1.3 Fuel Temperature. The test fuel shall be at the test facility temperature of 18 to 32°C (65 to 90°F).

7.1.4 Fuel Dimensions. The dimensions of each test fuel piece shall conform to the nominal measurements of 2×4 and 4×4 lumber. Each piece of test fuel (not including spacers) shall be of equal length, except as necessary to meet requirements in Section 8.8, and shall closely approximate 5/6 the dimensions of the length of the usable firebox. The fuel piece dimensions shall be determined in relation to the appliance's firebox volume according to guidelines listed below:

7.1.4.1 If the usable firebox volume is less than or equal to 0.043 m^3 (1.5 ft^3), use 2×4 lumber.

7.1.4.2 If the usable firebox volume is greater than 0.043 m^3 (1.5 ft^3) and less than or equal to 0.085 m^3 (3.0 ft^3), use 2×4 and 4×4 lumber. About half the weight of the test fuel charge shall be 2×4 lumber, and the remainder shall be 4×4 lumber.

7.1.4.3 If the usable firebox volume is greater than 0.085 m^3 (3.0 ft^3), use 4×4 lumber.

7.2 Test Fuel Spacers. Air-dried, Douglas fir lumber meeting the requirements outlined in Sections 7.1.1 through 7.1.3. The spacers shall be 130×40×20 mm (5×1.5×0.75 in.).

8.0 Sample Collection, Preservation, Storage, and Transport

8.1 Test Run Requirements.

8.1.1 Burn Rate Categories. One emission test run is required in each of the following burn rate categories:

Burn Rate Categories

[Average kg/hr (lb/hr), dry basis]

Category 1	Category 2	Category 3	Category 4
<0.80	0.80 to 1.25	1.25 to 1.90	Maximum.
(<1.76)	(1.76 to 2.76)	(2.76 to 4.19)	burn rate.

8.1.1.1 Maximum Burn Rate. For Category 4, the wood heater shall be operated with the primary air supply inlet controls fully open (or, if thermostatically controlled, the thermostat shall be set at maximum heat output) during the entire test run, or the maximum burn rate setting specified by the manufacturer's written instructions.

8.1.1.2 Other Burn Rate Categories. For burn rates in Categories 1 through 3, the wood heater shall be operated with the primary air supply inlet control, or other mechanical control device, set at a predetermined position necessary to obtain the average burn rate required for the category.

8.1.1.3 Alternative Burn Rates for Burn Rate Categories 1 and 2.

8.1.1.3.1 If a wood heater cannot be operated at a burn rate below 0.80 kg/hr (1.76 lb/hr), two test runs shall be conducted with burn rates within Category 2. If a wood heater cannot be operated at a burn rate below 1.25 kg/hr (2.76 lb/hr), the flue shall be dampered or the air supply otherwise controlled in order to achieve two test runs within Category 2.

8.1.1.3.2 Evidence that a wood heater cannot be operated at a burn rate less than 0.80 kg/hr shall include documentation of two or more attempts to operate the wood heater in burn rate Category 1 and fuel combustion has stopped, or results of two or more test runs demonstrating that the burn rates were greater than 0.80 kg/hr when the air supply controls were adjusted to the lowest possible position or settings. Stopped fuel combustion is evidenced when an elapsed time of 30 minutes or more has occurred without a measurable (< 0.05 kg (0.1 lb) or 1.0 percent, whichever is greater) weight change in the test fuel charge. See also Section 8.8.3. Report the evidence and the reasoning used to determine that a test in burn rate Category 1 cannot be achieved; for example, two unsuccessful attempts to operate at a burn rate of 0.4 kg/hr are not sufficient evidence that burn rate Category 1 cannot be achieved.

Note: After July 1, 1990, if a wood heater cannot be operated at a burn rate less than 0.80 kg/hr, at least one test run with an average burn rate of 1.00 kg/hr or less shall be conducted. Additionally, if flue dampering must be used to achieve burn rates below 1.25 kg/hr (or 1.0 kg/hr), results from a test run conducted at burn rates below 0.90 kg/hr need not be reported or included in the test run average provided that such results are replaced with results from a test run meeting the criteria above.

8.2 Catalytic Combustor and Wood Heater Aging. The catalyst-equipped wood heater or a wood heater of any type shall be aged before the certification test begins. The aging procedure shall be conducted and documented by a testing laboratory accredited according to procedures in §60.535 of 40 CFR part 60.

8.2.1 Catalyst-equipped Wood Heater. Operate the catalyst-equipped wood heater using fuel meeting the specifications outlined in Sections 7.1.1 through 7.1.3, or cordwood with a moisture content between 15 and 25 percent on a wet basis. Operate the wood heater at a medium burn rate (Category 2 or 3) with a new catalytic combustor in place and in operation for at least 50 hours. Record and report hourly catalyst exit temperature data (Section 8.6.2) and the hours of operation.

8.2.2 Non-Catalyst Wood Heater. Operate the wood heater using the fuel described in Section 8.4.1 at a medium burn rate for at least 10 hours. Record and report the hours of operation.

8.3 Pretest Recordkeeping. Record the test fuel charge dimensions and weights, and wood heater and catalyst descriptions as shown in the example in Figure 28–1.

8.4 Wood Heater Installation. Assemble the wood heater appliance and parts in conformance with the manufacturer's written installation instructions. Place the wood heater centrally on the platform scale and connect the wood heater to the flue described in Section 6.11. Clean the flue with an appropriately sized, wire chimney brush before each certification test.

8.5 Wood Heater Temperature Monitors.

8.5.1 For catalyst-equipped wood heaters, locate a temperature monitor (optional) about 25 mm (1 in.) upstream of the catalyst at the centroid of the catalyst face area, and locate a temperature monitor (mandatory) that will indicate the catalyst exhaust temperature. This temperature monitor is centrally located within 25 mm (1 in.) downstream at the centroid of catalyst face area. Record these locations.

8.5.2 Locate wood heater surface temperature monitors at five locations on the wood heater firebox exterior surface. Position the temperature monitors centrally on the top surface, on two sidewall surfaces, and on the bottom and back surfaces. Position the monitor sensing tip on the firebox exterior surface inside of any heat shield, air circulation walls, or other wall or shield separated from the firebox exterior surface. Surface temperature locations for unusual design shapes (*e.g.,* spherical, etc.) shall be positioned so that there are four surface temperature monitors in both the vertical and horizontal planes passing at right angles through the centroid of the firebox, not including the fuel loading door (total of five temperature monitors).

8.6 Test Facility Conditions.

8.6.1 Locate the test facility temperature monitor on the horizontal plane that includes the primary air intake opening for the wood heater. Locate the temperature monitor 1 to 2 m (3 to 6 ft) from the front of the wood heater in the 90° sector in front of the wood heater.

8.6.2 Use an anemometer to measure the air velocity. Measure and record the room air velocity before the pretest ignition period (Section 8.7) and once immediately following the test run completion.

8.6.3 Measure and record the test facility's ambient relative humidity, barometric pressure, and temperature before and after each test run.

8.6.4 Measure and record the flue draft or static pressure in the flue at a location no greater than 0.3 m (1 ft) above the flue connector at the wood heater exhaust during the test run at the recording intervals (Section 8.8.2).

8.7 Wood Heater Firebox Volume.

8.7.1 Determine the firebox volume using the definitions for height, width, and length in Section 3. Volume adjustments due to presence of firebrick and other permanent fixtures may be necessary. Adjust width and length dimensions to extend to the metal wall of the wood heater above the firebrick or permanent obstruction if the firebrick or obstruction extending the length of the side(s) or back wall extends less than one-third of the usable firebox height. Use the width or length dimensions inside the firebrick if the firebrick extends more than one-third of the usable firebox height. If a log retainer or grate is a permanent fixture and the manufacturer recommends that no fuel be placed outside the retainer, the area outside of the retainer is excluded from the firebox volume calculations.

8.7.2 In general, exclude the area above the ash lip if that area is less than 10 percent of the usable firebox volume. Otherwise, take into account consumer loading practices. For instance, if fuel is to be loaded front-to-back, an ash lip may be considered usable firebox volume.

8.7.3 Include areas adjacent to and above a baffle (up to two inches above the fuel loading opening) if four inches or more horizontal space exist between the edge of the baffle and a vertical obstruction (*e.g.,* sidewalls or air channels).

8.8 Test Fuel Charge.

8.8.1 Prepare the test fuel pieces in accordance with the specifications outlined in Sections 7.1 and 7.2. Determine the test fuel moisture content with a calibrated electrical resistance meter or other equivalent performance meter. If necessary, convert fuel moisture content values from dry basis ($\%M_d$) to wet basis ($\%M_w$) in Section 12.2 using Equation 28–1. Determine fuel moisture for each fuel piece (not including spacers) by averaging at least three moisture meter readings, one from each of three sides, measured parallel to the wood grain. Average all the readings for all the fuel pieces in the test fuel charge. If an electrical resistance type meter is used, penetration of insulated electrodes shall be one-fourth the thickness of the test fuel piece or 19 mm (0.75 in.), whichever is greater. Measure the moisture content within a 4-hour period prior to the test run. Determine the fuel temperature by measuring the temperature of the room where the wood has been stored for at least 24 hours prior to the moisture determination.

8.8.2 Attach the spacers to the test fuel pieces with uncoated, ungalvanized nails or staples as illustrated in Figure 28–2. Attachment of spacers to the top of the test fuel piece(s) on top of the test fuel charge is optional.

8.8.3 To avoid stacking difficulties, or when a whole number of test fuel pieces does not result, all piece lengths shall be adjusted uniformly to remain within the specified loading density. The shape of the test fuel crib shall be geometrically similar to the shape of the firebox volume without resorting to special angular or round cuts on the individual fuel pieces.

8.8.4 The test fuel loading density shall be 112 ±11.2 kg/m^3 (7 ±0.7 lb/ft3) of usable firebox volume on a wet basis.

8.9 Sampling Equipment. Prepare the sampling equipment as defined by the selected method (*i.e.,* either Method 5G or Method 5H). Collect one particulate emission sample for each test run.

8.10 Secondary Air Adjustment Validation.

8.10.1 If design drawings do not show the introduction of secondary air into a chamber outside the firebox (see "secondary air supply" under Section 3.0, Definitions), conduct a separate test of the wood heater's secondary air supply. Operate the wood heater at a burn rate in Category 1 (Section 8.1.1) with the secondary air supply operated following the manufacturer's written instructions. Start the secondary air validation test run as described in Section 8.8.1, except no emission sampling is necessary and burn rate data shall be recorded at 5-minute intervals.

8.10.2 After the start of the test run, operate the wood heater with the secondary air supply set as per the manufacturer's instructions, but with no adjustments to this setting. After 25 percent of the test fuel has been consumed, adjust the secondary air supply controls to another setting, as per the manufacturer's instructions. Record the burn rate data (5-minute intervals) for 20 minutes following the air supply adjustment.

8.10.3 Adjust the air supply control(s) to the original position(s), operate at this condition for at least 20 minutes, and repeat the air supply adjustment procedure above. Repeat the procedure three times at equal intervals over the entire burn period as defined in Section 8.8. If the secondary air adjustment results in a burn rate change of more than an average of 25 percent between the 20-minute periods before and after the secondary adjustments, the secondary air supply shall be considered a primary air supply, and no adjustment to this air supply is allowed during the test run.

8.10.4 The example sequence below describes a typical secondary air adjustment validation check. The first cycle begins after at least 25 percent of the test fuel charge has been consumed.

Cycle 1

Part 1, sec air adjusted to final position—20 min

Part 2, sec air adjusted to final position—20 min

Part 3, sec air adjusted to final position—20 min

Cycle 2

Part 1, sec air adjusted to final position—20 min

Part 2, sec air adjusted to final position—20 min

Part 3, sec air adjusted to final position—20 min

Cycle 3

Part 1, sec air adjusted to final position—20 min

Part 2, sec air adjusted to final position—20 min

Part 3, sec air adjusted to final position—20 min

Note that the cycles may overlap; that is, Part 3 of Cycle 1 may coincide in part or in total with Part 1 of Cycle 2. The calculation of the secondary air percent effect for this example is as follows:

$$\%BR_{sec} = \frac{\left|\overline{BR_{L3}} - \overline{BR_2}\right|}{\overline{BR_{L3}}} \times 100 \qquad \text{Eq. 28-1}$$

8.11 Pretest Ignition. Build a fire in the wood heater in accordance with the manufacturer's written instructions.

8.11.1 Pretest Fuel Charge. Crumpled newspaper loaded with kindling may be used to help ignite the pretest fuel. The pretest fuel, used to sustain the fire, shall meet the same fuel requirements prescribed in Section 7.1. The pretest fuel charge shall consist of whole 2×4's that are no less than 1/3 the length of the test fuel pieces. Pieces of 4×4 lumber in approximately the same weight ratio as for the test fuel charge may be added to the pretest fuel charge.

8.11.2 Wood Heater Operation and Adjustments. Set the air inlet supply controls at any position that will maintain combustion of the pretest fuel load. At least one hour before the start of the test run, set the air supply controls at the approximate positions necessary to achieve the burn rate desired for the test run. Adjustment of the air supply controls, fuel addition or subtractions, and coalbed raking shall be kept to a minimum but are allowed up to 15 minutes prior to the start of the test run. For the purposes of this method, coalbed raking is the use of a metal tool (poker) to stir coals, break burning fuel into smaller pieces, dislodge fuel pieces from positions of poor combustion, and check for the condition of uniform charcoalization. Record all adjustments made to the air supply controls, adjustments to and additions or subtractions of fuel, and any other changes to wood heater operations that occur during pretest ignition period. Record fuel weight data and wood heater temperature measurements at 10-minute intervals during the hour of the pretest ignition period preceding the start of the test run. During the 15-minute period prior to the start of the test run, the wood heater loading door shall not be open more than a total of 1 minute. Coalbed raking is the only adjustment allowed during this period.

Note: One purpose of the pretest ignition period is to achieve uniform charcoalization of the test fuel bed prior to loading the test fuel charge. Uniform charcoalization is a general condition of the test fuel bed evidenced by an absence of large pieces of burning wood in the coal bed and the remaining fuel pieces being brittle enough to be broken into smaller charcoal pieces with a metal poker. Manipulations to the fuel bed prior to the start of the test run should be done to achieve uniform charcoalization while maintaining the desired burn rate. In addition, some wood heaters (*e.g.,* high mass units) may require extended pretest burn time and fuel additions to reach an initial average surface temperature sufficient to meet the thermal equilibrium criteria in Section 8.3.

8.11.3 The weight of pretest fuel remaining at the start of the test run is determined as the difference between the weight of the wood heater with the remaining pretest fuel and the tare weight of the cleaned, dry wood heater with or without dry ash or sand added consistent with the manufacturer's instructions and the owner's manual. The tare weight of the wood heater must be determined with the wood heater (and ash, if added) in a dry condition.

8.12 Test Run. Complete a test run in each burn rate category, as follows:

8.12.1 Test Run Start.

8.12.1.1 When the kindling and pretest fuel have been consumed to leave a fuel weight between 20 and 25 percent of the weight of the test fuel charge, record the weight of the fuel remaining and start the test run. Record and report any other criteria, in addition to those specified in this section, used to determine

the moment of the test run start (*e.g.,* firebox or catalyst temperature), whether such criteria are specified by the wood heater manufacturer or the testing laboratory. Record all wood heater individual surface temperatures, catalyst temperatures, any initial sampling method measurement values, and begin the particulate emission sampling. Within 1 minute following the start of the test run, open the wood heater door, load the test fuel charge, and record the test fuel charge weight. Recording of average, rather than individual, surface temperatures is acceptable for tests conducted in accordance with §60.533(o)(3)(i) of 40 CFR part 60.

8.12.1.2 Position the fuel charge so that the spacers are parallel to the floor of the firebox, with the spacer edges abutting each other. If loading difficulties result, some fuel pieces may be placed on edge. If the usable firebox volume is between 0.043 and 0.085 m^3 (1.5 and 3.0 ft^3), alternate the piece sizes in vertical stacking layers to the extent possible. For example, place 2 × 4's on the bottom layer in direct contact with the coal bed and 4 × 4's on the next layer, etc. (See Figure 28–3). Position the fuel pieces parallel to each other and parallel to the longest wall of the firebox to the extent possible within the specifications in Section 8.8.

8.12.1.3 Load the test fuel in appliances having unusual or unconventional firebox design maintaining air space intervals between the test fuel pieces and in conformance with the manufacturer's written instructions. For any appliance that will not accommodate the loading arrangement specified in the paragraph above, the test facility personnel shall contact the Administrator for an alternative loading arrangement.

8.12.1.4 The wood heater door may remain open and the air supply controls adjusted up to five minutes after the start of the test run in order to make adjustments to the test fuel charge and to ensure ignition of the test fuel charge has occurred. Within the five minutes after the start of the test run, close the wood heater door and adjust the air supply controls to the position determined to produce the desired burn rate. No other adjustments to the air supply controls or the test fuel charge are allowed (except as specified in Sections 8.12.3 and 8.12.4) after the first five minutes of the test run. Record the length of time the wood heater door remains open, the adjustments to the air supply controls, and any other operational adjustments.

8.12.2 Data Recording. Record on a data sheet similar to that shown in Figure 28–4, at intervals no greater than 10 minutes, fuel weight data, wood heater individual surface and catalyst temperature measurements, other wood heater operational data (*e.g.,* draft), test facility temperature and sampling method data.

8.12.3 Test Fuel Charge Adjustment. The test fuel charge may be adjusted (*i.e.,* repositioned) once during a test run if more than 60 percent of the initial test fuel charge weight has been consumed and more than 10 minutes have elapsed without a measurable (<0.05 kg (0.1 lb) or 1.0 percent, whichever is greater) weight change. The time used to make this adjustment shall be less than 15 seconds.

8.12.4 Air Supply Adjustment. Secondary air supply controls may be adjusted once during the test run following the manufacturer's written instructions (see Section 8.10). No other air supply adjustments are allowed during the test run. Recording of wood heater flue draft during the test run is optional for tests conducted in accordance with §60.533(o)(3)(i) of 40 CFR part 60.

8.12.5 Auxiliary Wood Heater Equipment Operation. Heat exchange blowers sold with the wood heater shall be operated during the test run following the manufacturer's written instructions. If no manufacturer's written instructions are available, operate the heat exchange blower in the “high” position. (Automatically operated blowers shall be operated as designed.) Shaker grates, by-pass controls, or other

auxiliary equipment may be adjusted only one time during the test run following the manufacturer's written instructions.

Record all adjustments on a wood heater operational written record.

Note: If the wood heater is sold with a heat exchange blower as an option, test the wood heater with the heat exchange blower operating as described in Sections 8.1 through 8.12 and report the results. As an alternative to repeating all test runs without the heat exchange blower operating, one additional test run may be without the blower operating as described in Section 8.12.5 at a burn rate in Category 2 (Section 8.1.1). If the emission rate resulting from this test run without the blower operating is equal to or less than the emission rate plus 1.0 g/hr (0.0022 lb/hr) for the test run in burn rate Category 2 with the blower operating, the wood heater may be considered to have the same average emission rate with or without the blower operating. Additional test runs without the blower operating are unnecessary.

8.13 Test Run Completion. Continue emission sampling and wood heater operation for 2 hours. The test run is completed when the remaining weight of the test fuel charge is 0.00 kg (0.0 lb). End the test run when the scale has indicated a test fuel charge weight of 0.00 kg (0.0 lb) or less for 30 seconds. At the end of the test run, stop the particulate sampling, and record the final fuel weight, the run time, and all final measurement values.

8.14 Wood Heater Thermal Equilibrium. The average of the wood heater surface temperatures at the end of the test run shall agree with the average surface temperature at the start of the test run to within 70 C (126 °F).

8.15 Consecutive Test Runs. Test runs on a wood heater may be conducted consecutively provided that a minimum one-hour interval occurs between test runs.

8.16 Additional Test Runs. The testing laboratory may conduct more than one test run in each of the burn rate categories specified in Section 8.1.1. If more than one test run is conducted at a specified burn rate, the results from at least two-thirds of the test runs in that burn rate category shall be used in calculating the weighted average emission rate (see Section 12.2). The measurement data and results of all test runs shall be reported regardless of which values are used in calculating the weighted average emission rate (see Note in Section 8.1).

9.0 Quality Control

Same as Section 9.0 of either Method 5G or Method 5H.

10.0 Calibration and Standardizations

Same as Section 10.0 of either Method 5G or Method 5H, with the addition of the following:

10.1 Platform Scale. Perform a multi-point calibration (at least five points spanning the operational range) of the platform scale before its initial use. The scale manufacturer's calibration results are sufficient for this purpose. Before each certification test, audit the scale with the wood heater in place by weighing at least one calibration weight (Class F) that corresponds to between 20 percent and 80 percent of the expected test fuel charge weight. If the scale cannot reproduce the value of the calibration weight within 0.05 kg (0.1 lb) or 1 percent of the expected test fuel charge weight, whichever is greater, recalibrate the scale before use with at least five calibration weights spanning the operational range of the scale.

10.2 Balance (optional). Calibrate as described in Section 10.1.

10.3 Temperature Monitor. Calibrate as in Method 2, Section 4.3, before the first certification test and semiannually thereafter.

10.4 Moisture Meter. Calibrate as per the manufacturer's instructions before each certification test.

10.5 Anemometer. Calibrate the anemometer as specified by the manufacturer's instructions before the first certification test and semiannually thereafter.

10.6 Barometer. Calibrate against a mercury barometer before the first certification test and semiannually thereafter.

10.7 Draft Gauge. Calibrate as per the manufacturer's instructions; a liquid manometer does not require calibration.

10.8 Humidity Gauge. Calibrate as per the manufacturer's instructions before the first certification test and semiannually thereafter.

11.0 Analytical Procedures

Same as Section 11.0 of either Method 5G or Method 5H.

12.0 Data Analysis and Calculations

Same as Section 12.0 of either Method 5G or Method 5H, with the addition of the following:

12.1 Nomenclature.

BR = Dry wood burn rate, kg/hr (lb/hr)

E_i = Emission rate for test run, i, from Method 5G or 5H, g/hr (lb/hr)

E_w = Weighted average emission rate, g/hr (lb/hr)

k_i = Test run weighting factor=Pi+1− P_{i-1}

$\%M_d$ = Fuel moisture content, dry basis, percent.

$\%M_w$ = Average moisture in test fuel charge, wet basis, percent.

N = Total number of test runs.

P_i = Probability for burn rate during test run, i, obtained from Table 28–1. Use linear interpolation to determine probability values for burn rates between those listed on the table.

W_{wd} = Total mass of wood burned during the test run, kg (lb).

12.2 Wet Basis Fuel Moisture Content.

$$\%M_w = \frac{100(\%M_d)}{100 + \%M_d} \qquad \text{Eq. 28-2}$$

12.3 Weighted Average Emission Rate. Calculate the weighted average emission rate (E_w) using Equation 28–1:

$$E_w = \frac{\sum_{i=1}^{n}(K_i E_i)}{\sum_{i=1}^{n} K_i} \qquad \text{Eq. 28-3}$$

Note: P_o always equals 0, $P_{(n+1)}$always equals 1, P_1corresponds to the probability of the lowest recorded burn rate, P_2corresponds to the probability of the next lowest burn rate, etc. An example calculation is in Section 12.3.1.

12.3.1 Example Calculation of Weighted Average Emission Rate.

Burn rate category	Test No.	Burn rate (Dry-kg/hr)	Emissions (g/hr)
1	1	0.65	5.0
2[1]	2	0.85	6.7
2	3	0.90	4.7
2	4	1.00	5.3
3	5	1.45	3.8
4	6	2.00	5.1

[1]As permitted in Section 6.6, this test run may be omitted from the calculation of the weighted average emission rate because three runs were conducted for this burn rate category.

Test No.	Burn rate	P_i	E_i	K_i
0		0.000		
1	0.65	0.121	5.0	0.300
2	0.90	0.300	4.7	0.259
3	1.00	0.380	5.3	0.422
4	1.45	0.722	3.8	0.532
5	2.00	0.912	5.1	0.278
6		1.000		

$K_1=P_2-P_0=0.300-0=0.300$

$K_2=P_3-P_1=0.381-0.121=0.259$

$K_3=P_4-P_2=0.722-0.300=0.422$

$K_4=P_5-P_3=0.912-0.380=0.532$

$K_5=P_6-P_4=1.000-0.722=0.278$

Weighted Average Emission Rate, E_w, Calculation

$$E_w = \frac{\sum(K_i E_i)}{\sum K_i}$$
$$= \frac{(0.3)(5.0)+(0.259)(4.7)+(0.422)(5.3)+(0.532)(3.8)+(0.278)(5.1)}{1.791}$$
$$= 4.69\ g/hr$$

12.4 Average Wood Heater Surface Temperatures. Calculate the average of the wood heater surface temperatures for the start of the test run (Section 8.12.1) and for the test run completion (Section 8.13). If the two average temperatures do not agree within 70°C (125°F), report the test run results, but do not include the test run results in the test average. Replace such test run results with results from another test run in the same burn rate category.

12.5 Burn Rate. Calculate the burn rate (BR) using Equation 28–3:

$$BR = \frac{60 W_{wd}}{\theta} \times \frac{100 - \%M_w}{100} \qquad \text{Eq. 28-3}$$

12.6 Reporting Criteria. Submit both raw and reduced test data for wood heater tests.

12.6.1 Suggested Test Report Format.

12.6.1.1 Introduction.

12.6.1.1.1 Purpose of test-certification, audit, efficiency, research and development.

12.6.1.1.2 Wood heater identification-manufacturer, model number, catalytic/noncatalytic, options.

12.6.1.1.3 Laboratory-name, location (altitude), participants.

12.6.1.1.4 Test information-date wood heater received, date of tests, sampling methods used, number of test runs.

12.6.1.2 Summary and Discussion of Results

12.6.1.2.1 Table of results (in order of increasing burn rate)-test run number, burn rate, particulate emission rate, efficiency (if determined), averages (indicate which test runs are used).

12.6.1.2.2 Summary of other data-test facility conditions, surface temperature averages, catalyst temperature averages, pretest fuel weights, test fuel charge weights, run times.

12.6.1.2.3 Discussion-Burn rate categories achieved, test run result selection, specific test run problems and solutions.

12.6.1.3 Process Description.

12.6.1.3.1 Wood heater dimensions-volume, height, width, lengths (or other linear dimensions), weight, volume adjustments.

12.6.1.3.2 Firebox configuration-air supply locations and operation, air supply introduction location, refractory location and dimensions, catalyst location, baffle and by-pass location and operation (include line drawings or photographs).

12.6.1.3.3 Process operation during test-air supply settings and adjustments, fuel bed adjustments, draft.

12.6.1.3.4 Test fuel-test fuel properties (moisture and temperature), test fuel crib description (include line drawing or photograph), test fuel loading density.

12.6.1.4 Sampling Locations.

12.6.1.4.1 Describe sampling location relative to wood heater. Include drawing or photograph.

12.6.1.5 Sampling and Analytical Procedures

12.6.1.5.1 Sampling methods-brief reference to operational and sampling procedures and optional and alternative procedures used.

12.6.1.5.2 Analytical methods-brief description of sample recovery and analysis procedures.

12.6.1.6 Quality Control and Assurance Procedures and Results

12.6.1.6.1 Calibration procedures and results-certification procedures, sampling and analysis procedures.

12.6.1.6.2 Test method quality control procedures-leak-checks, volume meter checks, stratification (velocity) checks, proportionality results.

12.6.1.7 Appendices

12.6.1.7.1 Results and Example Calculations. Complete summary tables and accompanying examples of all calculations.

12.6.1.7.2 Raw Data. Copies of all uncorrected data sheets for sampling measurements, temperature records and sample recovery data. Copies of all pretest burn rate and wood heater temperature data.

12.6.1.7.3 Sampling and Analytical Procedures. Detailed description of procedures followed by laboratory personnel in conducting the certification test, emphasizing particular parts of the procedures differing from the methods (*e.g.,* approved alternatives).

12.6.1.7.4 Calibration Results. Summary of all calibrations, checks, and audits pertinent to certification test results with dates.

12.6.1.7.5 Participants. Test personnel, manufacturer representatives, and regulatory observers.

12.6.1.7.6 Sampling and Operation Records. Copies of uncorrected records of activities not included on raw data sheets (*e.g.,* wood heater door open times and durations).

12.6.1.7.7 Additional Information. Wood heater manufacturer's written instructions for operation during the certification test.

12.6.2.1 Wood Heater Identification. Report wood heater identification information. An example data form is shown in Figure 28–4.

12.6.2.2 Test Facility Information. Report test facility temperature, air velocity, and humidity information. An example data form is shown on Figure 28–4.

12.6.2.3 Test Equipment Calibration and Audit Information. Report calibration and audit results for the platform scale, test fuel balance, test fuel moisture meter, and sampling equipment including volume metering systems and gaseous analyzers.

12.6.2.4 Pretest Procedure Description. Report all pretest procedures including pretest fuel weight, burn rates, wood heater temperatures, and air supply settings. An example data form is shown on Figure 28–4.

12.6.2.5 Particulate Emission Data. Report a summary of test results for all test runs and the weighted average emission rate. Submit copies of all data sheets and other records collected during the testing. Submit examples of all calculations.

13.0 Method Performance[Reserved]

14.0 Pollution Prevention[Reserved]

15.0 Waste Management[Reserved]

16.0 Alternative Procedures

16.1 Pellet Burning Heaters. Certification testing requirements and procedures for pellet burning wood heaters are identical to those for other wood heaters, with the following exceptions:

16.1.1 Test Fuel Properties. The test fuel shall be all wood pellets with a moisture content no greater than 20 percent on a wet basis (25 percent on a dry basis). Determine the wood moisture content with either ASTM D 2016–74 or 83, (Method A), ASTM D 4444–92, or ASTM D 4442–84 or 92 (all noted ASTM standards are incorporated by reference—see §60.17).

16.1.2 Test Fuel Charge Specifications. The test fuel charge size shall be as per the manufacturer's written instructions for maintaining the desired burn rate.

16.1.3 Wood Heater Firebox Volume. The firebox volume need not be measured or determined for establishing the test fuel charge size. The firebox dimensions and other heater specifications needed to identify the heater for certification purposes shall be reported.

16.1.4 Heater Installation. Arrange the heater with the fuel supply hopper on the platform scale as described in Section 8.6.1.

16.1.5 Pretest Ignition. Start a fire in the heater as directed by the manufacturer's written instructions, and adjust the heater controls to achieve the desired burn rate. Operate the heater at the desired burn rate for at least 1 hour before the start of the test run.

16.1.6 Test Run. Complete a test run in each burn rate category as follows:

16.1.6.1 Test Run Start. When the wood heater has operated for at least 1 hour at the desired burn rate, add fuel to the supply hopper as necessary to complete the test run, record the weight of the fuel in the supply hopper (the wood heater weight), and start the test run. Add no additional fuel to the hopper during the test run.

Record all the wood heater surface temperatures, the initial sampling method measurement values, the time at the start of the test, and begin the emission sampling. Make no adjustments to the wood heater air supply or wood supply rate during the test run.

16.1.6.2 Data Recording. Record the fuel (wood heater) weight data, wood heater temperature and operational data, and emission sampling data as described in Section 8.12.2.

16.1.6.3 Test Run Completion. Continue emission sampling and wood heater operation for 2 hours. At the end of the test run, stop the particulate sampling, and record the final fuel weight, the run time, and all final measurement values, including all wood heater individual surface temperatures.

16.1.7 Calculations. Determine the burn rate using the difference between the initial and final fuel (wood heater) weights and the procedures described in Section 12.4. Complete the other calculations as described in Section 12.0.

17.0 References

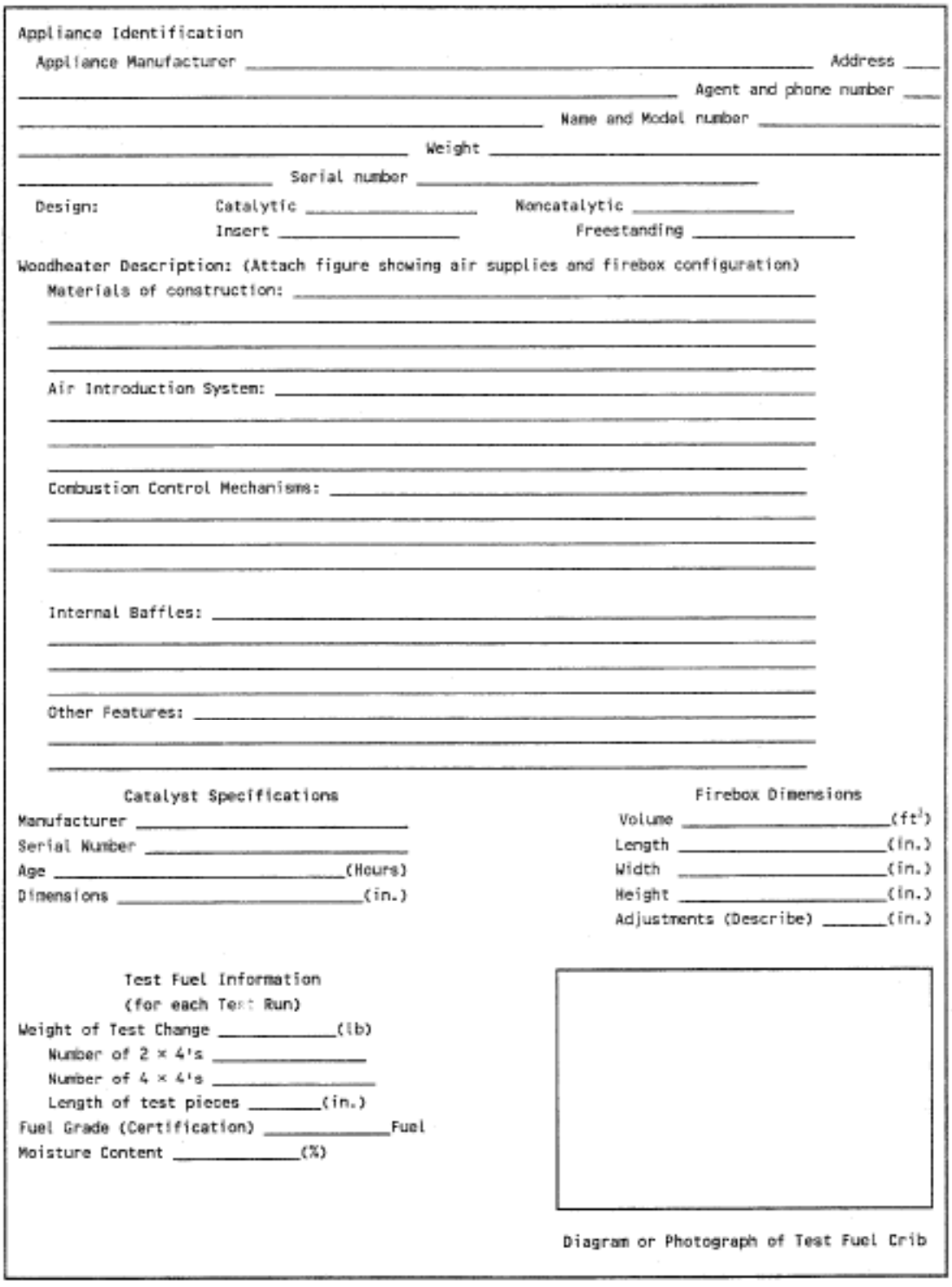
Same as Method 5G, with the addition of the following:

1. Radian Corporation. OMNI Environmental Services, Inc., Cumulative Probability for a Given Burn Rate Based on Data Generated in the CONEG and BPA Studies. Package of materials submitted to the Fifth Session of the Regulatory Negotiation Committee, July 16–17, 1986.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Table 28–1—Burn Rate Weighted Probabilities for Calculating Weighted Average Emission Rates

Burn rate (kg/hr-dry)	Cumulative probability (P)	Burn rate (kg/hr-dry)	Cumulative probability (P)	Burn rate (kg/hr-dry)	Cumulative probability (P)
0.00	0.000	1.70	0.840	3.40	0.989
0.05	0.002	1.75	0.857	3.45	0.989
0.10	0.007	1.80	0.875	3.50	0.990
0.15	0.012	1.85	0.882	3.55	0.991
0.20	0.016	1.90	0.895	3.60	0.991
0.25	0.021	1.95	0.906	3.65	0.992
0.30	0.028	2.00	0.912	3.70	0.992
0.35	0.033	2.05	0.920	3.75	0.992
0.40	0.041	2.10	0.925	3.80	0.993
0.45	0.054	2.15	0.932	3.85	0.994
0.50	0.065	2.20	0.936	3.90	0.994
0.55	0.086	2.25	0.940	3.95	0.994
0.60	0.100	2.30	0.945	4.00	0.994
0.65	0.121	2.35	0.951	4.05	0.995
0.70	0.150	2.40	0.956	4.10	0.995
0.75	0.185	2.45	0.959	4.15	0.995
0.80	0.220	2.50	0.964	4.20	0.995
0.85	0.254	2.55	0.968	4.25	0.995
0.90	0.300	2.60	0.972	4.30	0.996
0.95	0.328	2.65	0.975	4.35	0.996
1.00	0.380	2.70	0.977	4.40	0.996
1.05	0.407	2.75	0.979	4.45	0.996
1.10	0.460	2.80	0.980	4.50	0.996
1.15	0.490	2.85	0.981	4.55	0.996
1.20	0.550	2.90	0.982	4.60	0.996
1.25	0.572	2.95	0.984	4.65	0.996
1.30	0.620	3.00	0.984	4.70	0.996
1.35	0.654	3.05	0.985	4.75	0.997
1.40	0.695	3.10	0.986	4.80	0.997
1.45	0.722	3.15	0.987	4.85	0.997
1.50	0.750	3.20	0.987	4.90	0.997
1.55	0.779	3.25	0.988	4.95	0.997
1.60	0.800	3.30	0.988	≥5.00	1.000
1.65	0.825	3.35	0.989		



Appliance Identification

Appliance Manufacturer _____ Address ___

_____ Agent and phone number ___

_____ Name and Model number _____

_____ Weight _____

_____ Serial number _____

Design: Catalytic _____ Noncatalytic _____

Insert _____ Freestanding _____

Woodheater Description: (Attach figure showing air supplies and firebox configuration)

Materials of construction: _____

Air Introduction System: _____

Combustion Control Mechanisms: _____

Internal Baffles: _____

Other Features: _____

Catalyst Specifications

Manufacturer _____

Serial Number _____

Age _____(Hours)

Dimensions _____(in.)

Firebox Dimensions

Volume _____(ft^3)

Length _____(in.)

Width _____(in.)

Height _____(in.)

Adjustments (Describe) _____(in.)

Test Fuel Information

(for each Test Run)

Weight of Test Charge _____(lb)

Number of 2 × 4's _____

Number of 4 × 4's _____

Length of test pieces _____(in.)

Fuel Grade (Certification) _____Fuel

Moisture Content _____(%)

Diagram or Photograph of Test Fuel Crib

Figure 28-1. Wood Heater and Test Fuel Information.

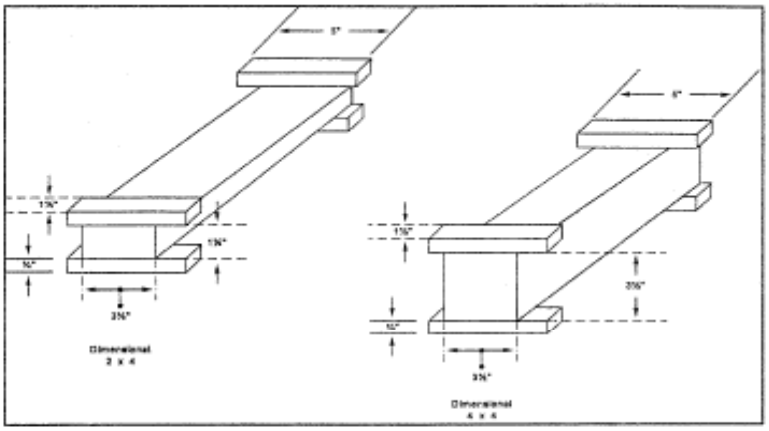


Figure 28-2. Test Fuel Spacer Dimensions.

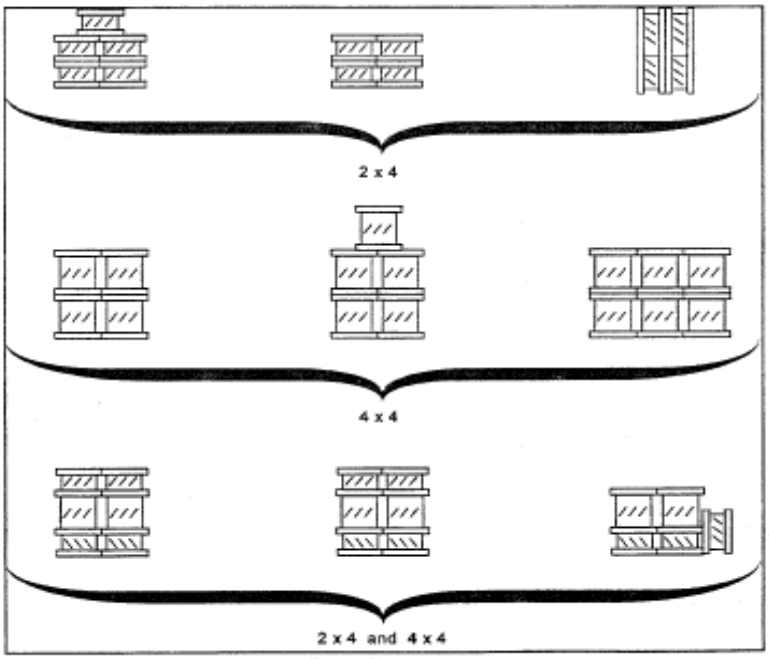


Figure 28-3. Test Fuel Crib Arrangements.

Sheet _____ of _____

Date _____

Operator _____

Sampling Method _____

Wood Heater Information

Manufacturer _____

Model _____

Primary Air Setting _____

Secondary Air Setting _____

Thermostat Setting _____

Other Settings _____

Test Run Information

Test Run No. _____

Burn Rate _____

Room Temperature before/after ____/____

Barometric Pressure before/after ____/____

Relative Humidity before/after ____/____

Room Air Velocity before/after ____/____

Surface Temp Average Pretest _____ end _____

Test Run Time (minutes)	Test Fuel Scale Reading (lb)	Surface Temperature					Catalyst Temperature		Flue Draft (in. H_2O)
							Inlet (°F)	Outlet (°F)	
(Pretest Period)									
(Test Run Start)									

Figure 28-4. Test Run Wood Heater Operation Data Sheet.

While we have taken steps to ensure the accuracy of this Internet version of the document, it is not the official version. To see a complete version including any recent edits, visit: https://www.ecfr.gov/cgi-bin/ECFR?page=browse and search under Title 40, Protection of Environment.

Test Method 28R for Certification and Auditing of Wood Heaters

1.0 Scope and Application

1.1 This test method applies to certification and auditing of wood-fired room heaters and fireplace inserts.

1.2 The test method covers the fueling and operating protocol for measuring particulate emissions, as well as determining burn rates, heat output and efficiency.

1.3 Particulate emissions are measured by the dilution tunnel method as specified in ASTM E2515-11 *Standard Test Method for Determination of Particulate Matter Emissions Collected in a Dilution Tunnel*. (IBR, see § 60.17) Upon request, four-inch filters may be used. Upon request, Teflon-coated glass fiber filters may be used.

2.0 Procedures

2.1 This method incorporates the provisions of ASTM E2780-10 (IBR, see § 60.17) except as follows:

2.1.1 The burn rate categories, low burn rate requirement, and weightings in Method 28 shall be used.

2.1.2 The startup procedures shall be the same as in Method 28.

2.1.3 Manufacturers shall not specify a smaller volume of the firebox for testing than the full usable firebox.

2.1.4 Prior to testing, the heater must be operated for a minimum of 50 hours using a medium burn rate. The conditioning may be at the manufacturer's facility prior to the certification test. If the conditioning is at the certification test laboratory, the pre-burn for the first test can be included as part of the conditioning requirement.

2.2 Manufacturers may use ASTM E871-82 (reapproved 2013) (IBR, see § 60.17) as an alternative to the procedures in Method 5H or Method 28 for determining total weight basis moisture in the analysis sample of particulate wood fuel.

intertek
Total Quality. Assured.

Certificate of Conformity

Emissions – Adjustable burn rate wood burning heater

EPA 40 CFR Part 60, Subpart AAA, EPA Method 28R, ASTM E2515-2011, ASTM E2780-2010, CSA B415.1-2010

Certificate number: WHI19 – 208507008

This is a certificate of conformity to certify that the bearer has successfully completed the requirements of the above scheme which include the testing of products, the initial assessment, and are subject to continuing annual assessments of their compliance and testing of samples of products taken from production (as applicable to the scheme) and has been registered within the scheme for the products detailed.

Organization:

Company Name: England's Stove Works, Inc.
Address: 589 S. Five Forks Road
City, State: Monroe, VA
Zip Code: 24574
Country: USA

Product: Model 15-SSW01, 50-SHSSW01, 50-TRSSW01
Maximum Output: 27,500 Btu/hour
Weighted Average Emissions Rate: 1.956 g/hr
Weighted Average Efficiency: 73.77%
Test Fuel Type: Douglas fir Crib
Compliance: Certified to comply with 2020 particulate emissions standard.
Report Number: 103758222MID-001

Certification body: Intertek Testing Services NA, Inc.
Initial registration: April 5, 2019
Date of expiry: NA
Issue status: 1

Charles Meyers Certification Manager		4/5/2019
Name	Signature	Date

Registered address:
Intertek Testing Services NA, Inc. 545 E. Algonquin Rd. Arlington Heights, IL 60005 USA

www.intertek.com

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ENGLAND STOVE WORKS. INC.
TEST REPORT

SCOPE OF WORK
EPA EMISSIONS TESTING FOR MODEL 15-SSW01

REPORT NUMBER
103758222MID-001

TEST DATE(S)
01/24/19 THROUGH 2/05/19

ISSUE DATE **[REVISED DATE]**
11/18/19

PAGES
19

DOCUMENT CONTROL NUMBER
GFT-OP-10c (05/10/17)
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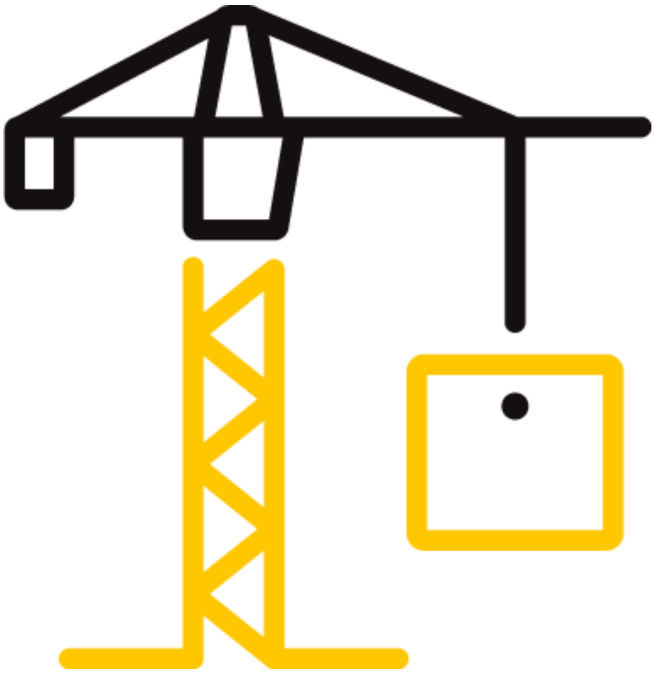

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Report No.: 103758222MID-001
Date: 11/18/19

REPORT ISSUED TO

ENGLAND STOVE WORKS, INC.
589 South Five Forks Road
Monroe, VA 24574-2821

SECTION 1

SCOPE

Intertek Building & Construction (B&C) was contracted by England Stove Works, 589 South Five Forks Road, Monroe, VA 24574-2821 to perform testing in accordance with, ASTM E2515-2011 "Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel", ASTM E2780-2010 "Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters" on their Model 15-SSW01, Wood Fuel Room Heater. Results obtained are tested values and were secured by using the designated test method(s). Testing was conducted at Intertek test facility in Middleton, WI.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory.

SECTION 2

SUMMARY OF TEST RESULTS

The appliance tests resulted in the following performance:

Particulate Emissions: 1.956 g/hr
Carbon Monoxide: 1.659 g/min
Heating Efficiency: 73.77% (Higher Heating Value Basis)

For INTERTEK B&C:

COMPLETED BY:	Ken Slater	**REVIEWED BY:**	Brian Ziegler
TITLE:	Associate Engineer – Hearth	**TITLE:**	Technical Team Leader - Hearth
SIGNATURE:	Ken Slater	**SIGNATURE:**	
DATE:	02/21/19	**DATE:**	02/21/19

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SECTION 3
TEST METHOD(S)

The specimen was evaluated in accordance with the following:

ASTM E2515-2011 - Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel

ASTM E2780-2010 – Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters

SECTION 4
MATERIAL SOURCE

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 01/18/19 and was shipped via the client. The unit was assigned sample ID # MID1901181005-001. 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 England Stove Works, Inc. staff.

The unit's chimney system and laboratory dilution tunnels were cleaned using standard wire brush chimney cleaning equipment. On 01/24/19 the unit was set-up for testing.

SECTION 5
EQUIPMENT

Equipment	INV Number	Calibration Due	MU
Platform Scale	008	4/10/19	± 27g
Balance	713	4/10/19	± 0.47mg
Data Logger	986	4/10/19	± 0.33°F
Scale	1134	4/10/19	± 27g

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Timer	1212	4/4/19	±0.3 sec
Timer	1213	4/4/19	±0.3 sec
Flow Meter	1413	7/18/19	± 17mL/min
Flow Meter	1414	7/18/19	± 17mL/min
Barometer	1420	4/12/19	± 0.24°F,1.7%RH, 0.011 in Hg
Dry Gas Meter	1210	6/27/19	± 0.00284 cfm

SECTION 6
LIST OF OFFICIAL OBSERVERS

NAME	COMPANY
Ken Slater	Intertek B&C
John Wray	England Stove Works, Inc.

SECTION 7
TEST PROCEDURE

From 01/24/19 to 02/05/19, the unit was tested for emissions. The tests were conducted in accordance with ASTM E2780-10. The fuel used for the test run was Douglas Fir.

TEST SET-UP DESCRIPTON

A 6" diameter vertical single wall pipe and insulated chimney system was installed to 15' above floor level. The single wall pipe extended to 8 feet above the floor and uninsulated chimney extended the remaining height.

AIR SUPPLY SYSTEM

Combustion air enters the rear of the unit, which is directed to the firebox. All gasses exit through the 6" flue located at the top of the heater

TEST FUEL PROPERTIES

Wood used for the testing is nominal 4" x 4" Douglas Fir Cribs. Douglas Fir has a default heating value of 8523 Btu/hr (19810 kJ/kg) and a moisture content between 19% and 25% on a dry basis.

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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.)

FIGURE 1 – DILUTION TUNNEL

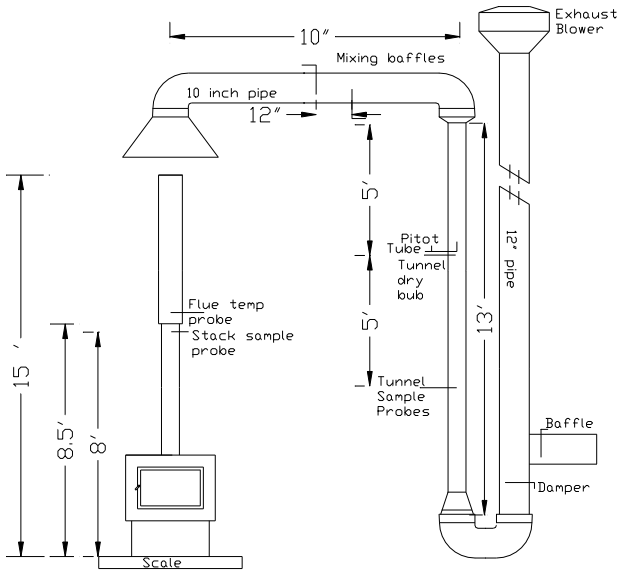

FIGURE 1

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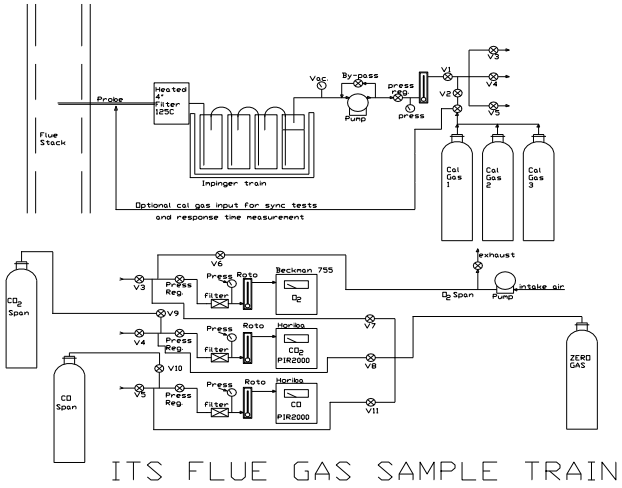
FIGURE 2 – STACK GAS SAMPLE TRAIN



ITS FLUE GAS SAMPLE TRAIN

FIGURE 2

FIGURE 3 – DILUTION TUNNEL SAMPLE SYSTEMS

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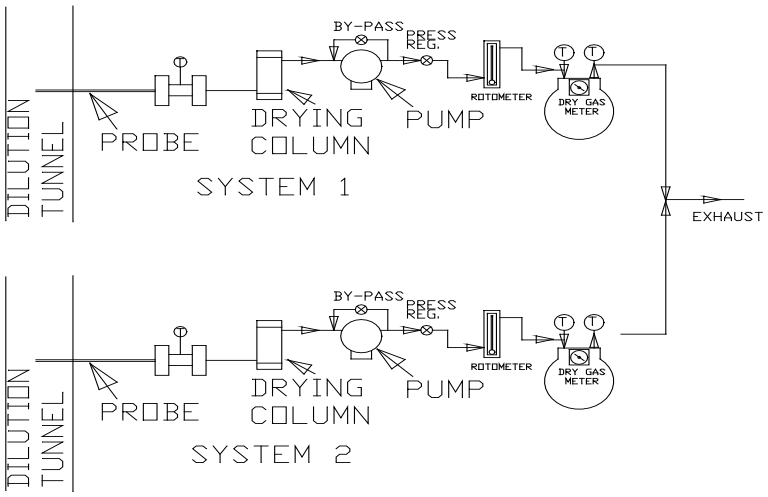

Figure 3

SAMPLING METHODS

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.

INSTRUMENT CALIBRATION

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

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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.

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.

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.

TEST METHOD PROCEDURES

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

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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.

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.

PM SAMPLING PROPORTIONALITY

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

DEVIATIONS FROM STANDARD METHOD:

SECTION 8
TEST CALCULATIONS

NOMENCLATURE FOR ASTM E2515:

A = Cross-sectional area of tunnel m2 (ft2).

B_{ws} = Water vapor in the gas stream, proportion by volume (assumed to be 0.02 (2.0 %)).

C_p = Pitot tube coefficient, dimensionless (assigned a value of 0.99).

c_r = Concentration of particulate matter room air, dry basis, corrected to standard conditions, g/dscm (gr/ dscf) (mg/dscf).

c_s = Concentration of particulate matter in tunnel gas, dry basis, corrected to standard conditions, g/dscm (gr/dscf) (mg/dscf).

E_T = Total particulate emissions, g.

F_p = Adjustment factor for center of tunnel pitot tube placement.

$F_p = V_{stravv}/V_{scent}$

K_P = Pitot Tube Constant, 34.97 $\frac{m}{\sec}\left[\frac{\left(\frac{g}{g}\blacksquare mole\right)(mm\ Hg)}{(K)(mm\ water)}\right]^{\frac{1}{2}}$

or

= Pitot Tube Constant, 85.49 $\frac{ft}{\sec}\left[\frac{\left(\frac{lb}{lb}-mole\right)(in\ Hg)}{(R)(in\ water)}\right]^{\frac{1}{2}}$

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L_a = Maximum acceptable leakage rate for either a pretest or post-test leak- check, equal to 0.0003 m3/min (0.010 cfm) or 4 % of the average sampling rate, whichever is less.

L_p = Leakage rate observed during the post-test leak-check, m3/min (cfm).

m_p = mass of particulate from probe, mg.

m_f = mass of particulate from filters, mg.

m_g = mass of particulate from filter gaskets, mg.

m_r = mass of particulate from the filter, filter gasket, and probe assembly from the room air blank filter holder assembly, mg.

m_n = Total amount of particulate matter collected, mg.

M_s = the dilution tunnel dry gas molecular weight (may be assumed to be 29 g/g mole (lb/lb mole).

P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).

P_g = Static Pressure in the tunnel (in. water).

P_R = Percent of proportional sampling rate.

P_s = Absolute average gas static pressure in dilution tunnel, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

Q_{std} = Average gas flow rate in dilution tunnel.

$Q_{std} = 60\ (1 - B_{ws})\ V_s\ A\ [T_{std}\ P_s / T_s\ P_{std}]$

dscm/min (dscf/min).

T_m = Absolute average dry gas meter temperature, K (R).

T_{mi} = Absolute average dry gas meter temperature during each 10-min interval, *i*, of the test run.

$$T_{mi} = (T_{mi(b)} + T_{mi(e)})/2$$

where:

$T_{mi(b)}$ = Absolute dry gas meter temperature at the beginning of each 10-min test interval, i, of the test run, K (R), and

$T_{mi(e)}$ = Absolute dry gas meter temperature at the end of each 10-min test interval, i, of the test run, K (R).

Ts = Absolute average gas temperature in the dilution tunnel, K (R).

Tsi = Absolute average gas temperature in the dilution tunnel during each 10-min interval, i, of the test run, K (R).

$$T_{si} = (T_{si(b)} + T_{m=si(e)})/2$$

where:

$T_{si(b)}$ = Absolute gas temperature in the dilution tunnel at the beginning of each 10-min test interval, i, of the test run, K (R), and

$T_{si(e)}$ = Absolute gas temperature in the dilution tunnel at the end of each 10-min test interval, i, of the test run, K (R).

V_m = Volume of gas sample as measured by dry gas meter, dcm (dcf).

V_{mc} = Volume of gas sampled corrected for the post test leak rate, dcm (dcf).

V_{mi} = Volume of gas sample as measured by dry gas meter during each 10-min interval, i, of the test run, dcm.

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$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions.

$$V_{m(std)} = K_1 V_m Y [(P_{bar} + (\Delta H/13.6))/T_m]$$

where:

K_1 = 0.3855 K/mm Hg for SI units and = 17.64 R/in. Hg for inch-pound units.

$$V_{m(std)} = K_1 V_{mc} Y [(P_{bar} + (\Delta H/13.6))/T_m]$$

where:

V_{mc} = Vm– (Lp– La)u

V_{mr} = Volume of room air sample as measured by dry gas meter, dcm (dcf), and

$V_{mr(std)}$ = Volume of room air sample measured by the dry gas meter, corrected to standard conditions.

$$V_{m(std)} = K_1 V_{mr} Y [(P_{bar} + (\Delta H/13.6))/T_m]$$

Where:

K_1 = 0.3855 K/mm Hg for SI units and = 17.64 R/in. Hg for inch-pound units, and

V_s = Average gas velocity in the dilution tunnel.

$$V_s = F_p K_p C_p (\sqrt{\Delta P_{avg}})(\sqrt{(T_s/P_s M_s)})$$

V_{si} = Average gas velocity in dilution tunnel during each 10-min interval, i, of the test run.

$$V_{si} = F_p K_p C_p (\sqrt{\Delta P_i})(\sqrt{(T_{si}/P_s M_s)})$$

V_{scent} = Average gas velocity at the center of the dilution tunnel calculated after the Pitot tube traverse.

V_{strav} = Average gas velocity calculated after the multipoint Pitot traverse.

Y = Dry gas meter calibration factor.

ΔH = Average pressure at the outlet of the dry gas meter or the average differential pressure across the orifice meter, if used, mm water (in. water).

ΔP_{avg} = Average velocity pressure in the dilution tunnel, mm water (in. water).

ΔP_i = Velocity pressure in the dilution tunnel as measured with the Pitot tube during each 10-min interval, i, of the test run.

$$\Delta P_i = (\Delta P_{i(b)} + \Delta P_{i(e)})/2$$

where:

$\Delta P_{i(b)}$ = Velocity pressure in the dilution tunnel as measured with the Pitot tube at the beginning of each 10-min interval, i, of the test run, mm water (in. water), and

$\Delta P_{i(e)}$ = Velocity pressure in the dilution tunnel as measured with the Pitot tube at the end of each 10-min interval, i, of the test run, mm water (in. water).

θ = Total sampling time, min.

10 = ten min, length of first sampling period.

13.6 = Specific gravity of mercury.

100 = Conversion to percent.

TOTAL PARTICULATE WEIGHT – ASTM E2515

$$M_n = m_p + m_f + m_g$$

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PARTICULATE CONCENTRATION – ASTM E2515

$C_s = K_2(m_n/V_{m(std)})$ g/dscm (g/dscf)

where:

K_2 = 0.001 g/mg

TOTAL PARTICULATE EMISSIONS (g) – ASTM E2515

$E_T = (C_s - C_r)Q_{std}\theta$

PROPORTIONAL RATE VARIATION (%) – ASTM E2515

$PR = [\theta(V_{mi}\ V_s\ T_m\ T_{si})/(10(V_m\ V_{si}\ T_s\ T_{mi})] \times 100$

MEASUREMENT OF UNCERTAINTY – ASTM E2515

$MU_{weighing} = \sqrt{0.1^2} \bullet X$

GENERAL FORMULA – ASTM E2515

$uY = \sqrt{((\delta Y/\delta x_1) \times u_1)^2 + \ldots + ((\delta Y/\delta x_n) \times u_n)^2}$

Where:

$\delta Y/\delta x_i$ = Partial derivative of the combining formula with respect to individual measurement xi,

u_i = is the uncertainty associated with that measurement.

TOTAL PARTICULATE EMISSIONS – ASTM E2515

$E_T = (c_s - c_r)\ Q_{std}\ \theta$

where:

c_s = sample filter catch/(sample flow rate x test duration), g/dscf,

c_r = room background filter catch/(sample flow x sampling time), g/dscf,

Q_{std} = average dilution tunnel flow rate, dscf/min, and

θ = sampling time, minutes.

MU OF c_s

$c_s = F_c/(Q_{sample} \times \theta) = 0.025/(0.25 \times 180) = 0.0005555$

$\delta c_s/\delta F_c = 1/Q_{sample} \bullet \Theta = 1/0.25 \bullet 180 = 0.0222$

$\delta c_s/\delta Q_{sample} = -F_c/Q^2_{sample} \bullet \Theta = -0.025/0.25^2 \bullet 180 = -0.00222$

$\delta c_s/\delta\Theta = -F_c/Q_{sample} \bullet \Theta^2 = -0.025/0.25 \bullet 180^2 = -0.000003$

$MUc_s = \sqrt{(0.00027 \bullet 0.0222)^2 + (0.0025 \bullet - 0.00222)^2}$

$\sqrt{} + (0.1 \bullet - 0.000003)^2 = 0.0000091g$

Thus, c_s would be 0.555 mg/dscf ± 0.0081 mg/dscf at 95% confidence level.

MU OF c_r

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$c_r = BG_c/(QBG \times \theta) = 0.002/(0.15 \times 180) = 0.000074$
$\delta c_r/\delta BG_c = 1/Q_{BG} \bullet \Theta = 1/0.15 \bullet 180 = 0.03704$
$\delta c_r/\delta Q_{BG} = -BG_c/Q^2_{BG} \bullet \Theta = -0.002/0.15^2 \bullet 180 = -0.0004938$
$\delta c_r/\delta \Theta = -BG_c/Q_{BG} \bullet \Theta^2 = -0.002/0.15 \bullet 180^2 = -0.0000004$
$MUc_r = \sqrt{(0.00027 \bullet 0.03704)^2 + (0.0015 \bullet - 0.0004938)^2}$
$\sqrt{} + (0.1 \bullet - 0.0000004)^2 = 0.00001g$
Thus, c_r would be 0.074 mg/dscf ± 0.01 mg/dscf at 95% confidence level.

E_T AND MU_{ET}

$E_T = (c_s - c_r)\, Q_{sd}\, \theta = (0.000555 - 0.000074) \times 150 \times 180 = 13.00g$
$\delta E_T/\delta c_s = Q_{std} \bullet \Theta = 150 \bullet 180 = 27{,}000$
$\delta E_T/\delta c_r = Q_{std} \bullet \Theta = 150 \bullet 180 = 27{,}000$
$\delta E_T/\delta Q_{std} = c_s \bullet \Theta - c_r \bullet \Theta = 0.000555 \bullet 180 - 0.000074 \bullet 180 = 0.08667$
$\delta E_T/\delta \Theta = c_s \bullet Q_{std} - c_r \bullet Q_{std} = 0.000555 \bullet 180 - 0.000074 \bullet 180 = 0.07222$
$MU_{ET} = \sqrt{(27{,}000 \bullet 0.0000081)^2 + (27{,}000 \bullet 0.00001)^2\, (0.08667 \bullet 3)^2}$
$\sqrt{} + (0.07222 \bullet 0.1)^2 = 0.436$
Thus the result in this example would be:
ET = 13.00g ± 0.44 g at a 95% confidence level.

EFFICIENCY – CSA B415.1

The change in enthalpy of the circulating air shall be calculated using the moisture content and temperature rise of the circulating air, as follows:

$$\Delta h = \Delta t\,(1.006 + 1.84x)$$

Where:
Δh = change in enthalpy, kJ/kg
Δt = temperature rise, °C
1.006 = specific heat of air, kJ/kg °C
1.84 = specific heat of water vapor, kJ/kg °C
x = humidity ratio, kg/kg

The equivalent duct diameter shall be calculated as follows:

$$ED = 2HW/H+W$$

Where:
ED = equivalent duct diameter
H = duct height, m
W = duct width, m

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The air flow velocity shall be calculated as follows:

$$V = F_p \times C_p \times 34.97 \times \sqrt{T}/28.56(P_{baro} + P_s)$$

where
V = velocity, m/s
F_P = Pitot tube calibration factor determined from vane anemometer measurements
C_P = Pitot factor
= 0.99 for a standard Pitot tube or as determined by calibration for a Type S Pitot tube
34.97 = Pitot tube constant
Note: The Pitot tube constant is determined on the basis of the following units: $m/s[g/g\ mole\ (mm\ Hg)/(K)(mm\ H_2O)]^{0.5}$
ΔP = velocity pressure, mm H2O
T = temperature, K
28.56 = molecular weight of air
P_{Baro} = barometric pressure, mm Hg
P_s = duct static pressure, mm Hg

The mass flow rate shall be calculated as follows:

$$m = 3600VAp$$

where:
m = mass flow rate, kg/h
V = air flow velocity, m/s
3600 = number of seconds per hour
A = duct cross-sectional area, m2
p = density of air at standard temperature and pressure (use 1.204 kg/m3)

The rate of heat release into the circulating air shall be calculated using the air flow and change in enthalpy, as follows:

$$\Delta e = \Delta h \times m$$

Where:
Δe = rate of heat release into the circulating air, kJ/h
Δh = change in enthalpy of the circulating air, kJ/kg
m = mass air flow rate, kg/h

The heat output over any time interval shall be calculated as the sum of the heat released over each measurement time interval, as follows:

$$E_t = \sum(\Delta e \times i) \text{ for } i = t_1 \text{ to } t_2$$

Where:

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Et = delivered heat output over any time interval t_2–t_1, kJ
i = time interval for each measurement, h

The average heat output rate over any time interval shall be calculated as follows:

$$e_t = E_t / t$$

where
e_t = average heat output, kJ/h
t = time interval over which the average output is desired, h

The total heat output during the burn shall be calculated as the sum of all the heat outputs over each time interval, as follows:

$$E_d = \sum(E_t) \text{ for } t = t_0 \text{ to } t_{final}$$

Where:
E_d = heat output over a burn, kJ/h (Btu/h)
E_t = heat output during each time interval, kJ/h (Btu/h)

The efficiency shall be calculated as the total heat output divided by the total energy input, expressed as a percentage as follows:

$$\text{Efficiency, \%} = 100 \times E_d / I$$

Where:
E_d = total heat output of the appliance over the test period, kJ/kg
I = input energy (fuel calorific value as-fired times weight of fuel charge), kJ/kg (Btu/lb)

SECTION 9
TEST SPECIMEN DESCRIPTION

The model 15-SSW01 Wood Fuel Room Heater is constructed of sheet steel. The outer dimensions are 35.75-inches high, 22-inches wide, and 27-inches deep. The unit has a door located on the front with a viewing glass.

SECTION 10
TEST RESULTS

DESCRIPTION OF TEST RUNS:

RUN #1 (01/24/19): Air control set for a category 1 burn rate with a burn time of 292 minutes. The test was loaded in 60 seconds with the door remaining open for 5 minutes after the fuel

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was added. Air shutter was fully closed. The fan was set to low position. The results of the test ended as a category 3 burn rate of 1.283 kg/hr. This test was not used.

RUN #2 (01/25/1): Air control set for a category 1 burn rate with a burn time of 167 minutes. The test was loaded in 60 seconds with the door remaining open for 3.5 minutes after the fuel was added. The fan was set to low position. The bi-metal spring did not activate as required and the test resulted in a category 4 with a burn rate of 2.208 kg/hr. This test was not used

RUN #3 (01/28/19): Air control set for a category 1 burn rate with a burn time of 340 minutes. The test was loaded in 60 seconds with the door remaining open for 4.5 minutes after the fuel was added. Air shutter fully closed. The fan was set to low position. The results of the test ended as a category 2 burn rate of 1.155 kg/hr. This test was not used.

RUN #4 (01/29/19): Air control set for a category 2 burn rate with a burn time of 312 minutes. The test was loaded in 60 seconds with the door remaining open for 1 minute after the fuel was added. Air shutter fully closed. The fan was set to low position. The results of the test ended as a category 2 burn rate of 1.217 kg/hr.

RUN #5 (01/31/19): Air control set for a category 4 burn rate with a burn time of 70 minutes. The test was loaded in 60 seconds with the door remaining open for 3 minutes after the fuel was added. Air shutter full open. The fan was set to low position. The filters began to plug after 30 minutes of testing and became completely plugged at 70 minutes, Test was discontinued. This test was not used.

RUN #6 (01/31/19): Air control set for a category 4 burn rate with a burn time of 182 minutes. The test was loaded in 60 seconds with the door remaining open for 5 minutes after the fuel was added. Air shutter full open. The fan was set to high position. The results of the test ended as a category 4 burn rate of 2.021 kg/hr.

RUN #7 (02/01/19): Air control set for a category 3 burn rate with a burn time of 187 minutes. The test was loaded in 60 seconds with the door remaining open for 1 minute after the fuel was added. Air shutter set at 1/8” from fully closed. The fan was set to high position. The results of the test ended as a category 4 burn rate of 2.005 kg/hr. This test was not used.

RUN #8 (02/04/19): Air control set for a category 3 burn rate with a burn time of 260 minutes. The test was loaded in 60 seconds with the door remaining open for 1.75 minutes after the fuel was added. Air shutter set at 1/6” from fully closed. The fan was set to high position. The results of the test ended as a category 3 burn rate of 1.466 kg/hr.

RUN #9 (02/05/19): Air control set for a category 1 burn rate with a burn time of 387 minutes. The test was loaded in 60 seconds with the door remaining open for 5 minutes after the fuel

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was added. Air shutter fully closed. The fan was set to low position. The results of the test ended as a category 1 burn rate of 0.923 kg/hr.

TABLE 1 – EMISSIONS

RUN#	TEST DATE	BURN RATES (kg/hr)(Dry)	PARTICULATE EMISSION RATE (g/hr)	1st HOUR EMISSIONS (g)	CO EMISSIONS (g/min)	HEATING EFFICIENCY (%HHV)
4	01/29/19	1.217	2.228	11.62	1.62	73.9
6	01/31/19	2.021	2.562	7.137	1.97	73.1
8	02/04/19	1.446	0.858	3.042	1.56	74.4
9	02/05/19	0.923	2.166	9.934	1.49	73.6

TABLE 2 – WEIGHTED AVERAGE CALCULATION

RUN #	BURN RATE	(E) AVERAGE EMISSION RATE g/hr	(CO) AVERAGE EMISSION RATE g/hr	(OHE)	HEAT OUTPUT (Btu/hr)	PROBABILITY	(K) WEIGHTING FACTOR	(KxE)	(KxOHE)
9	0.923	2.166	89.26	73.60	11129.72	0.3129	0.5575	1.2075	41.03
4	1.217	2.228	97.16	73.90	14674.83	0.5575	0.4181	0.9315	30.90
8	1.466	0.858	93.54	74.40	17677.32	0.7310	0.3579	0.3071	26.63
6	2.021	2.562	118.36	73.10	24369.62	0.9154	0.2690	0.6893	19.67
						Totals	1.60248	3.1353	118.22
								Weighted Average Emissions (g/hr)	1.96
								Weighted Average Overall Efficiency (%)	73.77

TABLE 3 – TEST FACILITY CONDITIONS

RUN #	ROOM TEMP BEFORE (°F)	ROOM TEMP AFTER (°F)	BARO PRES BEFORE (in/Hg)	BARO PRES AFTER (in/Hg)	R. H. BEFORE (%)	R. H. AFTER (%)	AIR VEL BEFORE (ft/min)	AIR VEL AFTER (ft/min)
4	69	70	28.82	28.83	14.0	13.0	0	0
6	68	72	29.29	29.26	11.0	11.0	0	0
8	72	71	28.57	28.69	31.0	28.0	0	0
9	70	68	29.10	29.03	24.0	19.0	0	0

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Report No.: 103758222MID-001
Date: 11/18/19

TABLE 4 – DILUTION TUNNEL FLOW RATE MEASUREMENTS AND SAMPLING DATA

RUN #	BURN TIME (min)	VELOCITY (ft/sec)	VOLUMETRIC FLOW RATE (dscf/min)	AVG TEMP (°R)	SAMPLE VOLUME (dscf)		PARTICULATE CATCH (mg)	
					1	2	1	2
4	312	18.77	201.70	546.31	73.93	73.82	14.30	12.90
6	182	17.68	186.44	565.30	43.94	43.84	10.50	9.60
8	260	19.60	207.01	551.99	59.37	59.30	4.60	3.60
9	387	22.72	248.89	540.19	90.71	90.58	14.10	12.20

TABLE 5 - DILUTION TUNNEL DUAL TRAIN PRECISION

RUN #	SAMPLE RATIOS		TOTAL EMISSIONS (g)		DEVIATION (%)	DEVIATION (g/kg)
	TRAIN 1	TRAIN 2	TRAIN 1	TRAIN 2		
4	851.22	852.54	12.17	11.00	5.07	0.186
6	772.32	774.01	8.11	7.43	4.37	0.111
8	906.62	907.67	4.17	3.27	12.14	0.142
9	1061.85	1063.42	14.97	12.97	7.15	0.336

TABLE 6 - GENERAL SUMMARY OF RESULTS

RUN #	BURN RATE (kg/hr)(dry) (OVERALL)	INITIAL DRAFT (in/H_2O)	RUN TIME (min)	AVERAGE DRAFT (in/H_2O)
4	1.217	0.033	312	0.026
6	2.021	0.028	182	0.035
8	1.466	0.046	260	0.029
9	0.923	0.036	387	0.021

TABLE 7 - CSA B415.1 RESULTS

BURN RATE (kg/hr)(dry)	CO EMISSIONS (g/min)	HEATING EFFICIENCY (% HHV)	HEAT OUTPUT (Btu/hr)
Run #4 – 1.20	1.62	73.9	16,622
Run #6 – 2.01	1.97	73.1	27,546
Run #8 – 1.44	1.56	74.4	20,162
Run #9 – 0.91	1.49	73.6	12,617

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SECTION 11
CONCLUSION

This test demonstrates that this unit is an affected facility under the definition given in the regulation. The emission rate of 1.956 g/hr meets the EPA requirements for the Step 2 limits.

Model 15-SSW01 is a representative for similar models 50-SHSSW01 and 50-TRSSW01. All models have the same internal design, electrical components, and controls. The only differences are external cosmetic designs.

SECTION 12
PHOTGRAPHS

Photo No. 1

Final security wrap

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SECTION 13
REVISION LOG

REVISION #	DATE	PAGES	REVISION
0	11/18/19	N/A	Original Report Issue

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
30-DAY NOTIFICATION FORM
PURSUANT TO 40 CFR PART 60 SUBPARTS AAA AND QQQQ
2015 STANDARDS OF PERFORMANCE FOR NEW RESIDENTIAL WOOD HEATERS, NEW RESIDENTIAL HYDRONIC HEATERS AND FORCED-AIR FURNACES

Disclaimer: The statutory provisions and the EPA regulations described in this document contain legally binding requirements. This document is not a substitute for those provisions or regulations, nor is it a regulation itself. In the event of a discrepancy, please refer to 40 CFR PART 60 Subparts AAA AND QQQQ, Sections 60.533 and 60.5475. This document may be revised periodically without public notice. If you have additional questions, please contact Rafael Sanchez at 202-564-7028 or via email at sanchez.rafael@epa.gov.

- **The manufacturer of an affected wood/pellet heater/central heater model line must notify the Administrator of the date that certification testing is scheduled to begin by email to WoodHeaterReports@epa.gov.**
- **This notice must be received by the EPA at least 30 days before the start of testing.**

GENERAL INFORMATION						
Manufacturer's Name: **England's Stove Works, Inc.**						
Appliance Type (Circle One):	Adjustable Burn Rate Wood Heater	Pellet Stove	Single Burn Rate Heater	Hydronic Heater	Forced Air Furnace	Other:
Hydronic Heater Type (Circle One):	Traditional	Full Storage	Partial Storage	Indoor/Outdoor	Other:	
Forced-Air Furnace Type (Circle One):	Small (less than 65,000 BTU/hr heat output)		Large (greater than 65,000 BTU/hr heat output)		Other:	
Fuel Type:	Crib	Pellet	Cordwood	Other:		
Model Name and Number: **15-SSW01, 50-SHSSW01, 50-TRSSW01**						
Catalyst: Yes_____ No___X____						
Mailing Address: **PO BOX 206 MONROE, VA 24574**						
Street Address: **589 SOUTH FIVE FORKS ROAD**						
City: **MONROE**	**State:** **VA**	**ZIP Code:** **24574**				
Phone: **434-929-0120**	**Fax:** **434-929-4810**	**Web Site:** **WWW.HEATREDEFINED.COM**				
Address of Manufacturing Facility: **100 WEST PROGRESS LANE**						
City: **MADISON HEIGHTS**	**State** **VA**	**ZIP Code:** **24572**				

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EPA APPROVED TEST LABORATORY		
Name and Title of Authorized Representative: **Brian Ziegler – Technical Team Leader - Hearth**		
Company: **Intertek**		
Phone: **608-824-7425**	**E-mail:** **brian.ziegler@intertek.com**	**Fax:** **608-831-9279**
City: **Middleton**	**State:** **WI**	**ZIP Code:** **53562**
EPA APPROVED THIRD-PARTY CERTIFIER		
Name and Title of Authorized Representative: **Charles Meyers – Certification Manager**		
Company: **Intertek**		
Phone: **312-906-7783**	**E-mail:** **charles.meyers@intertek.com**	**Fax:**
City: **Arlington Heights**	**State:** **IL**	**ZIP Code:** **60005**
COMPLIANCE TEST INFORMATION		
Test Method(s): **EPA METHOD 28A, ASTM E2780 and ASTM E2515**		
Date(s) of Proposed Test: **01/21/19**		
Testing Location: **Intertek** **8431 Murphy Drive** **Middleton, WI 53562**		

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- **This notice must be received by the EPA at least 30 days before the start of testing.**

Michael Speight, Purchasing

Print Name and Title of Authorized Official

Signature

12/11/18

Date

Remarks:

v1

INTRODUCTION

This document provides a systematic guide for the technician conducting tests to EPA standard requirements. Procedures outlined here, when followed, will result in tests in conformance with EPA Method 28R, ASTM E2780, and ASTM E2515. This guide cannot cover every possible contingency that may develop during a particular test program. Many questions that may arise can be answered by a complete understanding of the test standards and their intent. When in doubt on any detail check with the laboratory manager and be sure you understand the procedures involved.

The primary measurements to be obtained are particulate emission data and efficiency data. The technician's duties include the following steps. It is critical that all spaces on the data forms be properly filled in. Each test must be represented by a complete record of what was done and when.

I. APPLIANCE INSPECTION AND SET-UP
   - A. Incoming Inspection
   - B. Unit Set-Up

II. SAMPLING SYSTEMS - SET-UP
   - A. Gas Analysis
   - B. Dilution Tunnel

III. TEST CONDUCT
   - A. Pre-Test Fuel Load
   - B. Test Fuel Load
   - C. Unit Start - up
   - D. Test Run

IV. POST TEST PROCEDURE
   - A. Leak Checks
   - B. Particulate Sample Recovery

The technician running this test must be familiar with the following documents that are to be kept in the laboratory at all times.

1. EPA Method 28R
2. ASTM E2780
3. ASTM E2515

I. APPLIANCE INSPECTION AND SET-UP

A. Incoming Inspection

1. Check for completeness of unit including parts, accessories, installation and operating instructions, drawings and specifications, etc. Note any discrepancies or missing parts.
2. Check for shipping damage. If damage has occurred, notify the laboratory manager. In some cases repairs may be made, provided the manufacturer and laboratory manager concur that repairs will not affect the unit's performance. If damage is irreparable, a new unit will need to be obtained.
3. Note whether unit is catalytic or non-catalytic.
4. Mark unit with manufacturer's name, model number, work order number, and date received.
5. If unit is safety listed, note label data including listing agency and serial number.

B. Unit Set-Up

1. All units must be operated by the manufacturer or Intertek for a break-in period of 50 hours at a medium burn rate. NOTE: Inserts are tested as if they are freestanding stoves.
2. Once break-in is completed, allow unit to cool then clean unit thoroughly.
3. Thermocouples must be attached to surfaces of wood heaters prior to testing. EPA requires a thermocouple on the outside bottom of the firebox. This must be installed prior to putting the unit on the scale. In some cases the required thermocouple locations will be inaccessible on finished units. Check with the laboratory manager if problems are encountered in proper thermocouple attachment.
4. Prior to placing unit on scale, the scale must be turned on and allowed to warm up for 1-hour minimum.
5. Place unit on scale and align so chimney will be centered in hood. Record the weight of the unit and all accessories. (Do not weigh with chimney attached.)
6. Chimney and connector should be cleaned with a wire brush prior to mounting. Attach chimney and connector then seal all joints. Be sure the single wall stove pipe terminates and insulated pipe starts at proper level above scale platform. Chimney must be supported from scale so that it does not touch test enclosure or hood walls.
7. Measure firebox dimensions and record on appropriate data form. Make a three dimensional sketch of the firebox including firebrick, baffles, and obstructions. Calculate firebox volume in cubic feet. See Section 9.3 of ASTM E2780-10 for details.
8. If unit is equipped with a catalyst additional thermocouples must be installed downstream of the catalyst.

9. Plug thermocouples into data acquisition system jacks and verify that all instrumentation is working properly.
10. Dilution tunnel must be cleaned prior to each certification test series, and at anytime a higher burn rate follows a lower burn rate.

II. SAMPLING SYSTEMS SET-UP

A. Gas Analysis

1. All instruments should be turned on and allowed to warm up for 1-hour minimum.
2. Prior to calibrating, make sure that the outlet pressure on each calibration gas bottle reads 10 PSI. Adjust flow meters at each gas analyzer to required flow.

The gas analyzer (CO_2, CO, O_2) is zeroed on nitrogen. The O_2, CO_2 and CO analyzer is spanned with a certified span gas mixture.

Calibrate analyzers as follows:

a. With calibration switch at "SPAN", adjust all span controls to values specified on span gas label.
b. Switch to "ZERO" and adjust zero controls to provide 0.00 readout on all analyzers.
c. Repeat a. and b. until no further adjustment is required.
d. Record these values on the appropriate data sheet.
e. Switch to "CAL." and record all analyzer values.

3. Response time synchronization check.

a. With switch at "SAMPLE" and no fire in unit, allow readings to stabilize (O_2 analyzer should read 20.93, CO and CO_2 should read 0.00).
b. Switch to "CAL" setting and start the stopwatch. Note the time required for each unit to reach the calibration gas bottle value. If all three analyzers reach this value within 5 seconds of each other, synchronization is adequate. If not, contact the laboratory manager. Synchronization is adjusted by either internal instrument setting or adjustment of sample line length.
c. Use EPA Method 5H 6.7-6.9 procedures to check calibration of instruments.

4. Sample clean-up train.

a. Load a new filter in 4-inch glass filter holder.
b. Load four Impingers as follows:
#1: 100 ml. distilled water
#2: 100 ml. distilled water
#3: Empty
#4: 200-300 grams Drierite.

c. Place Impingers in container and connect with greased "U TUBES". (Grease carefully on bottom half of ball joint so that grease will not get into tubes.)
d. Connect filter to impinger #1 and sample line to impinger #4.
e. Connect stack probe to filter.
f. Leak check system as follows:
1) Plug probe.
2) Turn on sample system and increase flow rate slowly.
3) Set vacuum-adjust valve to obtain a vacuum of 10 inches mercury.
4) If sapphire float in rotometer does not stabilize below 10 on scale, system must be resealed.
5) Repeat leak-check procedure until satisfactory results are obtained.
6) Unplug probe slowly, then decrease flow rate slowly before shutting off system.

g. Just prior to starting test, fill impinger container with ice.

B. Dilution Tunnel Sample Train Set-Up:

1. Filters and holders.
a. Clean probes and filter holder front housings carefully and desiccate to a constant weight prior to use.
b. Filters and filter probe combinations should be numbered and labeled prior to use.
c. Weigh desiccated filters and probe filter units on analytical balance. Record the weights on the appropriate form. Note that the probe and front half of the front filter holder is to be weighed as a unit.
d. Carefully assemble the filter holder units and connect to sampling systems.
e. Change desiccate columns with dry absorbent before each test series.

2. Leak checking.

   a. Each sample system is to be checked for leakage prior to inserting probes in tunnel.
   b. Plug probes and start the samplers. Adjust pump bypass valve to produce a vacuum reading of 10 inches mercury. NOTE: During test, highest vacuum recorded is required for posttest leak check.
   c. Allow vacuum indication to stabilize at 10" mercury, record dry gas meter readings, (DGM_1, DGM_2). At a convenient DGM value start stopwatch. Time for 1 minute then stop vacuum pumps. Record dry gas meter readings again, (DGM_3, DGM_4). NOTE: If rotometer ball is floating above the 5-mm mark, system is leaking too much and all seals should be checked.
   d. Calculate leakage rate as follows.

      System 1: DGM3-DGM_1 = CFM_1
      System 2: DGM4-DGM_2 = CFM_2

      If CFM_1 or CFM_2 is greater than 0.02 cfm, or $_1$S greater than 0.04 x Sample Rate, leakage is unacceptable and system must be resealed. For most tests the sample rate will be 0.25 cfm, thus leakage rates in excess of 0.04 x 0.25 = 0.010 cfm are not acceptable.
   e. To prevent contamination, do not insert probes in tunnel until the start of the test run.

III. TEST CONDUCT

A. Pre-Test Fuel Load

1. Using 2x4 Douglas fir cut enough pieces to approximate test load weight. (Piece length must be greater than 1/3 of the test load length.)
2. Measure percent moisture content using Delmhorst moisture meter. The average percent moisture must be within 19 to 25 percent.

B. Test Fuel Load

1. Determine optimum load weight by multiplying firebox volume (cubic feet) by 7. This is the ideal load weight.
2. Determine piece size mix i.e. <1.5 cubic feet volume use 2x4's only; 1.5 ft^3 to 3.0 ft^3 use a mix of 2.4's and 4x4's; >3.0 ft_3 use only 4x4's. Ideal length is 5/6 of the longest firebox dimension.
3. Weigh out test load and appropriate number of spacers and adjust weight by shortening or lengthening all pieces equally if necessary.
4. Construct test loads by attaching spacers as shown in ASTM E2780.
5. Measure and record moisture content of each fuel piece (use three sides).

Determine if fuel load moisture content is within required range (19-25%). If not, construct new fuel pieces using wood with required moisture content.
All wood in the humidity chamber is Douglas fir and should be within range. Contact laboratory manager if you cannot find suitable pieces.

C. Unit Start-Up

1. With all doors and air controls closed, zero draft Magnehelic using screw located at bottom of meter.
2. Before lighting a fire turn on dilution tunnel and set flow rate to 140 scfm (approximately 715 fpm) if burn rate is to be less than 3 kg/hr. For higher burn rates set flow for a 150:1 air fuel ratio (see chart for approximate values).
3. Check draft imposed on cold stove. All inlets must be closed and a draft gauge in the chimney. If draft is greater than 0.005 inches water column, adjust tunnel to stack gap until draft is less than 0.005 inches water column.
4. With hot wire anemometer check for ambient airflow around unit (must be less than 50 ft/min).
5. Zero scale and start fire with newspaper and Douglas Fir kindling. (Make sure stack sample probe is on the unit.)
6. Once kindling is burning well, add preload fuel. Operate at high fire for sufficient time to get fuel load burning well. Then adjust settings to intended test run levels.
7. Perform the dilution tunnel traverse as prescribed in ASTM E2515, Section 9.3.2. (Pitot tube should be carefully cleaned prior to each test.)
8. Pretest load must burn for a minimum of 1 hour. Record stove surface, catalyst, room, and flue temperatures.
9. Stir fire often during preburn (after a reading) to get a good coal bed. Fire can only be raked once (door open 1 minute or less) during the 15 minutes prior to the start of the test.

D. Test Run

1. Stack gas analyzers should be on and in the sample mode.
2. When the fuel bed is between 20-25% of the test load weight the test is to be started.
   a. Insert the sample probes into the tunnel being careful not to hit sides of tunnel with probe tip.
   b. Check tunnel Pitot tube for proper position.
   c. Record initial readings.
   d. Turn on probe sample systems and start timing test.
   e. Tare platform scale.
   f. Open stove doors and load stove. Close door or follow manufacturer's start-up procedures. Five minutes is the maximum time before all doors and controls must be set to final positions for duration of test.

g. Record length of time door and bypass are open, include any air control setting adjustments.
h. Every 10 minutes record the following:
   1) Dry gas meter readings.
   2) Weight remaining.
   3) All thermocouple temperatures.
   4) Tunnel Pitot tube reading.
   5) Draft reading.
   6) Rotometer readings.
i. Filter temperatures shall not exceed 90ºF anytime during the test. If the filters are approaching 90ºF turn on cooling pump. Filters must be kept above the dilution tunnel wet bulb temperature in order to prevent condensation.
j. Regularly check impinger train for ice level during test.
k. After 30 seconds of 0.00 lbs. weight, and on the minute, shut off sample trains and record last reading.
l. Record final dry gas meter values.

IV. POST TEST PROCEDURES

A. Leak Checks

1. Dilution Tunnel
   a. Remove both sample probes from tunnel and plug with rubber stopper.
   b. Turn on sample system and set vacuum to 10" mercury or to the highest value reached during the test.
   c. At a convenient value start stopwatch and record the DGM starting value.
   d. After 1 minute stop sample system and record ending DGM value.
   e. Calculate leakage rate per pre-test description (see II.B.2.c.).

2. Gas Analyzers

   a. Set stack sample flow to about 75 mm on the rotometer.
   b. Plug with rubber stopper.
   c. Adjust vacuum to 10" mercury.
   d. Let system stabilize then record rotometer readings.
   e. If the rotometer readings do not equal zero, check with the laboratory manager.
   f. SLOWLY unplug probe and decrease flow rate to zero.
   g. Turn off stack sampling system.
   h. Zero, span and calibrate the analyzers (see Gas Analysis). RECORD ONLY these meter values.

B. Particulate Sample Recovery

1. Disassemble filter holder and scrape gasket with scalpel. Collect all loose material on filters.
2. Weigh and record probes and filters for each train. NOTE: 24 hours of desiccation must pass before final "no change" weight values can be recorded.
3. Weigh and record probes and fillers at 6-hour intervals until weight change between weighing is less than 0.5 mg.

V. DISPOSITION OF TESTED UNIT.

In order to meet the requirements of section 60.533(b)(8) of the EPA's 40CFR Part 60 Standards of Performance for New Stationary Sources; New Residential Wood Heaters, Intertek Testing Services seals certified wood heaters by:

1) Applying tamper-indicating tape to the firebox door, ash pan door, and the air controls.
2) Totally covering the unit with stretch wrap and stamping the stretch wrap with our WHI logo at various locations.
3) Strapping the door and ash pan closed with plastic banding so that the banding goes both around the unit laterally and from top to bottom. The banding is then stamped with our WHI logo so that the banding can't be simply replaced.
4) The certificate is then placed on the top of the unit and a second layer of stretch wrap is applied and stamped with our WHI logo.
5) The unit is placed on a pallet and strapped down with additional strapping to keep it on the pallet. It is then shipped back to the manufacturer.

Test No.	Burn Rate	Emission Rate g/hr	(OHE)	Output (BTU/HR)	Prob.	Weighting Factor	(KxE)	KxOHE
9	0.923	2.166	73.60	11129.72	0.3129	0.5575	1.2075	41.03
4	1.217	2.228	73.90	14674.83	0.5575	0.4181	0.9315	30.90
8	1.466	0.858	74.40	17677.32	0.7310	0.3579	0.3071	26.63
6	2.021	2.562	73.10	24369.62	0.9154	0.2690	0.6893	19.67
				0.00	1.0000	0.0000	0.0000	0.00
				0.00	1.0000	0.0000	0.0000	0.00
				0.00	1.0000	0.0000	0.0000	0.00
				0.00	1.0000	0.0000	0.0000	0.00
				0.00	1.0000	0.0000	0.0000	0.00
						0.0000	0.0000	0.00
				0.00				
						1.60248	3.1353	118.22

emissions rate:	1.9565
Weighted Average OHE	73.77

England Stove Works

Manufacturer: England Stoves
Model: 15SSW01
Date: 01/24/19
Run: 1
Control #: G103758222
Test Duration: 292
Output Category: 3

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	74.0%	80.0%
Combustion Efficiency	94.4%	94.4%
Heat Transfer Efficiency	78%	84.8%

Output Rate (kJ/h)	18,559	17,605	**(Btu/h)**
Burn Rate (kg/h)	1.27	2.79	**(lb/h)**
Input (kJ/h)	25,063	23,775	**(Btu/h)**

Test Load Weight (dry kg)	6.16	13.57	**dry lb**
MC wet (%)	16.88		
MC dry (%)	20.31		
Particulate (g)	7.71		
CO (g)	488		
Test Duration (h)	4.87		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.09	5.41	
g/kg Dry Fuel	1.25	79.29	
g/h	1.58	100.31	1.671886
lb/MM Btu Output	0.20	12.56	

Air/Fuel Ratio (A/F)	13.87

VERSION: **2.2** **12/14/2009**

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	70	0	28.76	28.82	20.0	19.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
292	18.74	200.68	547.40	68.76	68.71	9.30	8.20

	Dilution Tunnel Dual Train Precision				
	Sample Ratios		Total Emissions (g)		
	Train 1	Train 2	Train 1	Train 2	Deviation (%)
	852.14	852.84	7.92	6.99	6.24%

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
1.283		0.000		0.024		292.000	0.026

Run	Date	Burn Rate	Emission
1	1/24/2019	1.283	1.533

England Stove Works

Manufacturer: England Stoves
Model: 15SSW01
Date: 01/25/19
Run: 2
Control #: G103758222
Test Duration: 167
Output Category: 4

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	75.2%	81.3%
Combustion Efficiency	96.8%	96.8%
Heat Transfer Efficiency	78%	84.0%

Output Rate (kJ/h)	32,988	31,292	**(Btu/h)**
Burn Rate (kg/h)	2.21	4.88	**(lb/h)**
Input (kJ/h)	43,870	41,615	**(Btu/h)**

Test Load Weight (dry kg)	6.16	13.58	**dry lb**
MC wet (%)	16.26		
MC dry (%)	19.42		
Particulate (g)	8.96		
CO (g)	281		
Test Duration (h)	2.78		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.10	3.06	
g/kg Dry Fuel	1.45	45.61	
g/h	3.22	101.01	1.683532
lb/MM Btu Output	0.23	7.12	

Air/Fuel Ratio (A/F)	12.43

VERSION: **2.2** **12/14/2009**

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	69	0	29.10	29.10	16.0	15.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
167	18.82	197.55	564.52	39.05	39.04	8.40	7.80

Dilution Tunnel Dual Train Precision					
Sample Ratios		Total Emissions (g)			
Train 1	Train 2	Train 1	Train 2	Deviation (%)	
844.75	845.12	7.10	6.59	3.68%	

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
2.208		0.000		0.029		167.000	0.036

Run	Date	Burn Rate	Emission
2	1/25/2019	2.208	2.459

ABC Laboratories, Inc.

Manufacturer: England Stoves
Model: 15SSW01
Date: 01/21/19
Run: 1
Control #: G103758222
Test Duration: 252
Output Category: 4

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	73.5%	79.4%
Combustion Efficiency	97.4%	97.4%
Heat Transfer Efficiency	75%	81.6%

Output Rate (kJ/h)	20,058	19,027	**(Btu/h)**
Burn Rate (kg/h)	1.38	3.04	**(lb/h)**
Input (kJ/h)	27,297	25,894	**(Btu/h)**

Test Load Weight (dry kg)	5.79	12.76	**dry lb**
MC wet (%)	17.33		
MC dry (%)	20.96		
Particulate (g)	4.33		
CO (g)	250		
Test Duration (h)	4.20		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.05	2.96	
g/kg Dry Fuel	0.75	43.14	
g/h	1.03	59.45	0.990799
lb/MM Btu Output	0.12	6.89	

Air/Fuel Ratio (A/F)	18.77

VERSION: **2.2** **12/14/2009**

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	71	0	28.50	28.66	18.0	16.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
340	18.67	199.07	545.68	76.66	76.58	20.30	17.50

Dilution Tunnel Dual Train Precision					
Sample Ratios		Total Emissions (g)			
Train 1	Train 2	Train 1	Train 2	Deviation (%)	
882.92	883.85	17.92	15.47	7.35%	

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
1.155		0.000		0.036		340.000	0.024

Run	Date	Burn Rate	Emission
3	1/28/2019	1.155	2.946

ABC Laboratories, Inc.

Manufacturer: England Stoves
Model: 15SSW01
Date: 01/29/19
Run: 4
Control #: G103758222
Test Duration: 312
Output Category: 2

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	73.9%	79.9%
Combustion Efficiency	94.3%	94.3%
Heat Transfer Efficiency	78%	84.7%

Output Rate (kJ/h)	17,522	16,622	**(Btu/h)**
Burn Rate (kg/h)	1.20	2.64	**(lb/h)**
Input (kJ/h)	23,700	22,482	**(Btu/h)**

Test Load Weight (dry kg)	6.22	13.71	**dry lb**
MC wet (%)	16.48		
MC dry (%)	19.73		
Particulate (g)	11.59		
CO (g)	505		
Test Duration (h)	5.20		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.13	5.54	
g/kg Dry Fuel	1.86	81.21	
g/h	2.23	97.16	1.619259
lb/MM Btu Output	0.30	12.89	

Air/Fuel Ratio (A/F)	13.97

VERSION: **2.2** **12/14/2009**

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job # G103758222 Run #4 CAT E

Date 1-29-19
Tech Ken Slater

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 28.82 (inches Hg.) Static pressure (P_q) .336 (inches w.c.)
Inside diameter: Port A ____ in Port B ___ in Tunnel cross sectional area: ____ Ft^2
Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.103		
B-Centroid	3.00	.104		
A-1	0.50	.090		
A-2	1.50	.098		
A-3	4.50	.101		
A-4	5.50	.094		
B-1	0.50	.090		
B-2	1.50	.100		
B-3	4.50	.095		
B-4	5.50	.089		
		AVERAGE		

Adjustment factor application

Pitot correction 96.67

Where,
C_p = Pitot tube coefficient = 0.99 for standard pitot
Δ_p = manometer reading (inches H_2O)
T_s = average absolute dilution tunnel temperature (°F + 460)
P_s = absolute dilution tunnel gas pressure or Pbar + P_g

P_g = static pressure $\frac{inches H_2O}{13.6}$

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)

Adjustment factor for alternative Pitot tube placement:

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}} \qquad F_p = \frac{\left(\sqrt{\Delta_p}\right) avg}{\left(\sqrt{\Delta_p}\right) centroid}$$

K_p = 85.49 Pitot tube constant, (conversion factor for English units)

$\left(\sqrt{\Delta_p}\right) avg.$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #4 CAT 2

Date 1-29-19
Tech KW Ken Slater

Pre/Post Checks

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity.....	✓ fpm	✓ fpm
Smoke Capture Check.....	0	0
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned.....	1-21-19	
Date Dilution Tunnel Cleaned.....	1-21-19	
Induced Draft Check.....	✓	✓
Tunnel Velocity.....	.112	.109
Pitot Leak Check:		
Side A.....	✓	✓
Side B.....	✓	✓
Temperature System:		
Ambient (65°- 90°F).....	°F	
Proportional Checks:		
CO Analyzer Drift Check.....		✓
CO_2 Analyzer Check.....		✓
O_2 Analyzer Check.....		✓
Thermocouple check.....		

Sampling Train ID Numbers:	Train 1	Train 2	TRAIN 5
Probe.....	1	5	1
Filter Front.....	37	39	1
Filter Back.....	38	40	2
Filter Thermocouple.....	19	22	
Filter 5G-3 (<90°F).....			

mn

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #4 CAT 2

Date 1-29-19
Tech _____
Ken Grater

Pre-Test Scale Audit

Scale Type	Audit Weight		Measured Weight	
Platform	25.00	lbs., Class F	25.00	lbs.
Wood	10.00	lbs., Class F	10.00	lbs.
Analytical	100.000	mg, Class S	100.000	mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE: ..... 50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE ..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE ..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #4 CAT 2

Page 4 of 10
Date 1-29-19
Tech Ken Slater

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers
Leakage Checks Tunnel Samplers

	SAMPLE 1		SAMPLE 2		SAMPLE 3	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-test	Post Test
Vacuum (inches Hg.)	10"	10"	10"	10"	10"	10"
Final 1 minute DGM (ft^3)	0	0	0	0	426.086	435.879
Initial 1 minute DGM (ft^3)	0	0	0	0	426.086	435.879
Change (C) (ft^3)	0	0	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job # G103758222 Run #4 CAT 2

Date 1-29-19
Tech Ken Slater

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO_2	0	0	24.88	24.88	11.95	11.99
CO	0	0	8.976	8.976	4.06	4.001
O_2	0	0	20.95	20.95	9.99	10.01
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO_2	0.01	24.75	11.87	.01	.13	.12	✓	
CO	-0.09	8.52	3.80	.09	.45	.26	✓	
O_2	0.02	20.89	9.95	.02	.06	.04	✓	

* Greater than ± 5% of the range used.

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #4 CRT2

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Date 1-29-19
Tech Ken Slater

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2	System 3
Final (ft^3)	77.31	77.29	435.859
Initial (ft^3)	0	0	426.086

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	72.5	70.8
Temperature (°F)	14	13
Humidity (%)	28.82	28.83

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #4 CAT 2

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Date 1-22-19
Tech Ken Slater

READING #	REAL TIME	ELAPSED TIME	DGM 1	ROTOMETER 1	DGM 2	ROTOMETER 2	DGM 3	ROTOMETER 3	DRAFT	MAX DGM PRESSURE
0	9:07	0					426.086			
1		10					427,660			
2		20					429.300			
3		30					430.930			
4		40					432.560			
5		50					434.290			
6		60					435.859			
7		70								
8		80								
9		90								
10		100								
11		110								
12		120								
13		130								
14		140								
15		150								
16		160								
17		170								
18		180								
19		190								
20		200								
21		210								
22		220								
23		230								
24		240								
25		250								
26		260								
27		270								
28		280								
29		290								
30		300								
31		310								
32		320								
33		330								
34		340								
35		350								
36		360								

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Manufacturer: England Stoves ___ Model : 15-SSW01
Job # G103758222 Run #4 CAT 2

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Date 1-29-19
Tech Ken Slater

COMMENTS

7:13 AM - PRE TEST STARTED

907 A~ TEST STARTED
DOOR REMAINED OPEN FOR 1 MINUTE
Air shutter fully closed
SHUTTER ACTIVATED @ 4 MINUTES

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job # G103758222 Run #4 cat 2

Date 1-29-19
Tech Ken Slater

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: 4.6 lbs. Consisting of: Scrap and paper Fire lit Time:
Pre-test load weight: 16.15 lbs. Consisting of: 2X4X inches Time loaded:
Pre-test moisture content: Uncorrected: % Corrected Dry: % Wet: %

Test Air Control Settings: Time:
Test Unit Fan Settings: Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	15.12 Lbs.	16.80 lbs.	18.48 Lbs.

Fire Box Volume:	2.4 Ft.^{3}	Ideal Length:	Inches
Load Volume:	Ft.^{3}	Loading Density:	lbs/ft^3
Spacer weight	2.81 Lbs	Load Density:	lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 15 in.	1.53 lbs.	19.7 %	20 %	21 %
2 x 4 x 15 in	1.38 lbs.	19.9 %	18.1 %	22.1 %
2 x 4 x 15 in	1.20 lbs.	19.3 %	20.2 %	19.7 %
2 x 4 x 15 in	1.33 lbs.	19.2 %	19.4 %	19.9 %
2 x 4 x 15 in	1.21 lbs.	20.7 %	18.4 %	19.7 %
4 x 4 x 15 in	3.60 lbs.	18.5 %	18 %	18.6 %
4 x 4 x 15 in	3.65 lbs.	20.5 %	20.8 %	20.8 %
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%

TEST LOAD WEIGHT: 16.61 lbs. **DRY WEIGHT:** 6.37 kg.
AVERAGE MOISTURE CONTENT:
(DRY) 19.73 % CORRECTED TO TWO PIN: (DRY) 19.73 % (WET) 16.48 %
COAL BED RANGE:
3.4 lbs. to 4.1 lbs. (10% to 15% of test load)
lbs. to lbs. (20% to 25% of test load)
TEST CHARGE:
Time loaded: 9.07 Coal bed weight: 3.7 lbs. Coal bed weight = % of test load weight

CHARCOALIZATION: good |--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

Intertek

Manufacturer : ENGLAND STOVES
Job # G103758222

Model: 15.55NV1
Run #4 CAT 2

Date 1-29-19
Tech K- Slater

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			SYSTEM 3				
		Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Temp	Humidity
Date	Time	I	37	38	J	39	40	1	1	2	°F	%
1-22-19	10:00A	89.6811	1.8610	1.8347	92.0499	3.2723	3.3407	91.3675	1.8449	1.7892	61.9	19
1-29-19	7:00A	89.6909	1.8608	1.8346	92.0497	3.2761	3.3406	91.3673	1.8447	1.7891	64.4	14
		Total:	3.6954		Total:	6.6167		Total:	3.6338			

Post-test Weight Record		SYSTEM 1		SYSTEM 2		SYSTEM 3			
		Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Temp	Humidity
Date	Time	I	37+38	J	39+40	1	1+2	°F	%
1-29-19	2:28	89.6823	3.7111	92.0504	6.6302	91.3682	3.6444	71.8	13
1-31-19	7:47	89.6809	3.7097	92.0497	6.6296	91.3673	3.6428	54.9	11
2-1-19	8:18	—	3.7097	—	6.6296	—	3.6428	64.5	13
2-4-19	7:02	—	3.7097	—	6.6295	—	3.6428	68.9	31

Dry Down Weight

Date	Time	P1	F1	P2	F2	P3	F3	Gr/hr	Lb/MMbtu
1-29-19	2:28	1.4	15.7	.7	13.5	.9	10.6	2.564	1.217
1-31-19	7:47	0	14.3	0	12.9	0	9.0	2.228	
2-1-19	8:18	0	14.3	0	12.9	0	9.0		
2-4-19	7:02	0	14.3	0	12.8	0	9.0		

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	69	70	28.82	28.83	14.0	13.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
312	18.77	201.70	546.31	73.93	73.82	14.30	12.90

Dilution Tunnel Dual Train Precision				
Sample Ratios		Total Emissions (g)		
Train 1	Train 2	Train 1	Train 2	Deviation (%)
851.22	852.54	12.17	11.00	5.07%

Burn			Initial		Run	Average
Rate		Surface	Draft		Time	Draft
1.217		0.000	0.033		312.000	0.026

Run	Date	Burn Rate	Emission
4	1/29/2019	1.217	2.228

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	69	0	29.29	28.83	12.0	13.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
70	17.91	180.03	588.53	6.97	7.33	16.00	15.60

Dilution Tunnel Dual Train Precision					
Sample Ratios		Total Emissions (g)			
Train 1	Train 2	Train 1	Train 2	Deviation (%)	
1808.74	1719.09	28.94	26.82	3.81%	

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
5.650		0.000		0.042		70.000	0.046

Run	Date	Burn Rate	Emission
5	1/31/2019	5.650	23.896

ABC Laboratories, Inc.

Manufacturer: England Stoves
Model: 15SSW01
Date: 01/31/19
Run: 6
Control #: G103758222
Test Duration: 182
Output Category: 4

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	73.1%	79.0%
Combustion Efficiency	95.8%	95.8%
Heat Transfer Efficiency	76%	82.5%

Output Rate (kJ/h)	29,039	27,546	**(Btu/h)**
Burn Rate (kg/h)	2.01	4.42	**(lb/h)**
Input (kJ/h)	39,719	37,678	**(Btu/h)**

Test Load Weight (dry kg)	6.08	13.40	**dry lb**
MC wet (%)	17.33		
MC dry (%)	20.96		
Particulate (g)	7.77		
CO (g)	359		
Test Duration (h)	3.03		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.09	4.08	
g/kg Dry Fuel	1.28	59.03	
g/h	2.56	118.36	1.972696
lb/MM Btu Output	0.21	9.47	

Air/Fuel Ratio (A/F)	12.94

VERSION: **2.2** **12/14/2009**

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job # G103758222 Run # 6 CAT 4

Page 1 of 10
Date 1-31-19
Tech Ken Slater

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.09 (inches Hg.) Static pressure (P_q) .313 (inches w.c.)
Inside diameter: Port A ___ in Port B ___ in Tunnel cross sectional area: ___ Ft^2
Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.102		
B-Centroid	3.00	.103		
A-1	0.50	.089		
A-2	1.50	.097		
A-3	4.50	.100		
A-4	5.50	.095		
B-1	0.50	.089		
B-2	1.50	.099		
B-3	4.50	.095		
B-4	5.50	.058		
		AVERAGE		

Adjustment factor application

Pitot correction .9659

Where,
C_p = Pitot tube coefficient = 0.99 for standard pitot
Δ_p = manometer reading (inches H_2O)
T_s = average absolute dilution tunnel temperature (°F + 460)
P_s = absolute dilution tunnel gas pressure or Pbar + P_g

P_g = static pressure $\frac{inches H_2O}{13.6}$

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)

Adjustment factor for alternative Pitot tube placement:

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}} \qquad F_p = \frac{\left(\sqrt{\Delta_p}\right) avg}{\left(\sqrt{\Delta_p}\right) centroid}$$

K_p = 85.49 Pitot tube constant, (conversion factor for English units)

$\left(\sqrt{\Delta_p}\right) avg.$ = Average of the square roots of the velocity heads ()p) measured at each traverse point.

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

Intertek

Manufacturer: England Stoves ____ Model : 15-SSW01
Job #_G103758222 Run #6 CAT 4

Page 2 of 10
Date 1-31-19
Tech Ken Slater

Pre/Post Checks

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	✓ fpm	✓ fpm
Smoke Capture Check	0	0
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	1-21-19	
Date Dilution Tunnel Cleaned	1-21-19	
Induced Draft Check	✓	✓
Tunnel Velocity	.101	.099
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)		✓ °F
Proportional Checks:		
CO Analyzer Drift Check		✓
CO_2 Analyzer Check		✓
O_2 Analyzer Check		✓
Thermocouple check		

Sampling Train ID Numbers:	Train 1	Train 2
Probe	5	6
Filter Front	9	11
Filter Back	10	12
Filter Thermocouple	19	22
Filter 5G-3 (<90°F)		

7
13
14

mn

Intertek

Manufacturer: England Stoves ___ _____ Model : 15-SSW01 _____
Job #_G103758222_____ Run 6 OAT 4

Page 3 of 10
Date 1-31-19
Tech KWK
Ken Slater

Pre-Test Scale Audit

Scale Type	Audit Weight		Measured Weight	
Platform	25.00	lbs., Class F	25.00	lbs.
Wood	10.00	lbs., Class F	10.00	lbs.
Analytical	100.000	mg, Class S	100.800	mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE..... 50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #6 CRT 4

Page 4 of 10
Date 1-31-19
Tech Ken Slater

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers
Leakage Checks Tunnel Samplers

	SAMPLE 1		SAMPLE 2		SAMPLE 3	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-test	Post Test
Vacuum (inches Hg.)	10"	10"	10	10	10	10
Final 1 minute DGM (ft^3)	0	0	0	0	443.635	453.416
Initial 1 minute DGM (ft^3)	0	0	0	0	443.635	453.416
Change (C) (ft^3)	0	0	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10	10"
Rotometer Reading (mm)	0	6
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Intertek

Manufacturer: England Stoves ____ Model : 15-SSW01 ____
Job #_G103758222 ____ Run #6 CAT 4

Page 5 of 10
Date 1-31-19
Tech Ken Slater

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO_2	0	0	24.88	24.88	11.97	11.99
CO	0	0	8.876	8.876	4.03	4.001
O_2	0	0	20.95	20.95	10.00	10.01
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO_2	-0.05	24.83	11.89	.05	.05	.08	✓	
CO	-0.07	8.71	3.87	.07	.26	.16	✓	
O_2	0.02	20.95	9.97	.02	0	.03	✓	

* Greater than ± 5% of the range used.

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #6 cont 4

Page 6e of 10
Date 1-31-19
Tech Ken Slater

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2	System 3
Final (ft^3)	45.75	45.33	453.495
Initial (ft^3)	0	0	443.635

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.29	29.26
Temperature (°F)	71.0	73.4
Humidity (%)	11	11

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run# 6 CAT 4

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Date 1-31-19
Tech Ken Slater

READING #	REAL TIME	ELAPSED TIME	DGM 1	ROTOMETER 1	DGM 2	ROTOMETER 2	DGM 3	ROTOMETER 3	DRAFT	MAX DGM PRESSURE
0	12:25	0					443.635			
1		10					445.215			
2		20					446.850			
3		30					448.585			
4		40					450.110			
5		50					451.730			
6		60					453.495			
7		70								
8		80								
9		90								
10		100								
11		110								
12		120								
13		130								
14		140								
15		150								
16		160								
17		170								
18		180								
19		190								
20		200								
21		210								
22		220								
23		230								
24		240								
25		250								
26		260								
27		270								
28		280								
29		290								
30		300								
31		310								
32		320								
33		330								
34		340								
35		350								
36		360								

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job # G103758222 Run #4 CAT 4

Date 1-31-19
Tech Ken Slater

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: 4.5 lbs. Consisting of: Scrap and paper Fire lit Time:
Pre-test load weight: 16.03 lbs. Consisting of: 2X4X inches Time loaded:
Pre-test moisture content: Uncorrected: % Corrected Dry: % Wet: %

Test Air Control Settings: Time:
Test Unit Fan Settings: Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	15.12 Lbs.	16.80 lbs.	18.48 Lbs.

Fire Box Volume:	2.4 Ft.^{3}	Ideal Length:	Inches
Load Volume:	Ft.^{3}	Loading Density:	lbs/ft^3
Spacer weight	2.96 Lbs	Load Density:	lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
4 x 4 x 15 in.	3.43 lbs.	22.7 %	22.1 %	22.2 %
4 x 4 x 15 in	3.48 lbs.	22.7 %	22.3 %	22.5 %
2 x 4 x 15 in	1.36 lbs.	18.0 %	18.1 %	18.3 %
2 x 4 x 15 in	1.29 lbs.	21.8 %	21.0 %	22.5 %
2 x 4 x 15 in	1.2 lbs.	21.2 %	21.4 %	22.2 %
2 x 4 x 15 in	1.42 lbs.	19.1 %	18.6 %	18.9 %
2 x 4 x 15 in	1.22 lbs.	21.1 %	20.8 %	22.8 %
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%

TEST LOAD WEIGHT: 16.35 lbs. **DRY WEIGHT:** 6.13 kg.
AVERAGE MOISTURE CONTENT:
(DRY) 20.97% CORRECTED TO TWO PIN: (DRY) 20.97% (WET) 17.33%
COAL BED RANGE:
3.3 lbs. to 4.0 lbs. (10% to 15% of test load)
lbs. to lbs. (20% to 25% of test load)

TEST CHARGE:
Time loaded: 12:25 Coal bed weight: 3.9 lbs. Coal bed weight = % of test load weight

CHARCOALIZATION: good|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|poor

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job #_G103758222 Run # 4 CAT 4

Page 9 of 10
Date 1-31-09
Tech Ken Slater

COMMENTS

10:32 AM PRETEST STARTED

12:25 TEST ~~DO~~ STARTED

DOOR REMAINED OPEN FOR 5 MINUTES

SHUTTER FULL OPEN.

Intertek

Manufacturer : ENGLAND STONE
Job # C0103758222

Model: 15-55WO1
Run #6 CAT 4

Page 10 of 10
Date 1-31-19
Tech [illegible]

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			SYSTEM 3				
		Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Temp	Humidity
Date	Time	5	9	10	6	11	12	7	13	14	°F	%
1-29-19	10:00A	91.6659	1.8394	1.8210	91.5349	1.8402	1.8460	90.9218	1.8233	3.3003		
1-31-19	12:00P	91.0058	1.8392	1.8209	91.5349	1.8401	1.8460	90.9217	1.8231	3.3000	71.1	11
		Total:	3.6601		Total:	3.6861		Total:	5.1231			

Post-test Weight Record		SYSTEM 1		SYSTEM 2		SYSTEM 3			
		Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Temp	Humidity
Date	Time	5	9+10	6	11+12	7	13+14	°F	%
1-31-19	3:17	91.0058	3.6716	91.5349	3.6965	90.9217	5.1302	73.2	12%
2-1-19		—	3.6706	—	3.6957	—	5.1292	64.5	12
2-4-19	7:02	—	3.6706	—	3.6957	—	5.1292	68.5	31
2-5-19	6:24	—	3.6706	—	3.6957	—	5.1292	66.9	22

Dry Down Weight

Date	Time	P1	F1	P2	F2	P3	F3	Gr/hr	Lb/MMbtu
1-31-19		0	11.5	0	10.4	0	7.1	2.791	2.021
2-1-19		0	10.5	0	9.4	0	6.1	2.562	
2-4-19	7:02	0	10.5	0	9.4	0	6.1	2.562	
2-5-19		0	10.5	0	9.4	0	6.1	2.562	

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	68	72	29.29	29.26	11.0	11.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
182	17.68	186.44	565.30	43.94	43.84	10.50	9.60

Dilution Tunnel Dual Train Precision				
Sample Ratios		Total Emissions (g)		
Train 1	Train 2	Train 1	Train 2	Deviation (%)
772.32	774.01	8.11	7.43	4.37%

Burn			Initial		Run	Average
Rate		Surface	Draft		Time	Draft
2.021		0.000	0.028		182.000	0.035

Run	Date	Burn Rate	Emission
6	1/31/2019	2.021	2.562

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	66	71	29.23	29.26	13.0	15.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
187	17.61	187.30	559.88	44.58	44.53	5.40	3.90

Dilution Tunnel Dual Train Precision					
Sample Ratios		Total Emissions (g)			
Train 1	Train 2	Train 1	Train 2	Deviation (%)	
785.58	786.48	4.24	3.07	16.07%	

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
2.005		0.000		0.042		187.000	0.036

Run	Date	Burn Rate	Emission
7	2/1/2019	2.005	1.173

ABC Laboratories, Inc.

Manufacturer: England Stoves
Model: 15SSW01
Date: 02/04/19
Run: 8
Control #: G103758222
Test Duration: 260
Output Category: 3

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	74.4%	80.4%
Combustion Efficiency	95.4%	95.4%
Heat Transfer Efficiency	78%	84.3%

Output Rate (kJ/h)	21,254	20,162	**(Btu/h)**
Burn Rate (kg/h)	1.44	3.18	**(lb/h)**
Input (kJ/h)	28,556	27,088	**(Btu/h)**

Test Load Weight (dry kg)	6.25	13.77	**dry lb**
MC wet (%)	16.66		
MC dry (%)	19.99		
Particulate (g)	7.44		
CO (g)	405		
Test Duration (h)	4.33		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.08	4.40	
g/kg Dry Fuel	1.19	64.89	
g/h	1.72	93.54	1.55905
lb/MM Btu Output	0.19	10.23	

Air/Fuel Ratio (A/F)	12.81

VERSION: **2.2** **12/14/2009**

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #8 CAT 3

Page 1 of 10
Date 2-4-19
Tech Ken Slater

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 28.59 (inches Hg.) Static pressure (P_q) .345 (inches w.c.)
Inside diameter: Port A ____in Port B ___in Tunnel cross sectional area: ____Ft^2
Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.105		
B-Centroid	3.00	.109		
A-1	0.50	.085		
A-2	1.50	.100		
A-3	4.50	.101		
A-4	5.50	.089		
B-1	0.50	.090		
B-2	1.50	.105		
B-3	4.50	.106		
B-4	5.50	.087		
		AVERAGE		

Adjustment factor application

Pitot correction .9547

Where,
C_p = Pitot tube coefficient = 0.99 for standard pitot
Δ_p = manometer reading (inches H_2O)
T_s = average absolute dilution tunnel temperature (°F + 460)
P_s = absolute dilution tunnel gas pressure or Pbar + P_g

P_g = static pressure $\frac{inches H_2O}{13.6}$

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)

Adjustment factor for alternative Pitot tube placement:

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}} \qquad F_p = \frac{\left(\sqrt{\Delta_p}\right) avg}{\left(\sqrt{\Delta_p}\right) centroid}$$

K_p = 85.49 Pitot tube constant, (conversion factor for English units)

$\left(\sqrt{\Delta_p}\right) avg.$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #8 CAT 3

Page 2 of 10
Date 2-4-19
Tech Ken Slater

Pre/Post Checks

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	0 fpm
Smoke Capture Check	✓	✓
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	1-21-19	
Date Dilution Tunnel Cleaned	1-21-19	
Induced Draft Check	✓	✓
Tunnel Velocity	1105	.112
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)		✓ °F
Proportional Checks:		
CO Analyzer Drift Check		✓
CO_2 Analyzer Check		✓
O_2 Analyzer Check		✓
Thermocouple check		✓

Sampling Train ID Numbers:	Train 1	Train 2	Train 3
Probe	A	B	C
Filter Front	21	23	25
Filter Back	22	24	26
Filter Thermocouple	19	22	
Filter 5G-3 (<90°F)			

mn

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #8 CAT 3

Page 3 of 10
Date 2-4-19
Tech Ken Slater

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	25.00 lbs., Class F	25.00 lbs.
Wood	10.00 lbs., Class F	10.00 lbs.
Analytical	100.000 mg, Class S	100.000 mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE..... 50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job #_G103758222 Run #8 CAT 3

Page 4 of 10
Date 2-4-19
Tech Ken Slater

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

Leakage Checks Tunnel Samplers

	SAMPLE 1		SAMPLE 2		SAMPLE 3	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-test	Post Test
Vacuum (inches Hg.)	10"	10"	10"	10"	10"	10"
Final 1 minute DGM (ft^3)	0	0	0	0	463.374	473.298
Initial 1 minute DGM (ft^3)	0	0	0	0	463.374	473.298
Change (C) (ft^3)	0	0	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #8 CWT 3

Date 2-4-19
Tech Ken Slater

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO_2	0	0	24.88	24.88	11.89	11.99
CO	0	0	8.97	8.976	3.98	4.001
O_2	0	0	20.95	20.95	10.00	10.01
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO_2	-0.01	24.68	11.85	.01	.20	.03	✓	
CO	-0.07	8.63	3.75	.07	.34	.23	✓	
O_2	-0.01	20.79	9.92	.01	.16	.08	✓	

* Greater than ± 5% of the range used.

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #8 CAT 3

Date 2-4-19
Tech Ken Slater

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2	System 3
Final (ft^3)	62.89	62.89	473.279
Initial (ft^3)	0	0	463.374

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	28.57	28.69
Temperature (°F)	69.7	75.0
Humidity (%)	31	28

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #8 Cat 3

Page 7 of 10
Date 2-4-19
Tech Ken Slater

READING #	REAL TIME	ELAPSED TIME	DGM 1	ROTOMETER 1	DGM 2	ROTOMETER 2	DGM 3	ROTOMETER 3	DRAFT	MAX DGM PRESSURE
0	10:24	0					463.374			
1		10					464.975			
2		20					466.630			
3		30					468.390			
4		40					469.940			
5		50					471.600			
6		60					473.279			
7		70								
8		80								
9		90								
10		100								
11		110								
12		120								
13		130								
14		140								
15		150								
16		160								
17		170								
18		180								
19		190								
20		200								
21		210								
22		220								
23		230								
24		240								
25		250								
26		260								
27		270								
28		280								
29		290								
30		300								
31		310								
32		320								
33		330								
34		340								
35		350								
36		360								

Intertek

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #8 CAT 3

Date 2-4-19
Tech Ken Slater

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: 4.6 lbs. Consisting of: Scrap and paper Fire lit Time:
Pre-test load weight: 16.76 lbs. Consisting of: 2X4X inches Time loaded:
Pre-test moisture content: Uncorrected: % Corrected Dry: % Wet: %

Test Air Control Settings: Time:
Test Unit Fan Settings: Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	15.12 Lbs.	16.80 lbs.	18.48 Lbs.

Fire Box Volume:	2.4 Ft.^{3}	Ideal Length:	Inches
Load Volume:	Ft.^{3}	Loading Density:	lbs/ft^3
Spacer weight	2.77 Lbs	Load Density:	lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 15 in.	1.51 lbs.	19.4 %	18.3 %	19.9 %
2 x 4 x 15 in	1.48 lbs.	21.1 %	18.6 %	21.6 %
2 x 4 x 15 in	1.72 lbs.	18 %	21.3 %	19.9 %
2 x 4 x 15 in	1.60 lbs.	19.7 %	19.9 %	19.2 %
2 x 4 x 15 in	1.54 lbs.	20.2 %	18.7 %	20.3 %
4 x 4 x 15 in	3.44 lbs.	20.4 %	21.9 %	21.5 %
4 x 4 x 15 in	2.74 lbs.	19.4 %	20.1 %	20.3 %
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%

TEST LOAD WEIGHT: 16.80 lbs. **DRY WEIGHT:** kg.
AVERAGE MOISTURE CONTENT:
(DRY) 19.99 % CORRECTED TO TWO PIN: (DRY) 19.99 % (WET) 16.66 %
COAL BED RANGE: 3.4 lbs. to 4.2 lbs. (10% to 15% of test load)
lbs. to lbs. (20% to 25% of test load)
TEST CHARGE:
Time loaded: 10:26 Coal bed weight: 3.9 lbs. Coal bed weight = % of test load weight

CHARCOALIZATION: good |--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job #_G103758222 Run #8 CAT 3

Page 9 of 10
Date 2-4-19
Tech Ken Slater

COMMENTS

8:22 AM PILOT STARTED

10:26 AM TEST STARTED
DOOR REMAINED OPEN FOR 1.45 MINUTES
SHUTTER SET @ 1/16" FROM FULLY CLOSED
TRIGGER ACTIVATED @ 22:39 MINUTES

Intertek

Manufacturer: England Stoves
Job # C103758222

Model: 15-SSWD1
Run # 8 CAT 3

Date 2-4-19
Tech K. Slater

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			SYSTEM 3				
		Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Temp	Humidity
Date	Time	A	21	22	B	23	24	C	25	26	°F	%
2-1-19	9:00 am	92.4392	1.8218	1.8565	92.3396	3.2349	3.3233	90.8949	3.2295	3.2904	67.8	15
2-4-19	7:30a	92.4391	1.8216	1.8564	92.3396	3.2348	3.3232	90.8947	3.2294	3.2903	67.7	33%
		Total:	3.678		Total:	6.558		Total:	6.5197			

Post-test Weight Record		SYSTEM 1		SYSTEM 2		SYSTEM 3			
		Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Temp	Humidity
Date	Time	A	21+22	B	23+24	C	25+26	°F	%
2-4-19	2:39p	92.4391	3.6840	92.3396	6.5626	90.8947	6.5231	75.0	28
2-5-19	6:29	—	3.6830	—	6.5620	—	6.5222	66.0	23
2-6-19	7:03	—	3.6826	—	6.5616	—	6.5220		

Dry Down Weight

Date	Time	P1	F1	P2	F2	P3	F3	Gr/hr	Lb/MMbtu
2-4-19	2:39	0	6.0	0	4.6	0	3.4	6.109	1.466
2-5-19	6:29	0	5.0	0	4.0	0	2.5	.942	
2-6-19	7:03	0	4.6	0	3.6	0	2.3	.858	

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	72	71	28.57	28.69	31.0	28.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
260	19.60	207.01	551.99	59.37	59.30	4.60	3.60

Dilution Tunnel Dual Train Precision					
Sample Ratios		Total Emissions (g)			
Train 1	Train 2	Train 1	Train 2	Deviation (%)	
906.62	907.67	4.17	3.27	12.14%	

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
1.466		0.000		0.046		260.000	0.029

Run	Date	Burn Rate	Emission
8	2/4/2019	1.466	0.858

ABC Laboratories, Inc.

Manufacturer: England Stoves
Model: 15SSW01
Date: 02/05/19
Run: 9
Control #: G103758222
Test Duration: 387
Output Category: 1

Technicians: Ken Slater

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	73.6%	79.5%
Combustion Efficiency	93.0%	93.0%
Heat Transfer Efficiency	79%	85.5%

Output Rate (kJ/h)	13,300	12,617	**(Btu/h)**
Burn Rate (kg/h)	0.91	2.01	**(lb/h)**
Input (kJ/h)	18,071	17,142	**(Btu/h)**

Test Load Weight (dry kg)	5.88	12.97	**dry lb**
MC wet (%)	15.94		
MC dry (%)	18.96		
Particulate (g)	13.97		
CO (g)	576		
Test Duration (h)	6.45		

Emissions	**Particulate**	**CO**	
g/MJ Output	0.16	6.71	
g/kg Dry Fuel	2.37	97.85	
g/h	2.17	89.26	1.487728
lb/MM Btu Output	0.38	15.60	

Air/Fuel Ratio (A/F)	13.62

VERSION: **2.2** **12/14/2009**

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #9 CAT 1

Date 2-5-19
Tech Ken Slater

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.10 (inches Hg.) Static pressure (P_q) .343 (inches w.c.)
Inside diameter: Port A ____in Port B ___in Tunnel cross sectional area: ____Ft^2
Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.105		
B-Centroid	3.00	.108		
A-1	0.50	.086		
A-2	1.50	.101		
A-3	4.50	.101		
A-4	5.50	.090		
B-1	0.50	.090		
B-2	1.50	.104		
B-3	4.50	.105		
B-4	5.50	.088		
		AVERAGE		

Adjustment factor application

Pitot correction .9575

Where,
C_p = Pitot tube coefficient = 0.99 for standard pitot
Δ_p = manometer reading (inches H_2O)
T_s = average absolute dilution tunnel temperature (°F + 460)
P_s = absolute dilution tunnel gas pressure or Pbar + P_g

P_g = static pressure $\frac{inches H_2O}{13.6}$

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)

Adjustment factor for alternative Pitot tube placement:

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}} \qquad F_p = \frac{\left(\sqrt{\Delta_p}\right) avg}{\left(\sqrt{\Delta_p}\right) centroid}$$

K_p = 85.49 Pitot tube constant, (conversion factor for English units)

$\left(\sqrt{\Delta_p}\right) avg.$ = Average of the square roots of the velocity heads ($)_p$) measured at each traverse point.

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #9 CUT 1

Date 2-5-19
Tech Ken Slater

Pre/Post Checks

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	✓ fpm	✓ fpm
Smoke Capture Check	0	0
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	1-21-19	
Date Dilution Tunnel Cleaned	1-21-19	
Induced Draft Check	✓	✓
Tunnel Velocity	.105	.145
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)		°F
Proportional Checks:		
CO Analyzer Drift Check		✓
CO_2 Analyzer Check		✓
O_2 Analyzer Check		✓
Thermocouple check		✓

Sampling Train ID Numbers:	Train 1	Train 2	TRAIN 3
Probe	D	E	F
Filter Front	27	29	31
Filter Back	28	30	32
Filter Thermocouple	19	22	
Filter 5G-3 (<90°F)			

mn

Intertek

Manufacturer: England Stoves___ _____ Model : 15-SSW01_____
Job #_G103758222_____ Run #9 CAT 1

Date 2-5-19
Tech _____
Ken Slater

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	25.00 lbs., Class F	25.00 lbs.
Wood	10.00 lbs., Class F	10.00 lbs.
Analytical	100.000 mg, Class S	100.000 mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE: ..... 50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE ..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE ..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #9 CAT 1

Page 4 of 10
Date 2-5-19
Tech Ken Slater

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers
Leakage Checks Tunnel Samplers

	SAMPLE 1		SAMPLE 2		SAMPLE 3	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-test	Post Test
Vacuum (inches Hg.)	10	10	10	10	10	10
Final 1 minute DGM (ft^3)	0	0	0	0	473.310	483.274
Initial 1 minute DGM (ft^3)	0	0	0	0	473.310	483.274
Change (C) (ft^3)	0	0	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10	10
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job #_G103758222 Run #9 CHT 1

Page 5 of 10
Date 2-5-19
Tech Ken Slater

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO_2	0	0	24.88	24.88	11.88	11.99
CO	0	0	8.97	8.976	4.00	4.001
O_2	0	0	20.95	20.95	9.94	10.01
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO_2	-.07	24.78	11.89	.07	.10	.01	✓	
CO	-0.10	8.68	3.88	.10	.29	.12	✓	
O_2	-0.03	20.86	9.93	.03	.09	.01	✓	

* Greater than ± 5% of the range used.

Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #9 CAT 1

Page 6 of 10
Date 2-5-19
Tech Ken Slater

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2	System 3
Final (ft^3)	94.15	94.15	183.275
Initial (ft^3)	0	0	473.310

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.10	29.03
Temperature (°F)	69.3	72.6
Humidity (%)	24	19

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job #_G103758222 Run #9 CHT 1

Page 7 of 10
Date 2-5-19
Tech Ken Slater

READING #	REAL TIME	ELAPSED TIME	DGM 1	ROTOMETER 1	DGM 2	ROTOMETER 2	DGM 3	ROTOMETER 3	DRAFT	MAX DGM PRESSURE
0	9:28	0					473.310			
1		10					474.900			
2		20					476.570			
3		30					478.235			
4		40					479.900			
5		50					481.565			
6		60					483.275			
7		70								
8		80								
9		90								
10		100								
11		110								
12		120								
13		130								
14		140								
15		150								
16		160								
17		170								
18		180								
19		190								
20		200								
21		210								
22		220								
23		230								
24		240								
25		250								
26		260								
27		270								
28		280								
29		290								
30		300								
31		310								
32		320								
33		330								
34		340								
35		350								
36		360								

Intertek

Manufacturer: England Stoves ___ Model : 15-SSW01
Job #_G103758222 Run #9 CAT 1

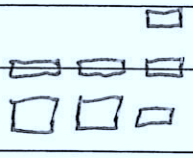
Page 8 of 10
Date 2-5-19
Tech Ken Slater

COMMENTS

7:13 AM PRETEST STARTED

9:28 TEST STARTED
DOOR REMAINED OPEN FOR 5 MINUTES
SHUTTER SET @ FULLY CLOSED
~~STOP~~ TRIGGER ACTIVATED @ 31 MINUTES

ROOM FAN SET TO LOW



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Manufacturer: England Stoves Model : 15-SSW01
Job #_G103758222 Run #9 CAT 1

Page 9 of 10
Date 2-5-19
Tech Ken Slater

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: 4.5 lbs. Consisting of: Scrap and paper Fire lit Time:
Pre-test load weight: 16.32 lbs. Consisting of: 2X4X inches Time loaded:
Pre-test moisture content: Uncorrected: % Corrected Dry: % Wet: %

Test Air Control Settings: Time:
Test Unit Fan Settings: Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	15.12 Lbs.	16.80 lbs.	18.48 Lbs.

Fire Box Volume:	2.4 Ft.^{3}	Ideal Length:	Inches
Load Volume:	Ft.^{3}	Loading Density:	lbs/ft^3
Spacer weight	2.46 Lbs	Load Density:	lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 15 in.	1.59 lbs.	19.2 %	19.5 %	19.6 %
2 x 4 x 15 in	1.53 lbs.	18.5 %	18.7 %	18.2 %
2 x 4 x 15 in	1.26 lbs.	18.2 %	18 %	18.7 %
2 x 4 x 15 in	1.40 lbs.	18.5 %	18.1 %	19.1 %
2 x 4 x 15 in	1.54 lbs.	18.0 %	20.8 %	20.5 %
4 x 4 x 15 in	2.93 lbs.	20.5 %	20.3 %	19.7 %
4 x 4 x 15 in	2.90 lbs.	18.0 %	18.2 %	18.0 %
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%
x x in	lbs.	%	%	%

TEST LOAD WEIGHT: 15.60 lbs. **DRY WEIGHT:** kg.
AVERAGE MOISTURE CONTENT:
(DRY) 18.97 % CORRECTED TO TWO PIN: (DRY) 18.97 % (WET) 18.94 %
COAL BED RANGE:
3.2 lbs. to 3.9 lbs. (10% to 15% of test load)
lbs. to lbs. (20% to 25% of test load)
TEST CHARGE:
Time loaded: 9:28 Coal bed weight: 3.9 lbs. Coal bed weight = % of test load weight

CHARCOALIZATION: good |--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

Intertek

Manufacturer : Envirosmo Stoves
Job # 6103758222

Model: 15-55WO1
Run #9 OAT 1

Page 10 of 10
Date 2-5-19
Tech K Slater

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			SYSTEM 3				
		Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Probe & Housing Number	Front Filter + gasket Number	Back Filter + gasket Number	Temp	Humidity
Date	Time	D	27	28	E	29	30	F	31	32	°F	%
2-4-19	7:30A	180.9107	3.2968	3.2371	92.5991	3.2595	3.2984	90.9604	3.3007	3.3406	67.7	33
2-5-19	6:32A	180.9106	3.2968	3.2370	92.5990	3.2594	3.2984	90.9603	3.3006	3.3406	65.8	23
		Total:	6.5338		Total:	6.5578		Total:	6.6412			

Post-test Weight Record		SYSTEM 1		SYSTEM 2		SYSTEM 3			
		Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Probe & Housing Number	Combined Filter/gasket Number	Temp	Humidity
Date	Time	D	27+28	E	29+30	F	31+32	°F	%
2.5.19	3:48	180.9141	6.5490	92.6009	6.5712	90.9615	6.6494	72.9	19
2-6-19	6:52	180.9110	6.5483	92.5996	6.5703	90.9603	6.6483	68.0	22
2-7-19	7:30A	180.9110	6.5480	92.5995	6.5701	—	6.6480	66.7	18
2-8-19	7:30A	180.9106	6.5479	92.5990	6.5700	—	6.6480	65.7	13

Dry Down Weight

Date	Time	P1	F1	P2	F2	P3	F3	Gr/hr	Lb/MMbtu
2-5-19	3:48	3.5	15.2	1.9	13.4	1.2	8.2	2.801	~~.940~~ .923
2-6-19	6:52	.4	14.5	.6	12.5	0	7.1	2.306	
2-7-19	7:30	.4	14.2	.5	12.3	0	6.8	2.257	
2-8-19	7:30A	0	14.1	0	12.2	0	6.8	2.166	

	Room Temp		Bar Pressure		Relative Humidity		Air Velocity	
	Before	After	Before	After	Before	After	Before	After
	70	68	29.10	29.03	24.0	19.0	0	0

Average Dilution Tunnel Measurements						Sample Data	
Burn	Velocity	Flow Rate	Temp	Total Sample		Particulate Catch	
Time	(Ft/sec)	(dscf/min)	(R)	1	2	1	2
387	22.72	248.89	540.19	90.71	90.58	14.10	12.20

Dilution Tunnel Dual Train Precision					
Sample Ratios		Total Emissions (g)			
Train 1	Train 2	Train 1	Train 2	Deviation (%)	
1061.85	1063.42	14.97	12.97	7.15%	

Burn				Initial		Run	Average
Rate		Surface		Draft		Time	Draft
0.923		0.000		0.036		387.000	0.021

Run	Date	Burn Rate	Emission
9	2/5/2019	0.923	2.166

Certificate Number
A2993577
Issue Date: 10/22/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:

ID Number: 986

Description:	DATA ACQUISITION SYSTEM	Calibration Date:	10/10/2018
Manufacturer:	OMEGA	Calibration Due:	04/10/2019
Model Number:	OMB-DAQ-56	Procedure:	OMEGA OM-DAQ-USB-2401 Rev: 1/12/2012
Serial Number:	NSN	Temperature:	75.5 F
Technician:	PERRY MURBARGER	Humidity:	71.7 % RH
On-Site Calibration:	☑	**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

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Measurements not currently on TMI's Scope of Accreditation are identified with an asterisk.

B. SCHICKOWSKI, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
0515114046	OMEGA	OM-73	2/1/2018	2/1/2019
RFD7526A-156	FLUKE	7526A-156	8/4/2017	10/20/2018

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AC-2080.03

Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Thermocouple Accuracy (K Type) Input 1	1000.0	998.2	1001.8	999.8	999.8	0.33	°F	
Thermocouple Accuracy (K Type) Input 2	1000.0	998.2	1001.8	1000.1	1000.1	0.33	°F	
Thermocouple Accuracy (K Type) Input 3	1000.0	998.2	1001.8	1000.6	1000.6	0.33	°F	
Thermocouple Accuracy (K Type) Input 4	1000.0	998.2	1001.8	1000.2	1000.2	0.33	°F	
Thermocouple Accuracy (K Type) Input 5	1000.0	998.2	1001.8	999.7	999.7	0.33	°F	
Thermocouple Accuracy (K Type) Input 6	1000.0	998.2	1001.8	1000.0	1000.0	0.33	°F	
Thermocouple Accuracy (K Type) Input 7	1000.0	998.2	1001.8	1000.3	1000.3	0.33	°F	
Thermocouple Accuracy (K Type) Input 8	1000.0	998.2	1001.8	1000.6	1000.6	0.33	°F	
Thermocouple Accuracy (T Type) Input 9	1000.0	998.2	1001.8	999.8	999.8	0.33	°F	
Thermocouple Accuracy (T Type) Input 10	1000.0	998.2	1001.8	1000.2	1000.2	0.33	°F	
Thermocouple Accuracy (T Type) Input 11	1000.0	998.2	1001.8	999.9	999.9	0.33	°F	
Thermocouple Accuracy (T Type) Input 12	1000.0	998.2	1001.8	1000.5	1000.5	0.33	°F	
Thermocouple Accuracy (K Type) Input 13	1000.0	998.2	1001.8	1000.6	1000.6	0.33	°F	
Thermocouple Accuracy (K Type) Input 14	1000.0	998.2	1001.8	999.7	999.7	0.33	°F	
Thermocouple Accuracy (K Type) Input 15	1000.0	998.2	1001.8	1000.3	1000.3	0.33	°F	
Thermocouple Accuracy (K Type) Input 16	1000.0	998.2	1001.8	1000.6	1000.6	0.33	°F	
Thermocouple Accuracy (K Type) Input 17	1000.0	998.2	1001.8	1000.8	1000.8	0.33	°F	
Thermocouple Accuracy (K Type) Input 18	1000.0	998.2	1001.8	1000.4	1000.4	0.33	°F	
Thermocouple Accuracy (K Type) Input 19	1000.0	998.2	1001.8	1000.6	1000.6	0.33	°F	
Thermocouple Accuracy (K Type) Input 20	1000.0	998.2	1001.8	1000.7	1000.7	0.33	°F	
Thermocouple Accuracy (K Type) Input 21	1000.0	998.2	1001.8	999.6	999.6	0.33	°F	
Thermocouple Accuracy (K Type) Input 22	1000.0	998.2	1001.8	1000.0	1000.0	0.33	°F	
Thermocouple Accuracy (K Type) Input 23	1000.0	998.2	1001.8	1000.3	1000.3	0.33	°F	
Thermocouple Accuracy (K Type) Input 24	1000.0	998.2	1001.8	1000.2	1000.2	0.33	°F	
Voltage Accuracy 1	10.0	9.5	10.5	10.1	10.1	0.0059	V	
Voltage Accuracy 2	10.0	9.5	10.5	10.1	10.1	0.0059	V	
Voltage Accuracy 3	10.0	9.5	10.5	10.0	10.0	0.0059	V	
Voltage Accuracy 4	10.0	9.5	10.5	10.1	10.1	0.0059	V	
Voltage Accuracy 5	10.0	9.5	10.5	10.0	10.0	0.0059	V	
Voltage Accuracy 6	10.0	9.5	10.5	9.9	9.9	0.0059	V	

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ANSI/NCSL Z540.3
AC-2080.03

Certificate Number
A2993412
Issue Date: 10/22/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:

ID Number: 1134

Description:	SCALE	Calibration Date:	10/10/2018
Manufacturer:	RICE LAKE	Calibration Due:	04/10/2019
Model Number:	520-1A	Procedure:	TMI-SCALES Rev: 5/13/2014
Serial Number:	1494600044	Temperature:	68 F
Technician:	ARMIN AHMETOVIC	Humidity:	33 % RH
On-Site Calibration:	☑	**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

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Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

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B. SCHICKOWSKI, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
DLOG-4	EXTECH	42270	3/5/2018	3/5/2019
RFD-500LBSET	RICE LAKE	500LBS	5/24/2018	6/30/2019

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Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Weight Accuracy	100.0	99.4	100.6	99.8	99.8	0.06	lbs	
Weight Accuracy	200.0	199.4	200.6	199.4	199.4	0.06	lbs	
Weight Accuracy	300.0	299.4	300.6	299.5	299.5	0.06	lbs	
Weight Accuracy	400.0	399.4	400.6	399.5	399.5	0.06	lbs	
Weight Accuracy	500.0	499.4	500.6	499.4	499.4	0.06	lbs	
Weight Accuracy	1000.0	999.4	1000.6	999.4	999.4	0.06	lbs	
Shift Test RF	100.0	99.4	100.6	99.9	99.9	0.06	lbs	
Shift Test LF	100.0	99.4	100.6	99.9	99.9	0.06	Lbs	
Shift Test RR	100.0	99.4	100.6	99.9	99.9	0.06	lbs	
Shift Test LR	100.0	99.4	100.6	99.9	99.9	0.06	lbs	
Shift Test Center	100.0	99.4	100.6	99.9	99.9	0.06	lbs	

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Certificate Number
A2799975
Issue Date: 04/09/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:
ID Number: 001212

Description: TIMER
Manufacturer: COLE PARMER
Model Number: 94440-10
Serial Number: NSN
Technician: ARMIN AHMETOVIC
On-Site Calibration: ☑
Comments:

Calibration Date: 04/04/2018
Calibration Due: 04/04/2019
Procedure: NIST SP 960-12
Rev: 1/1/2009
Temperature: 68 F
Humidity: 40 % RH
As Found Condition: IN TOLERANCE
Calibration Results: IN TOLERANCE

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

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Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
0515114046	OMEGA	OM-73	2/1/2018	2/1/2019
RFD806	HEWLETT PACKARD	53181A	5/9/2017	5/9/2018

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Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Timer Accuracy	60	59	61	60	60	0.3	sec	
Timer Accuracy	300	299	301	300	300	0.3	sec	
Timer Accuracy	1800	1799	1801	1800	1800	0.3	sec	

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Certificate Number
A2794500
Issue Date: 04/04/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:
ID Number: 001213

Description:	TIMER	Calibration Date:	04/04/2018
Manufacturer:	COLE PARMER	Calibration Due:	04/04/2019
Model Number:	94440-10	Procedure:	NIST SP 960-12 Rev: 1/1/2009
Serial Number:	NSN	Temperature:	68 F
Technician:	ARMIN AHMETOVIC	Humidity:	40 % RH
On-Site Calibration:	☑	**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

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B. SCHICKOWSKI, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
0515114046	OMEGA	OM-73	2/1/2018	2/1/2019
RFD806	HEWLETT PACKARD	53181A	5/9/2017	5/9/2018

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AC-2080.03

Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Timer Accuracy	60	59	61	60	60	0.3	sec	
Timer Accuracy	300	299	301	300	300	0.3	sec	
Timer Accuracy	1800	1799	1801	1800	1800	0.3	sec	

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ANSI/NCSL Z540.3
AC-2080.03

Certificate Number
A2984135
Issue Date: 10/12/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number: ONSITE

ID Number: 001420

Description:	THERMAL HYGROMETER	Calibration Date:	10/12/2018
Manufacturer:	CONTROL COMPANY	Calibration Due:	04/12/2019
Model Number:	68000-49	Procedure:	TMI-M-HYGROTHERMOGRAPHS Rev: 2/22/2011
Serial Number:	150810334	Temperature:	68 F
Technician:	ARMIN AHMETOVIC	Humidity:	33 % RH
On-Site Calibration: ☐		**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

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B. SCHICKOWSKI, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
0515114046	OMEGA	OM-73	2/1/2018	2/1/2019
RFD805	THUNDER SCIENTIFIC	1200	7/30/2018	7/30/2019

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Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Temperature Accuracy	60.0	59.3	60.7	60.3	60.3	0.24	°F	
Temperature Accuracy	70.0	69.3	70.7	70.4	70.4	0.24	°F	
Temperature Accuracy	80.0	79.3	80.7	80.4	80.4	0.24	°F	
Humidity Accuracy	33	30	36	34	34	1.7	%RH	
Humidity Accuracy	50	47	53	51	51	1.7	%RH	
Humidity Accuracy	75	72	78	76	76	1.7	%RH	

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Certificate Number
A2993447
Issue Date: 10/22/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:

ID Number: 008

Description:	SCALE	Calibration Date:	10/10/2018
Manufacturer:	GSE	Calibration Due:	04/10/2019
Model Number:	450	Procedure:	TMI-SCALES Rev: 5/13/2014
Serial Number:	101722	Temperature:	68 F
Technician:	ARMIN AHMETOVIC	Humidity:	33 % RH
On-Site Calibration:	☑	**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

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B. SCHICKOWSKI, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
DLOG-4	EXTECH	42270	3/5/2018	3/5/2019
RFD-500LBSET	RICE LAKE	500LBS	5/24/2018	6/30/2019

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Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Shift Test Center	25.00	24.90	25.10	25.00	25.00	0.06	lbs	
Shift Test RF	25.00	24.90	25.10	25.00	25.00	0.06	lbs	
Shift Test RR	25.00	24.90	25.10	25.00	25.00	0.06	lbs	
Shift Test LF	25.00	24.90	25.10	25.00	25.00	0.06	lbs	
Shift Test LR	25.00	24.90	25.10	25.00	25.00	0.06	lbs	
Weight Accuracy	25.00	24.90	25.10	25.00	25.00	0.06	lbs	
Weight Accuracy	50.00	49.90	50.10	50.00	50.00	0.06	lbs	
Weight Accuracy	75.00	74.90	75.10	74.99	74.99	0.06	lbs	
Weight Accuracy	100.00	99.90	100.10	100.00	100.00	0.06	lbs	

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AC-2080.03

Certificate Number
A2993455
Issue Date: 10/22/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:

ID Number: 713

Description:	SCALE	Calibration Date:	10/10/2018
Manufacturer:	OHAUS	Calibration Due:	04/10/2019
Model Number:	E12140	Procedure:	TMI-SCALES Rev: 5/13/2014
Serial Number:	B258010639	Temperature:	68 F
Technician:	ARMIN AHMETOVIC	Humidity:	33 % RH
On-Site Calibration:	☑	**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

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B. SCHICKOWSKI, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
DLOG-4	EXTECH	42270	3/5/2018	3/5/2019
RFD-WT-1	RICE LAKE	RFD-WT-1	5/8/2018	5/8/2020

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ilac-MRA ANAB ACCREDITED ISO/IEC 17025 ANSI/NCSL Z540-1 ANSI/NCSL Z540.3

AC-2080.03

Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Shift Test Center	10.0000	9.9900	10.0100	10.0005	10.0005	0.00047	Grams	
Shift Test RF	10.0000	9.9900	10.0100	10.0002	10.0002	0.00047	Grams	
Shift Test RR	10.0000	9.9900	10.0100	10.0002	10.0002	0.00047	Grams	
Shift Test LF	10.0000	9.9900	10.0100	10.0005	10.0005	0.00047	Grams	
Shift Test LR	10.0000	9.9900	10.0100	10.0005	10.0005	0.00047	Grams	
Weight Accuracy	10.0000	9.9900	10.0100	10.0002	10.0002	0.00047	Grams	
Weight Accuracy	50.0000	49.9900	50.0100	50.0010	50.0010	0.00047	Grams	
Weight Accuracy	100.0000	99.9900	100.0100	100.0018	100.0018	0.00047	Grams	
Weight Accuracy	150.0000	149.9900	150.0100	150.0020	150.0020	0.00047	Grams	
Weight Accuracy	200.0000	199.9900	200.0100	200.0039	200.0039	0.00047	Grams	

TMI Technical Maintenance, Inc.
3248 FOREST VIEW ROAD, ROCKFORD, IL 61109
Phone: 779-774-3877 Fax 779-774-3884
www.tmicalibration.com

ilac-MRA
ANAB ACCREDITED
ISO/IEC 17025
ANSI/NCSL Z540-1
ANSI/NCSL Z540.3
AC-2080.03

Model ☐15-SSW01 ☐50-SHSSW01 ☐50-TRSSW01
Solid Fuel Burning Room Heater; Free Standing Model "SUITABLE FOR MOBILE-HOME INSTALLATION (USA ONLY)"
Tested to UL-1482 & ULC-627-00, EPA METHOD 28A, ASTM E2780, ASTM E2515

Intertek
W/N# xxxxxx

SERIAL NO.	
MFG. DATE	

Manufactured by:
England's Stove Works, Inc.
589 S. Five Forks Rd.
Monroe, VA 24574

DO NOT REMOVE OR COVER THIS LABEL

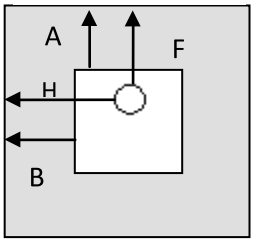
- PREVENT HOUSE FIRES – INSTALL AND USE ONLY IN ACCORDANCE WITH THE OWNER'S MANUAL PROVIDED WITH THIS APPLIANCE.
- CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTIONS IN YOUR AREA.

INSTALLATION REQUIREMENTS

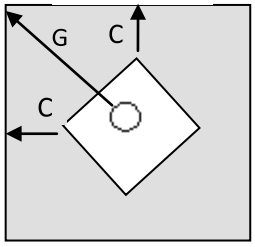
- DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.
- USE A RESIDENTIAL TYPE MASONRY OR FACTORY BUILT CHIMNEY LISTED TO UL-103 HT (US) AND ULC-629 (CANADA).
- USE 24 GAUGE MSG BLACK SINGLE WALL CHIMNEY CONNECTOR OR LISTED DOUBLE WALL CHIMNEY CONNECTOR.
- REFER TO LOCAL CODES AND THE CHIMNEY MANUFACTURER'S INSTRUCTIONS FOR PRECAUTIONS REQUIRED FOR PASSING A CHIMNEY THROUGH A COMBUSTIBLE WALL OR CEILING.
- FOR THE US: PLACE ON A NON-COMBUSTIBLE TYPE 1 UL SPARK AND EMBER FLOOR PROTECTOR, WHICH EXTENDS 16.0 IN. TO THE FRONT AND 8.0 IN. TO EACH SIDE OF THE FUEL LOADING OPENING.
- FOR CANADA: PLACE ON A NON-COMBUSTIBLE TYPE 1 ULC SPARK AND EMBER FLOOR PROTECTOR, WHICH EXTENDS 450.0 MM. TO THE FRONT AND 200.0 MM. TO EACH SIDE OF THE FUEL LOADING OPENING.
- ADHERE TO THE LISTED MINIMUM CLEARANCES TO COMBUSTIBLES WHEN USING SINGLE WALL CHIMNEY CONNECTOR. SEE THE OWNER'S MANUAL FOR ADDITIONAL CLEARANCE INFORMATION.
- ONLY OPERATE THIS UNIT WITH THE DOOR CLOSED AND LATCHED TIGHTLY.
- THE MAIN LOADING DOOR CONTAINS A CERAMIC VIEWING WINDOW; DO NOT SLAM THE DOOR OR STRIKE THIS VIEWING WINDOW AT ANY TIME.
- IF THE GLASS IS CRACKED OR BROKEN, REPLACE WITH CERAMIC GLASS ONLY.
- Emission value – 1.956 grams/hr
- U.S. ENVIRONMENTAL PROTECTION AGENCY Certified to comply with 2020 particulate emission standards using crib wood fuel.
- OPTIONAL PART- BLOWER PART NUMBER AC-30 (FASCO) ELECTRICAL RATING 115 V, 60 HZ., 0.8 A
- OPTIONAL PARTS- SIDE HEAT SHIELDS PART NUMBER AC-W01SHS (ESW INC.)
- Refer to Intertek's Directory of Building Products (HTTPS:BPDIRECTORY.INTERTEK.COM) for detailed information.

OPERATION REQUIREMENTS: FOR USE WITH SOLID WOOD FUEL ONLY. DO NOT OVER-FIRE, IF HEATER OR CHIMNEY CONNECTOR GLOWS YOU ARE OVER-FIRING. INSPECT AND CLEAN CHIMNEY FREQUENTLY, UNDER CERTAIN CONDITIONS OF USE, CREOSOTE BUILDUP MAY OCCUR RAPIDLY. DO NOT USE A GRATE OR ELEVATE THE FIRE, BURN WOOD FIRE DIRECTLY ON THE HEARTH. RISK OF SMOKE AND FLAME SPILLAGE, OPERATE ONLY WITH DOOR FULLY CLOSED.
This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instructions in the owner's manual.

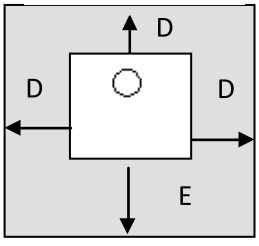
Back wall/Sidewall



Corner



Floor Protection



A = 7.5 inches (190.5 mm)
D = 8 inches (200 mm)
G = 19 inches (482.6 mm)

B = 21.5 inches (546.1 mm)
E = 16 inches (450mm)
H = 29 inches (736.6 mm)

C = 9.5 inches (241.3 mm)
F = 12 inches (304.8mm)

CAUTION - HOT WHILE IN OPERATION. DO NOT TOUCH. KEEP CHILDREN, CLOTHING, AND FURNITURE AWAY. CONTACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS.

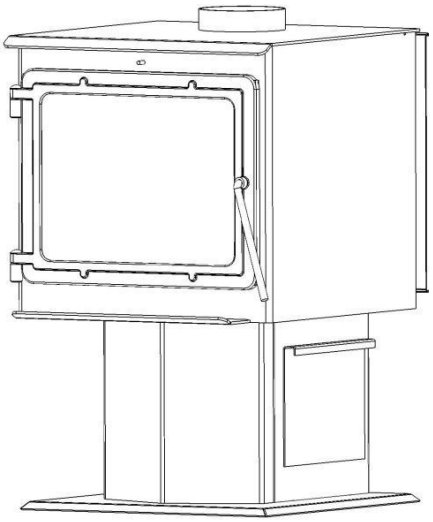
Smartstove™

England's STOVE WORKS

THE MADISON

15-SSW01, 50-SHSSW01, 50-TRSSW01

INSTALLATION & OPERATION MANUAL



Manufactured By:
England's Stove Works, Inc.
PO Box 206
Monroe, VA 24574
www.heatredefined.com
(800) 245-6489

Rev. 4/2019

CAUTION

Please read this entire manual before installation and use of this wood fuel-burning appliance. Keep children, furniture, fixtures and all combustibles away from any heating appliance.

SAVE THESE INSTRUCTIONS

SAFETY NOTICE

Failure to follow these instructions can result in property damage, bodily injury or even death. For your safety and protection, follow the installation instructions outlined in this manual. Contact your local building or fire officials about restrictions and installation inspection requirements (including permits) in your area.

IMPORTANT: IF YOU HAVE A PROBLEM WITH THIS UNIT, DO NOT RETURN IT TO THE DEALER. CONTACT TECHNICAL SUPPORT @ 1-800-245-6489

Mobile Home Use (Approved for USA only):
This freestanding wood unit is approved for mobile home or doublewide installation with the outside combustion air hook-up. See the "Installation" section of this manual for details pertaining to mobile home installations. Mobile home installation must be in accordance with the Manufactured Home and Safety Standard (HUD), CFR 3280, Part 24.

Retain for your files

Model Number_____
Date of Purchase_____
Date of Manufacture_____
Serial Number_____

* This information can be found on the safety tag attached to the rear of the unit. Have this information on hand if you phone the factory or your dealer regarding this product.

CAUTION

- Keep children away.
- Supervise children in the same room as this appliance.
- Alert children and adults to the hazards of high temperatures.
- Do NOT operate with protective barriers open or removed.
- Hot while in operation! Keep clothing, furniture, draperies and other combustibles away. Contact may cause skin burns!
- Installation MUST comply with local, regional, state and national codes and regulations.
- Consult local building, fire officials or authorities having jurisdiction about restrictions, installation inspection, and permits.

WELCOME!

NOTE: CLEARANCES MAY ONLY BE REDUCED BY MEANS APPROVED BY THE REGULATORY AUTHORITY HAVING JURISDICTION

DO NOT CONNECT TO ANY AIR DISTRIBUTION DUCT OR SYSTEM.

DO NOT BURN GARBAGE OR FLAMMABLE FLUIDS SUCH AS GASOLINE, NAPHTHA OR ENGINE OIL.

DO NOT USE CHEMICALS OR FLUIDS TO START THE FIRE.

***Thank you* for purchasing this fine product from England's Stove Works!**

England's Stove Works was started, and is still owned by, a family that believes strongly in a "Do It Yourself" spirit – that's one reason you found this product at your favorite "Do It Yourself" store.

We intentionally design and build our stoves so that any homeowner can maintain his or her unit with basic tools, and we're always more than happy to show you how to do the job as easily and as inexpensively as possible.

From our free, downloadable service sheets to our "wizard-style," click-through Troubleshooting guide on our web site, we have always tried to help our customers stay "heat-ready," especially when oil and electricity prices continue to skyrocket.

Please look at our vast Help section on our web site and call our Technical Support department at (800) 245-6489 if you need any help with your unit. We are nearly always able to help "walk you through" any repairs, problems or questions you may have.

PLEASE NOTE: While information obtained on our web site and through our 800 number is always free of charge, there will be a service charge incurred with any "on-site" repairs or maintenance that we may arrange.

Wishing you years of efficient, quality and "comfy" heating,
England's Stove Works
Technical Support Department

www.HeatRedefined.com
(800) 245-6489

CAUTION: Stove is heavy.
In addition, when handling any sheet metal products, be aware that there may be sharp edges or burrs. Although we make every effort to eliminate any sharp edges, please use caution when handling any metal parts. Remember to disconnect (unplug) the stove from the power source and allow it to completely cool down before performing any maintenance.

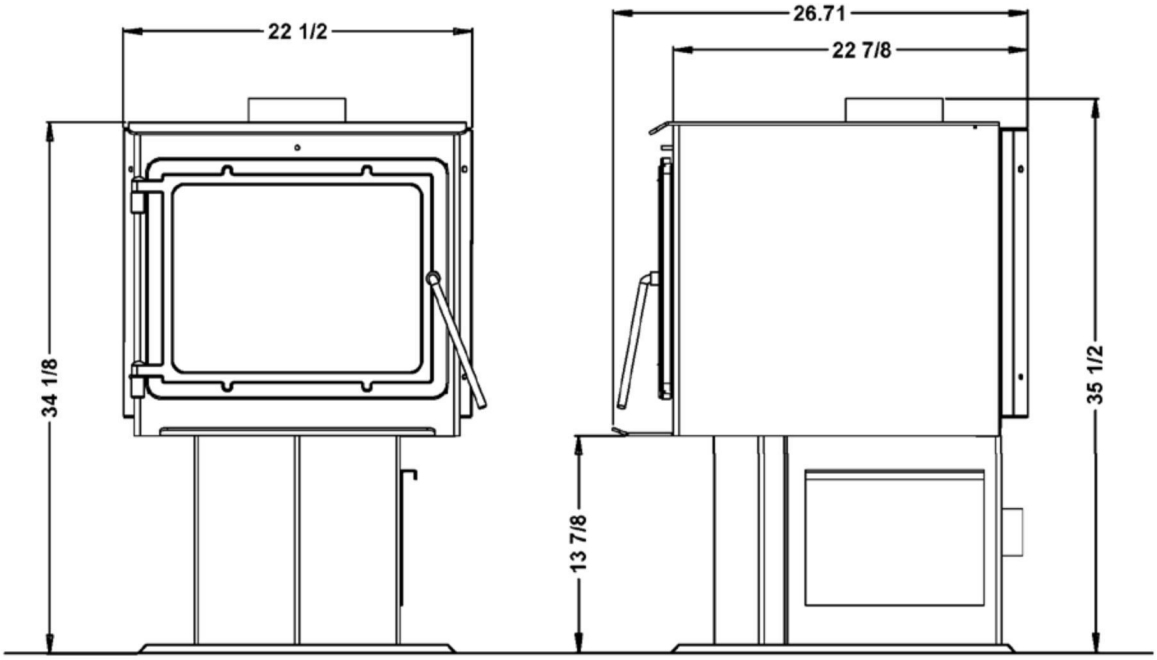
This manual is available for free download on the manufacturer's web site. It is a copyrighted document and resale is strictly prohibited. The manufacturer may update this manual occasionally and cannot be responsible for problems including injuries or damages resulting from the use of information found in any manual from unauthorized sources.
PLEASE NOTE: If you purchased this model from certain stores, their model number may end in "L" "LC" "H" "CT", etc. This manual does apply to those models as well.

SPECIFICATIONS

Heating Specifications

- Maximum Burn Time** ..... 6-8 hours
- Approximate Square Footage Heated*** ..... 2000 sq. ft.
- Firebox Capacity..... 35 pounds
- Flue Collar ..... 6.0 in. round

Dimensions (Inches)



EPA and Safety Compliance Specifications

- EPA Compliance Status ..... Certified to comply with 2020 particulate emission standards using crib wood fuel.
- U.S. Test Standard: US EPA 40 CFR Part 60, Subpart 60.536
- Particulate Emissions ..... 1.956 grams/hr
- CO Emissions ..... 1.659 grams/min
- Heat Output Range ..... 11,129 – 24,369 Btu/hr
- Efficiency..... ..... 73.77% (HHV)
- Tested To EPA Test Method 28A, ASTM E2780, ASTM E2515, ULC/ORD-C1482 & ULC S627-00

Notes for this unit: Product may vary slightly from diagram. Clearances are the minimum for **this unit** and may need to be increased in the rear to have proper vent clearances. **Follow all venting manufacturer clearances and local codes.**

*** - The maximum heating capacity of this unit can vary greatly based on climate, construction style, insulation and a myriad of other factors. Use this information in conjunction with a BTU loss calculation for your home to determine if this unit will be sufficient for your needs.

INSTALLATION

Installation Overview

When choosing a location for your new stove, there are a multitude of factors that should be taken into account before beginning the installation.

1. Traffic Patterns – To help prevent accidents, the stove should be placed in a location where it is out of the way of normal travel through the home.

2. Heat Flow – When deciding on a location for the stove, consider the way heat moves throughout your home. Install the stove where you need the heat; basement installations often do not allow sufficient heat to flow to the upper floors and a top floor installation will not allow any heat to reach the floors below. Always consider that heat rises and will take the path of least resistance while it is still hot.

3. Exhaust Location – The engine which drives a wood stove is the chimney system, so it is important to consider precisely how the chimney system will be integrated into the stove installation. Ideally, a wood stove chimney will run completely vertical from the flue collar of the unit all the way to the termination point above the roof line. Keeping the entire chimney system inside the heated envelope of the home will ensure a strong, easy to initiate draft in the chimney. Although exterior chimney systems often function properly, they are more likely to suffer from cold down drafts at start up or provide weak draft to the unit. Also, consider the cross-sectional area of the chimney; although existing masonry chimneys can often be used, a large external masonry chimney will result in a unit that is difficult or impossible to operate properly. In that case, an insulated chimney liner will often be required to supply the necessary draft.

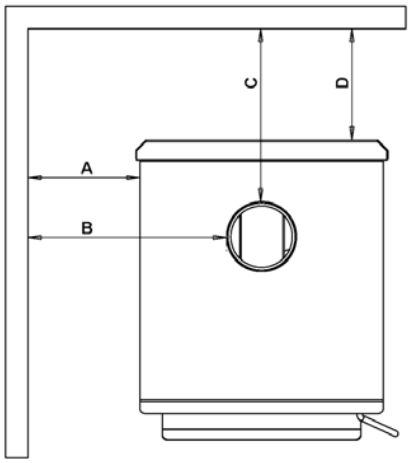
4. Wall Construction – Locating the stove so that the exhaust system can pass between studs will simplify the installation and eliminate the need to reframe any sections of the wall or ceiling to accommodate the wall thimble or ceiling box.

WARNING

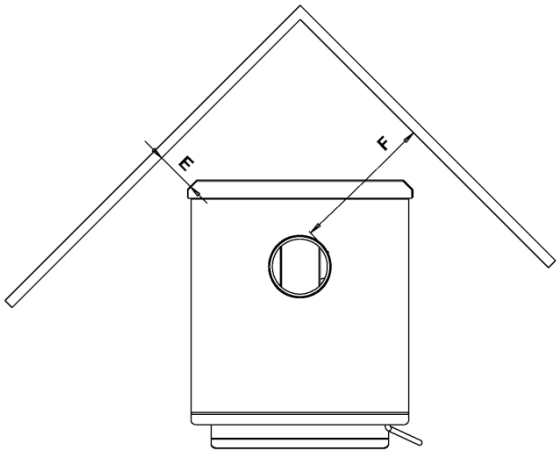
- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- Do Not Over-fire – If any external part starts to glow, you are over-firing. Reduce intake air supply. Over-firing will void your warranty.
- Comply with all minimum clearances to combustibles as specified. Failure to comply may result in a house fire.
- Tested and approved for **cordwood only**. Burning any other fuel will void your warranty.

INSTALLATION

Clearances to Combustibles



Parallel Wall Installation



Corner Installation

WARNING - INSTALL VENT AT CLEARANCES SPECIFIED BY THE VENT MANUFACTURER

	Unit to Side Wall *	Chimney Connector to Side Wall	Chimney Connector to Rear Wall	Unit to Rear Wall	Unit to Corner	Chimney Connector to Corner
	A	B	C	D	E	F
	in. (mm.)	in. (mm.)	in. (mm.)	in. (mm.)	in. (mm.)	in. (mm.)
Single Wall Chimney Connector Unprotected Surface	21.5 (546.1)	29 (736.6)	12 (304.8)	7.5 (190.5)	9.5 (241.3)	19 (482.6)
Double Wall Chimney Connector Unprotected Surface	N/A	N/A	N/A	N/A	N/A	N/A
Single Wall Chimney Connector Unprotected Surface with side shields.	17.5 (445.5)	25 (635)	12 (304.8)	7.5 (190.5)	5.5 (139.7)	15 (381)
Double Wall Chimney Connector Unprotected Surface with side shields.	N/A	N/A	N/A	N/A	N/A	N/A

INSTALLATION

Venting Introduction

This wood stove operates on a natural draft system, in which the chimney system pulls air through the stove. This unit must be installed in accordance with the following detailed descriptions of venting techniques; not installing the stove in accordance with the details listed here can result in poor stove performance, property damage, bodily injury or death. Avoid make-shift compromises when installing the venting system. England's Stove Works is not responsible for any damage incurred due to a poor or unsafe installation.

Be certain that all aspects of the venting system are installed to the venting manufacturer's instructions, particularly the required clearances to combustibles. Also, be certain to use an attic radiation shield to prevent insulation from contacting a chimney which passes through an attic.

The chimney system is the "engine" which drives a wood stove, so it is imperative for proper unit function that the venting system be installed exactly as described in the following section.

If questions arise pertaining to the safe installation of the stove, our Technical Support line (800-245-6489) is available. Contact your local code official to be certain your installation meets local and national fire codes, and if you're uncertain about how to safely install the stove, we strongly recommend contacting a local NFI certified installer to perform the installation.

Venting Guidelines

- **ALWAYS** install vent pipe in strict adherence to the instructions and clearances included with your venting system.
- **DO NOT** connect this wood stove to a chimney flue which also serves another appliance.
- **DO NOT** install a flue pipe damper or any other restrictive device in the exhaust venting system of this unit.
- **USE** an approved wall thimble when passing through a wall and a ceiling support/fire stop when passing through a ceiling.
- **INSTALL** three sheet metal screws at every chimney connector joint.
- **AVOID** excessive horizontal runs and elbows, as both will reduce the draft of the venting system and will result in poor stove performance.
- **INSPECT** your venting system often, to be certain it is clear of creosote, fly-ash and other restrictions.
- **CLEAN** the venting system as detailed in the maintenance section of this manual.
- **ADHERE** to the 10-3-2 rule regarding chimney terminations.
- **INSTALL** single wall chimney connector with the male end **down** to prevent creosote leakage. Follow double wall chimney connector manufacturer's instructions regarding proper pipe installation.

WARNING: Venting system surfaces get HOT, and can cause burns if touched. Noncombustible shielding or guards may be required.

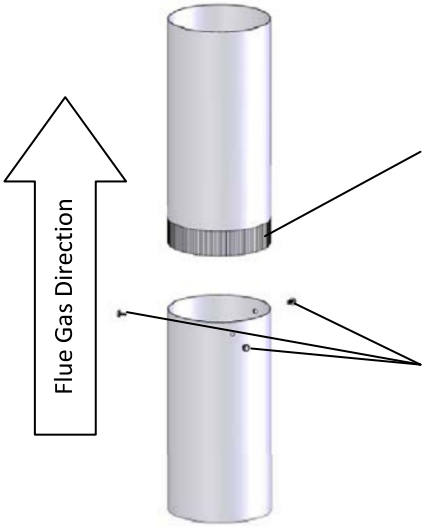
INSTALLATION

Additional Venting Information

- Do not mix and match components from different pipe manufacturers when assembling your venting system (i.e. Do **NOT** use venting pipe from one manufacturer and a thimble from another).
- We **require** a minimum chimney height of 15.0 ft. Chimney systems shorter than this may not create the amount of draft which is required to operate this wood burning unit.
- Do not use makeshift compromises when installing the venting system; have existing chimney systems inspected before use and be certain all new chimney systems are installed to the manufacturer's specifications and with only UL listed components (ULC if Canada).
- Prefabricated venting systems used for this stove must be listed to ULC S629 (Canada) and UL 103HT (US).
- Never install a draft inducer or any other system which increases the natural draft of the chimney; similarly, do not install a barometric or stovepipe damper with this unit.
- Never use single wall or double chimney connector as a chimney system; never pass either type of chimney connector through a combustible wall without carefully following the manufacturer's instructions and those listed in the following page on Wall Pass-Throughs. NEVER pass chimney connector through an attic, floor, closet or roof.
- Only use 24 gauge MSG black single wall chimney connector or UL Listed (ULC if Canada) double wall chimney connector.

Single Wall Chimney Connector Installation

The male end of single wall chimney connector is installed facing down so that any liquid creosote in the flue will run into the unit instead of onto the outside of the pipe (the natural draft in the chimney system will prevent smoke leakage at the joints).



Crimped or male end of single wall chimney connector must face down.

Fasten each single wall chimney connector joint with three sheet metal screws.

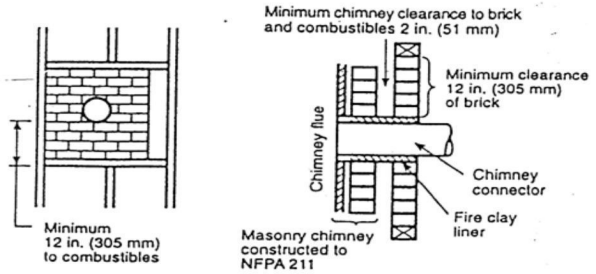
WARNING

- **INSTALL VENT AT CLEARANCES SPECIFIED BY THE VENT MANUFACTURER**.
- HOT! Do not touch! Severe burns or clothing ignition may result.
- Glass and other surfaces are hot during operation.

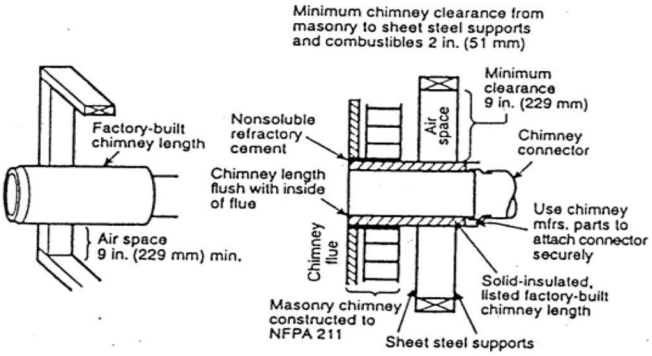
INSTALLATION

Wall Pass-Throughs

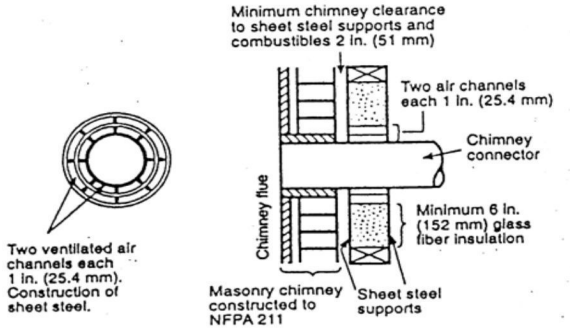
Chimney Connector Systems and Clearances from Combustible Walls for Residential Heating Appliances



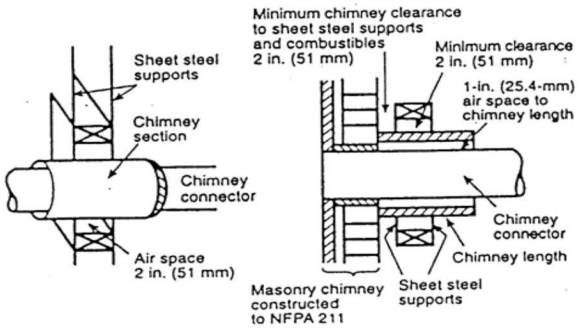
A Minimum 3.5-in thick brick masonry all framed into combustible wall with a minimum of 12-in brick separation from clay liner to combustibles. The fireclay liner shall run from outer surface of brick wall to, but not beyond, the inner surface of chimney flue liner and shall be firmly cemented in place.



B Solid-insulated, listed factory-built chimney length of the same inside diameter as the chimney connector and having 1-in. or more of insulation with a minimum 9-in. air space between the outer wall of the chimney length and combustibles.



C Sheet steel chimney connector, minimum 24 gauge in thickness, with a ventilated thimble, minimum 24 gauge in thickness, having two 1-in. air channels, separated from combustibles by a minimum of 6-in. of glass fiber insulation. Opening shall be covered, and thimble supported with a sheet steel support, minimum 24 gauge in thickness.

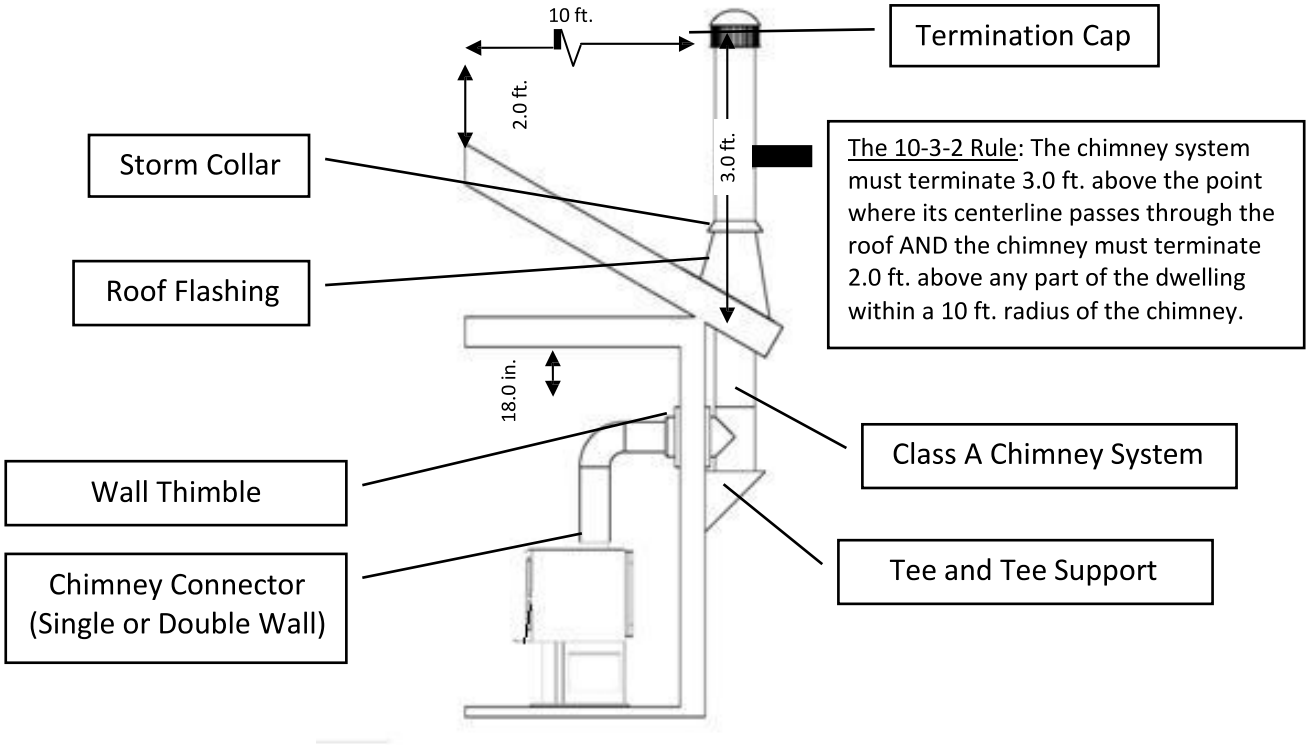


D Solid insulated, listed factory-built chimney length with an inside diameter 2-in. larger than the chimney connector and having 1-in. or more of insulation, serving as a pass-through for a single wall sheet steel chimney connector of minimum 24 gauge thickness, with a minimum 2-in. air space between the outer wall of chimney section and combustibles. Minimum length of chimney section shall be 12-in. chimney section spaced 1-in. away from connector using sheet steel support plates on both ends of chimney section. Opening shall be covered, and chimney section supported on both sides with sheet steel supports securely fastened to wall surfaces of minimum 24 gauge thickness. Fasteners used to secure chimney section shall not penetrate chimney flue liner.

In Canada, the installation must conform to CAN/CSA-8365 when passing through combustible construction.

INSTALLATION

Approved Venting Method 1: Through the Wall Factory Built Chimney

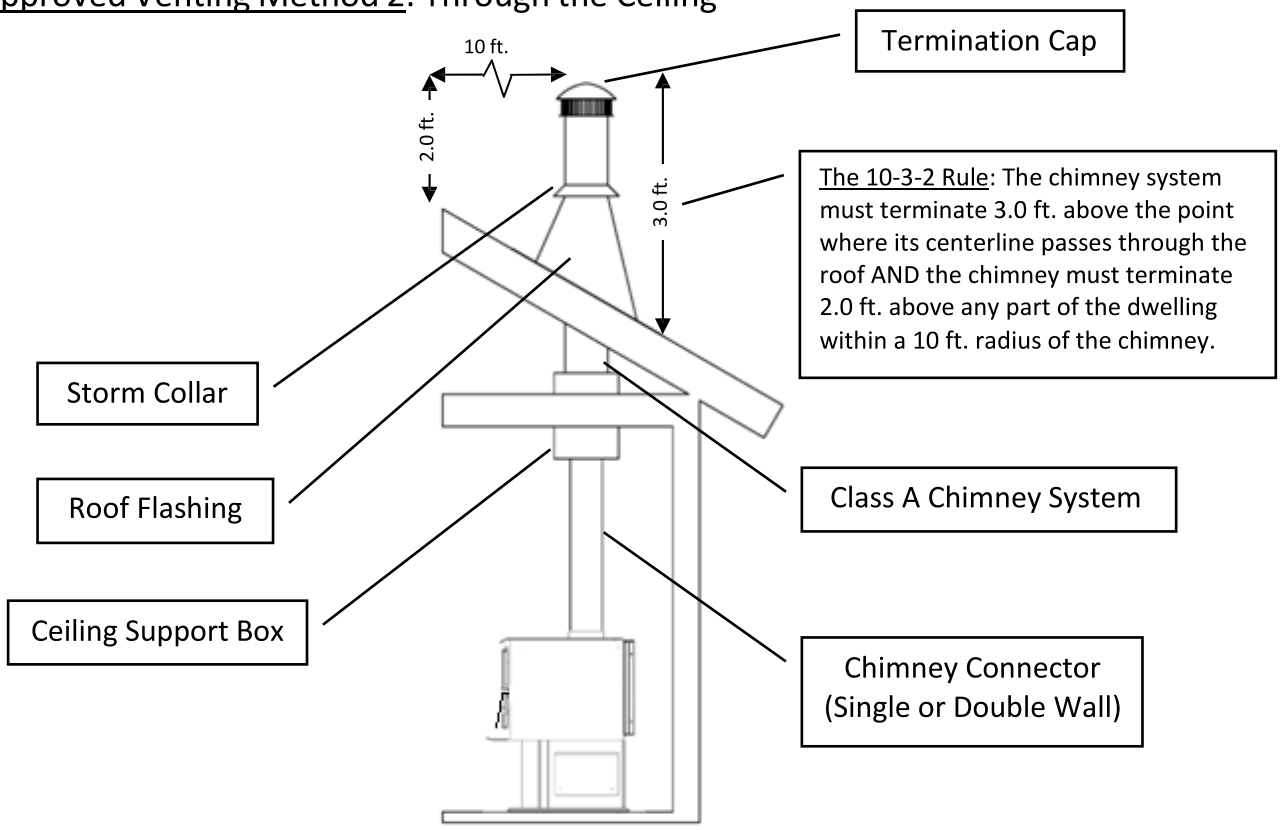


- Prefabricated chimney systems must conform to UL-103HT (2100 °F) for the U.S. and ULC-S629 (650°C) for Canada.
- This wood burning unit is only listed for installation with 6.0" diameter chimney connector and chimney systems. Installing this unit on prefabricated chimneys larger than 6.0" diameter will result in decreased draft and the potential for poor unit performance.
- Follow all venting system manufacturer's installation requirements and required clearances.
- Use three sheet metal screws at each single wall chimney connector joint (check manufacturer's recommendations when double wall chimney connector is used).
- Drill three holes in the flue collar of the unit and attach the chimney connector to the unit using sheet metal screws (holes should be pre-drilled in flue collar from factory).
- Properly attach the prefabricated chimney system to the home in strict accordance with the prefabricated chimney system manufacturer's instructions.
- Avoid numerous elbows and excessive horizontal runs as both will lead to poor draft and increased creosote accumulation. Horizontal runs of chimney connector must never exceed 4.0 ft. and the overall length of the chimney connector must not exceed 8.0 ft.
- Special adapters and slip connectors are available to eliminate the need to cut single wall chimney connector. Double wall chimney connector must be used with these slip connectors, as it cannot be trimmed to length.

Please Note: Installation diagrams are for reference purposes only and are not drawn to scale, nor meant to be used as plans for each individual installation. Please follow all venting system requirements, maintain the required clearances to combustibles, and follow all local codes.

INSTALLATION

Approved Venting Method 2: Through the Ceiling

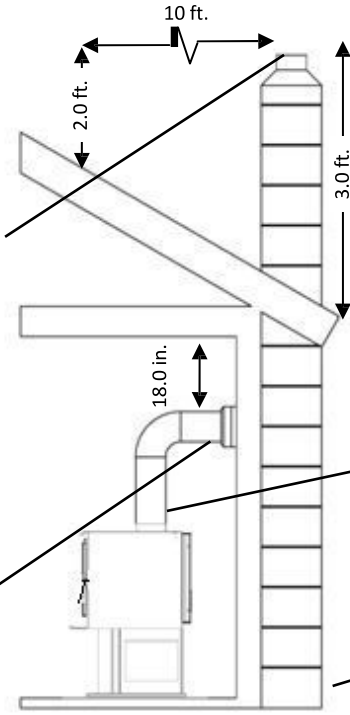


- Prefabricated chimney systems must conform to UL-103HT (2100 °F) for the U.S. and ULC-S629 (650°C) for Canada.
- This wood burning unit is only listed for installation with 6.0" diameter chimney connector and chimney systems. Installing this unit on prefabricated chimneys larger than 6.0" diameter will result in decreased draft and the potential for poor unit performance.
- Follow all venting system manufacturer's installation requirements and required clearances.
- Use three sheet metal screws at each single wall chimney connector joint (check manufacturer's recommendations when double wall chimney connector is used).
- Drill three holes in the flue collar of the unit and attach the chimney connector to the unit using sheet metal screws (holes should be pre-drilled in flue collar from factory).
- Properly attach the prefabricated chimney system to the home in strict accordance with the prefabricated chimney system manufacturer's instructions.
- The overall length of the chimney connector must not exceed 8.0 ft. In the case of cathedral ceilings, the prefabricated chimney system should extend to 8.0 ft. from the top of the unit.
- Special adapters and slip connectors are available to eliminate the need to cut single wall chimney connector. Double wall chimney connector must be used with these slip connectors, as it cannot be trimmed to length.

Please Note: Installation diagrams are for reference purposes only and are not drawn to scale, nor meant to be used as plans for each individual installation. Please follow all venting system requirements, maintain the required clearances to combustibles, and follow all local codes

INSTALLATION

Approved Venting Method 3: Internal or External Masonry Chimney System



Chimney liner cross-sectional area (Length x Width) must be no larger than twice the cross-sectional area of the flue collar (2 x 28.27 in^2 = 56.55 in^2). If chimney liner is larger than 56.55 in^2, relining with a 5.5" or 6.0" liner is required

The 10-3-2 Rule: The chimney system must terminate 3.0 ft. above the point where its centerline passes through the roof AND the chimney must terminate 2.0 ft. above any part of the dwelling within a 10 ft. radius of the chimney.

Chimney Connector (Single or Double Wall)

Masonry Thimble with proper clearance to combustibles

Ash Cleanouts must have an airtight seal to prevent weak draft.

- Follow the rules listed above concerning maximum permissible flue liner size; installing this unit on masonry chimneys exceeding 56.55 in^2 in cross-sectional area will result in decreased draft and the potential for poor unit performance.
- Use three sheet metal screws at each single wall chimney connector joint (check manufacturer's recommendations when double wall chimney connector is used).
- Drill three holes in the flue collar of the unit and attach the chimney connector to the unit using sheet metal screws (holes should be pre-drilled in flue collar from factory).
- Avoid numerous elbows and excessive horizontal runs as both will lead to poor draft and increased creosote accumulation. Horizontal runs of chimney connector must never exceed 4.0 ft. and the overall length of the chimney connector must not exceed 8.0 ft.
- A tight seal at the thimble is crucial for proper unit performance and to create a safe installation. Use the proper adapter designed for connecting single or double wall chimney connector to a masonry thimble.
- Have existing masonry chimneys inspected for safety and proper clearances to combustibles before putting them into service; a qualified chimney sweep can perform this inspection.
- External masonry chimneys often suffer cold downdrafts and poor draft performance even when they meet the cross-sectional area rules. In this case, a 6.0" insulated liner may be necessary.

Please Note: Installation diagrams are for reference purposes only and are not drawn to scale, nor meant to be used as plans for each individual installation. Please follow all venting system requirements, maintain the required clearances to combustibles, and follow all local codes.

INSTALLATION

INSTALLATION INTO A MASONRY FIREPLACE

Preparation
Measure your hearth to ensure it is large enough to accept the unit.

Unit must have a 36” clearance from the top of the stove to a mantel in accordance with NFPA 211

For the USA: Hearth must extend at least 16 in. from the front of the fuel opening.

For Canada: Hearth must extend at least 18 in (450.0 mm) from the front of the fuel opening.

Keep in mind that this type of a installation will make it difficult to change speeds on the blower frequently. We recommend picking a blower speed and sticking with it, since adjusting the blower will be difficult because of the tight installation.

WARNING: DO NOT ATTEMPT TO ADJUST BLOWER DURING OPERATION. SKIN BURNS MAY OCCUR WHEN MAKING CONTACT WITH THE UNIT. WAIT FOR UNIT TO COMPLETELY COOL BEFORE ATTEMPTING TO ADJUST BLOWER.

Inspect your hearth to be sure it is constructed of a noncombustible material such as brick or stone. Do **not** install this stove on a hearth that is constructed of wood framework that is covered by brick or stone and do **not** install this unit in a zero (0) clearance fireplace. The manufacturer will not be held responsible for an accident resulting from this stove being installed on a hearth constructed of a combustible material.

Inspect your fireplace to ensure it is in proper working order and free of any obstructions.

Prior to installation, remove the existing damper or wire it to fasten it open.

Venting Your Stove - Direct Connect
When this unit is direct connected it will require six inch (6”) diameter 24 gauge pipe from the stove through the damper opening. (**NOTE: The chimney connector must be attached to the appliance with a minimum of three (3) screws, and 3 screws should be used to attach each adjoining section.)**
We highly recommend having the chimney fully lined with a 6 inch liner to ensure proper draft. This will make it necessary to block off the open area on both sides of the pipe that passes through the damper opening, which can be done with sheet metal or by packing flame retardant fiberglass insulation in the open areas (no paper or combustibles). You must be sure the draft from the chimney is being pulled through the stove, and not around the connector pipe. .

We highly recommend you have this done by a professional. You should also contact your local authorities to be sure you are following all codes.

INSTALLATION

WARNING
DO NOT INSTALL IN A SLEEPING ROOM.

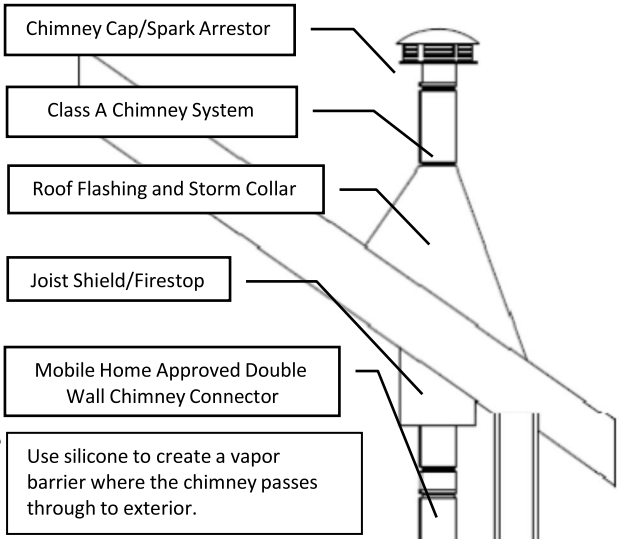
CAUTION

THE STRUCTURAL INTEGRITY OF THE MANUFACTURED HOME FLOOR, WALL AND CEILING/ROOF MUST BE MAINTAINED.

Caution
NEVER draw outside combustion air from:
Wall, floor or ceiling cavity or
enclosed space such as an attic, garage or crawl space.

Mobile Home Installation **(USA ONLY, NOT APPROVED FOR CANADIAN MOBILE HOME INSTALLATION)**

- The wood stove **MUST** be secured to the floor of the mobile home using lag bolts and the holes provided in the bottom of the unit for this purpose. Use a #8 copper wire to ground stove to frame of mobile home.
- The wood stove must be connected to the chimney system with double wall chimney connector which is UL listed for use in mobile and manufactured homes.
- Carefully follow all clearances listed in the appropriate section of this manual AND follow the venting manufacturer's minimum clearance requirements. Similarly, be certain the venting system used is approved for mobile home use.
- Installation must be in accordance with Manufacturers Home & Safety Standard (HUD) CFR 3280, Part 24 as well as any applicable local codes.

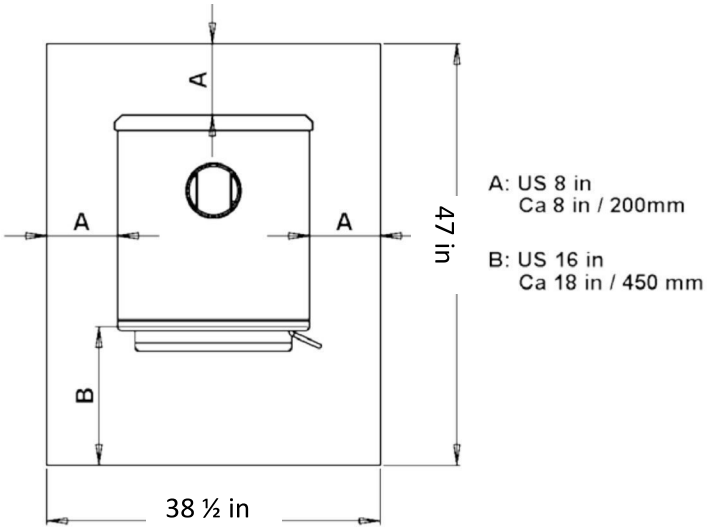


Outside Combustion Air

- The use of outside combustion air is **mandatory** when installing this wood stove in a mobile or manufactured home.
- The outside air connection pipe protrudes from the bottom center of the stove; a kit is available from England's Stove Works, Inc. designed for connecting this unit to outside combustion air. [Part No. AC-OAK3]
- If it is not feasible to use the AC-OAK3 outside air hookup kit in your stove installation, other materials may be used, provided the following rules are followed:
    - The pipe used for outside air hookup must be metal, with a minimum thickness of .0209in. (25 gauge mild steel) or greater and an inside diameter of approximately 2.75 in.
    - Keep pipe runs short and use a mechanical fastener at each pipe joint.
    - A screen or other protection device must be fitted over the outside air termination point to prevent rain, debris and nuisance animals from entering the piping system. Inspect the outside combustion air inlet for block and debris monthly.

FLOOR PROTECTION

- This wood stove requires a UL listed type 1 spark and ember floor protector if the stove is to be installed on a combustible floor. If the floor the stove is to be installed on is already non-combustible (i.e. a concrete floor in a basement), no floor protection is needed (although a decorative floor protector can still be used for aesthetic reasons).
- When using any UL listed type 1 spark and ember floor protector, consider that this stove is not only heavy but will induce heating and cooling cycles on the floor protector which can damage tile and loosen mortar and grout joints located near the stove.
- The spark and ember floor protector should be UL approved or equivalent (ULC if Canada) and must be noncombustible. Since the majority of the heat from this unit is radiant, the floor protector only serves to keep ashes and sparks from landing on combustible flooring near the unit. A hearth rug is NOT an approved substitute for a proper hearth pad. No R Value is necessary.
- For the US: The floor protector must extend at least 16 in. from the front of the fuel opening, 8 in. from the sides of the door opening and 8 in. from the rear of the unit.
- For Canada: The floor protector must extend at least 450.0 mm from the front of the fuel opening, 200.0 mm from the sides of the door opening and 200.0 mm from the rear of the unit.



- The spark and ember floor protector must extend 2 in. (50.8 mm.) on either side of any horizontal venting runs and extend directly underneath any vertical venting pipe.

CAUTION

NEVER USE GASOLINE, GASOLINE-TYPE LANTERN FUEL, KEROSENE, CHARCOAL LIGHTER FLUID, OR SIMILAR LIQUIDS TO START OR "FRESHEN UP" A FIRE IN THIS HEATER. KEEP ALL SUCH LIQUIDS WELL AWAY FROM THE HEATER WHILE IN USE. ADDITIONALLY, NEVER APPLY FIRE-STARTER TO ANY HOT SURFACE OR EMBERS IN THE STOVE.

OPERATION

Break-In Fires

- This wood burning unit is constructed of heavy gauge steel and cast iron and is built to last a long time. However, in order to ensure no excessive thermal stresses are induced on the metal during the first fire, three break-in fires should be burned, each one slightly hotter than the last. These break-in fires will not only help the stove body acclimate to the high temperatures of the fire, but will also slowly cure the high temperature stove paint, which will ensure the high quality finish lasts for years.
- This stove has a single air control rod which regulates the wood burn rate; when the primary air control slide is pulled all the way out of the unit, the stove will burn more slowly and put out heat over a longer time period. Conversely, when the air control slide is pushed all the way in, the unit will burn more quickly and put out a larger amount of heat over a relatively shorter time period. Do not attempt to modify the range of air control adjustment for any reason.
- The first break-in fire should be just a large kindling fire, getting the stove to about 300°F as measured by a magnetic thermometer on the right or left side of the stove, above the door. Once this temperature has been reached, allow the fire to die out with the air control open. The second and third break-in fires should be a bit larger, with some small dry splits added to the kindling load. The temperature goal during these fires is about 350°F – 450°F; don't let the fire get hotter than that.

Continuous Operation

- After the break-in fires are complete, this unit is ready for continuous operation. When burning the stove continuously, do not allow ash and coals to accumulate higher than the air hole in the dog box. Excessive coaling is often a result of burning wood at too high a burn rate, and the coal bed should be allowed to burn down before reloading the stove with fresh wood.
- Combustion air is delivered to the stove at two locations: The majority of the primary combustion air enters the firebox via the air-wash system which keeps the glass clean and feeds the primary combustion flames on the top surfaces of the wood; some primary combustion air is feed into the coal bed via the dog box hole in the bottom, front box of the stove. (This air is supplied from under the unit.) Every effort must be taken to maintain the area in front of this hole free of ash.
- When loading the stove for a long term burn, it is most useful to rake a "v" in the center of the coal bed, to allow the primary air bleed hole to push air all the way to the rear of the unit.
- After loading the stove with a full firebox of fresh wood, it is important to operate the unit with the air control in the full open position to properly char the wood load and drive off the initial moisture in the fresh wood. Once the wood has been properly charred and is completely ignited, the air control can then be set to the desired heat output level.
- This unit also offers a new feature. When loading the stove for a long low burn, you can set the air control damper to allow the unit to heat up and get a good burn going before the air is closed off to the low position. Simply pull the rod out to low and turn it counter-clockwise until you hear a slight "click" (about a quarter of a turn). When it is ready the damper will shut itself. This will work for low and medium low settings.

OPERATION

- England's Stove Works, Inc. always recommends the use of a magnetic stove thermometer, so that the temperature of the unit can be monitored. When using a magnetic stove thermometer, locate the thermometer above the door on either the left or right side of the stove and use the following temperatures as rough guidelines to determine the burn rate and heat output level of the stove:
    - Normal wood stove operation should occur between 350°F (177°C) and 550°F (288°C), with 350°F (177°C) to 450°F (232°C) being a low to medium heat output level and 450°F (232°C) to 550°F (288°C) being a medium to high heat output level. Operating the stove at 600°F (316°C) would be considered the maximum continuous operating temperature permissible and unit damage may result from operating at that high of a burn rate for extended time periods. Allowing the unit to reach 650°F (343°C) or higher is defined as over-firing and will result in unit damage.
- The optional room air convection blower was designed to extract the maximum amount of heat from the stove, for the highest possible heat transfer into the room. Since the blower is so efficient at removing heat from the unit, it is very important to only operate the room air blower after a fresh wood load has been allowed to burn for at least thirty (30) minutes. Allowing a fresh load of wood to burn without the blower on ensures that the entire unit reaches proper operation temperatures and that the secondary combustion system is functioning properly. Additionally, follow the guidelines below for acceptable blower speeds.
- When using the optional room air convection blower (Part No. AC-16, or you can upgrade to the AC-30), the blower should be operated as follows depending on heat output level:

Burn Rate	High	Medium High	Medium	Medium Low	Low
Blower Speed AC-16	High	High	Low	Low	Low
Blower Speed AC-30	High	Medium High	Medium	Medium Low	Low

Creosote – Formation and Need for Removal

When wood is burned slowly, it produces tar and other organic vapors, which combine with expelled moisture to form creosote. The creosote vapors condense in the relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited, this creosote makes an extremely hot fire. The chimney and chimney connector should be inspected at least once every two months during the heating season to determine if a creosote buildup has occurred. If creosote has accumulated, it should be removed to reduce the risk of chimney fire.

DO NOT USE GRATE OR ELEVATE FIRE – BUILD WOOD FIRE DIRECTLY ON HEARTH
DO NOT OPERATE WITH THE MAIN DOOR OPEN – OPERATING THE STOVE WITH THE MAIN DOOR OPEN WILL CREATE AN OVER-FIRE

In the event of a creosote or soot fire (chimney fire), close the air control on the stove, contact the local fire department and get out! Do not throw water on the fire! Contact your local fire authority for more information on how to handle a chimney fire and develop a safe evacuation plan for you and your family in the event of a chimney fire.

OPERATION

Additional Safety Guidelines

CAUTION: When adding fuel to the stove, the blower must be turned OFF.

- The installation of smoke detectors is highly recommended when installing this or any other solid fuel burning appliance. Smoke detectors should be located near or in every room of the home, particularly sleeping rooms.
- A smoke detector can be installed in the same room as this cordwood burning unit; installing the smoke detector too close to the unit can lead to nuisance alarms due to slight wisps of smoke emitted during the fire starting or reloading process. Due to this, the smoke detector in the same room as the unit will be most useful if it is located as far from the unit as the room will permit.
- This stove is meant for burning cordwood only; never burn pressure treated wood, kiln dried wood, creosote treated wood (railroad ties), ice covered or wet wood, green wood, drift wood, charcoal, coal, coke or ANY other fuel.
- Burning fuels other than cordwood, particularly coal and charcoal, can result in hazardous concentrations of carbon monoxide being emitted into the dwelling. For these reasons, NEVER burn coal or charcoal in this cordwood stove. Installing a carbon monoxide detector and being aware of the symptoms of carbon monoxide poisoning can help reduce the risk of carbon monoxide related issues.

Caution

This unit is meant to operate only with the main viewing door closed. Smoke spillage and an inefficient, lazy burn will result from attempting to operate the stove with the door open. In addition, using fuel other than wood pellets can create an unsafe situation and can also generate excess carbon monoxide. Carbon monoxide is an odorless, colorless gas which can be deadly. Burn ONLY wood pellets.

Carbon Monoxide Detector

England's Stove Works, Inc. highly recommends the use of a carbon monoxide detector in the proximity of the stove and one per floor of the home. A certain amount of carbon monoxide is produced within the stove as a by-product of combustion. All exhaust vent connections must be sealed with RTV Silicone to assure a tight seal. Any leaks into a confined area caused by faulty installation or improper operation of the stove could produce dizziness, nausea and in extreme cases, death. The CO concentration during testing was found to be 1.659 g/min.

- This unit was designed for operation only with the loading door closed and tightly latched. Operating this unit with the loading door latched loosely or open will allow excessive combustion air to reach the fire and will result in dangerously high unit temperatures. High unit temperatures can damage the unit, void the warranty or ignite creosote deposited in the chimney system by previous, slow burning fires.
- The natural draft that pulls air through this unit and allows the fire to burn uses the indoor air of the dwelling for combustion, unless the unit is connected to an outside combustion air source. Kitchen range vent hoods, furnaces and other air movement appliances in the home are often also removing air from the dwelling; if the amount of air filtration or leakage back into the home is exceeded by the air being removed, negative pressure may be created in the home.
- Since this is a natural draft appliance, it will often be the first appliance to have problems related to negative pressure. If smoke is forced out the chimney connector joints or out of the air induction system of the unit, the unit is likely fighting negative pressure in the dwelling. Cracking a window or door near the appliance can help equalize the negative pressure; ultimately, an unrestricted source of outside combustion may be necessary for proper unit function.
- If the unit is connected to outside air, be certain to monitor the exterior inlet to the combustion system for icing or snow accumulation. Allowing the outside air connection to become restricted will result in air starvation to the unit.

DO NOT STORE FUEL CLOSER THAN SPECIFIED CLEARANCES TO COMBUSTIBLES OR WITHIN THE SPACE NEEDED FOR LOADING THE STOVE AND FOR ASH REMOVAL.

MAINTENANCE

Daily Maintenance

- Inspect the firebox for ash accumulation; remove excess ash and follow instructions below regarding disposal. Ash should not be allowed to accumulate in the stove to the point that it covers the dog box hole.

Monthly Maintenance

- Check the blower for dust accumulation (if installed); check the door handle for proper operation and to be certain an airtight seal is still being made by the door.
- Inspect the chimney system and chimney connector and sweep if necessary. Although cleaning may be required less than monthly, ALWAYS inspect the venting system monthly to decrease the chance of a chimney fire.
- Visually inspect the ceramic fiber insulating boards in the firebox for cracks and/or breakage. Slight surface cracks will not affect the performance of the boards, but cracked or crumbling boards should be replaced immediately.
- Visually inspect the secondary combustion tubes for cracks, warping and corrosion. Although these tubes are constructed from stainless steel, they operate at very high temperatures and can eventually wear out from normal use.

Yearly Maintenance

- Check all gaskets (window and door) for wear and to be certain they still maintain an airtight seal. See the following page for instructions.
- Thoroughly clean the chimney system and the chimney connector system. Since the chimney connector is generally exposed to high exhaust temperatures, inspect it carefully for leaks and weak spots; replace any questionable pieces. [In the case of straight through the roof chimney system, be certain to remove the ceramic fiber baffles **before** pushing the chimney sweeping brush down into the firebox. Forcefully hitting the top of the baffle with a cleaning brush or rod can damage or destroy the baffle.]
- Remove all ash from the stove, including the ash which accumulates on the top of the firebox baffles. Leave the air control open during the non-heating months to allow some air to flow through the stove to help prevent corrosion. A small open container of cat litter in the stove can help prevent corrosion during the humid summer months; be certain to remove it before building a fire in the fall.

IMPROPER GASKET MAINTENANCE, INCLUDING FAILURE TO REPLACE GASKETS, CAN CAUSE AIR LEAKS RESULTING IN AN UNCONTROLLABLE FIRE IN THE UNIT.

Disposal of Ashes – Ashes should be placed in a metal container with a tight fitting lid. The closed container of ashes should be placed on a noncombustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have been thoroughly cooled.

MAINTENANCE

Inspecting Gaskets

An airtight seal at the door opening is crucial to proper stove performance. Any air leakage at this area can cause an over-fire situation and is therefore a serious safety threat. Because of this, gaskets should always be maintained in good condition. Gasket tightness can be checked using the "dollar-bill" method:

- Place a dollar bill between the gasket and the stove body (at the location where the gasket meets the stove).
- Close and tighten the door then attempt to pull the dollar bill out. If the dollar bill slides in and out easily, the gasket needs to be replaced. This test should be repeated around the entire gasket perimeter, as gaskets will sometimes seal tightly on one side, but will be worn and seal poorly on another side.
- Perform this test around the entire perimeter of the door, and visually inspect the window gasket for any leaks. Leaks in the window gasket can generally be located by following the prevailing soot trails left on the window after burning the unit.
- If any area fails the test, the entire gasket should be replaced. The part number appropriate to the gasket being replaced can be found in the "Illustrated Parts" section of this manual.
- Gaskets should only be replaced with equivalent fiberglass gaskets purchased from England's Stove Works ® specifically for this unit.

Gaskets

1. Door - This unit comes with a ¾" rope gasket around the door that should be replaced at least every year. To replace the door gasket (Part # AC-DGKHD), the old gasket must first be removed entirely — prior to adding the new adhesive, you may have to scrape the old cement from the door channel. Once the cement and gasket have been added, the door should be closed and latched for twenty-four hours to allow the cement to harden.
2. Window - If you are replacing the window gasket (Part # AC-GGK), the new gasket will already have adhesive on one side. First, remove the old gasket. Next, remove the paper on the adhesive side and place the gasket around the outside edge of the glass, centered over the edge. Fold the gasket edges over on the glass, forming a "U" shape.

Finish

This new unit has been painted with High-Temperature Paint that should retain its original look for years. If the unit should get wet and rust spots appear, the spots can be sanded with fine steel wool and repainted. It is crucial that only High-Temperature Spray Paint is used (Part # AC-MBSP), as others may not adhere to the surface or withstand the high temperatures. Similarly, some brands of paint will not adhere to different brands of paint, so we highly recommend using our proprietary High-Temperature Spray Paint.

REPLACING COMPONENTS

Glass

This unit has a ceramic glass panel (Part No. AC-G50) in the viewing door; self adhesive window gasket is included with replacement windows purchased directly from England's Stove Works. Never replace ceramic glass with tempered or any other type of glass and never operate this unit with cracked or broken glass.

- Glass Size: 12.75 in. (323.85 mm) x 16.75 in. (425.45 mm)
- Glass Type: 5mm Ceramic Glass (Keralite Pyroceram)
- Glass Manufacturer: Eurokera

Glass Precautions

1. Never replace ceramic glass with tempered or any other type of glass.
2. Never operate this unit with cracked or broken glass.
3. Do not slam the door or strike the glass with any objects.
4. Do not build the fire directly against the glass.

Glass Cleaning

1. Be certain the stove **and** the glass are completely cool.
2. The build-up on the glass will generally be light and water is normally sufficient to remove the deposits. If stubborn soot persists, use a cleaner made specifically for this purpose. Do not scrape the glass or use abrasive cleaners.
3. Rinse the glass with clean water and dry the glass before resuming normal operation.

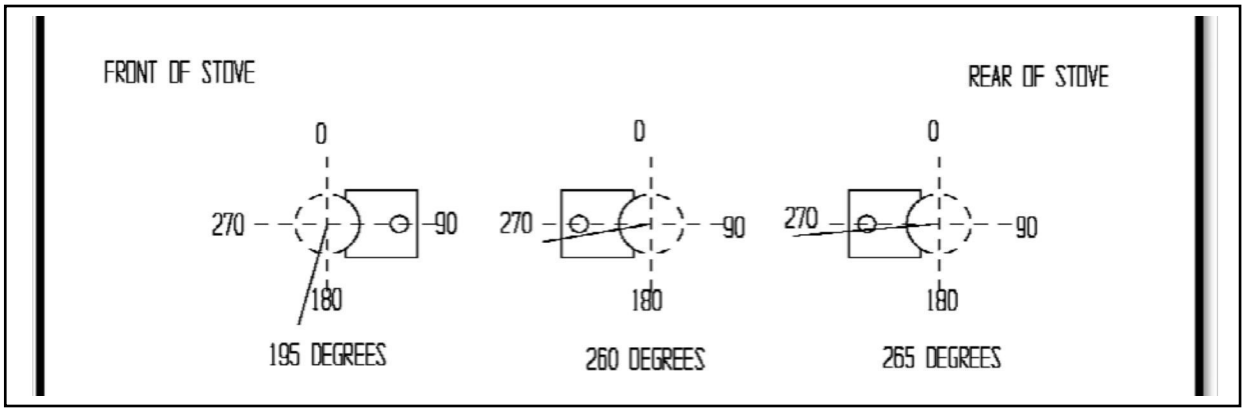
Glass Replacement

1. Remove the door from the stove and rest it face down on a firm work surface.
2. Using a 5/16" wrench, remove the four window bracket retaining screws.
3. Remove the four window tabs from the door. Take extra care to avoid shards of glass if the glass window has been broken.
4. Lift the old glass panel out of the door and discard.
5. The glass panel must be wrapped with a self-adhesive fiberglass tape gasket (AC-GGK). If you purchased a new glass, it will come already wrapped. If reusing the same piece of glass, remove old gasket, scrape off old adhesive and wrapped with the AC-GGK. This gasket serves to cushion the glass from the cast iron door.
6. Reinstall the window retaining tabs using the four screws previously removed. Do not over-tighten the screws.

REPLACING COMPONENTS

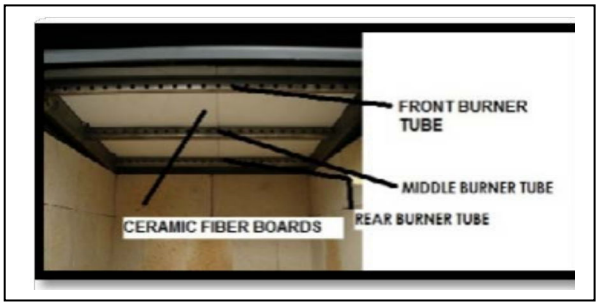
Burner tube replacement

There are three different burner tubes in the top of the stove. To replace a tube, first be sure that you order the correct tube you need to replace. Then using a 5/16" socket or open end wrench, remove the screw located on the left side of the tube. Be sure to keep the screw. Push the tube to the right then remove the tube (pulling the tube back to the left after that side has been removed from the hole). To replace, reverse the above procedure...make sure to install the tubes in the correct order. (Front to Back)



Ceramic fiberboard replacement

To replace a cracked or broken board, first remove the front burner tube. Then remove the board you need to replace. Install the new board (the two boards should sit flush on the tubes side by side). Replace the tube previously removed.



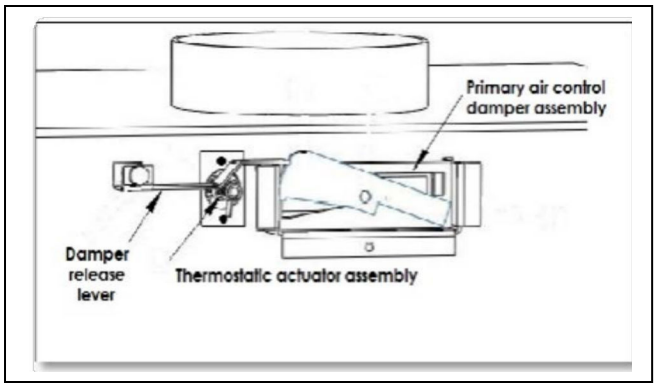
Door hinges

The hinges on this unit were designed to be adjustable. The plates are secured using a ½" bolt and nut. To adjust the hinge plates in or out first remove the door, then use a ½" socket and ½" open ended wrench (one on the nut and one on the bolt head) and loosen the bolt/nut. Slide the plate in/out as desired and then use the socket and wrench to tighten the bolt/nut. * Use care when adjusting hinges. If enough room is not left for the door to clear the side of the unit, the hinge could break. *

Heat shield and back panel removal (to access other components)

There are two 5/16" screws that are on the rear of the heat shield. To remove the heat shield, using a 5/16" socket or open ended wrench, remove the two screws. Then pull the heat shield up and back off the back panel. Next to remove the back panel, there are three 5/16" screws on the rear of the panel. Using a 5/16" socket or open ended wrench, remove the three screws. It may be necessary to pry the top of the panel with a flat head screwdriver (at the top of the stove). Lift the panel up and off the stove.

Other Components continued:

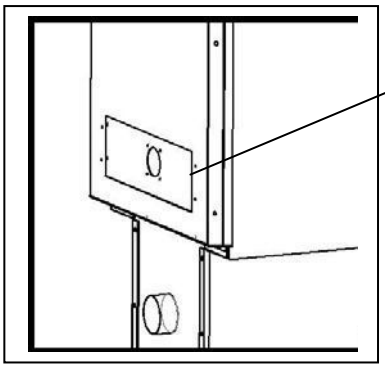


At this point you can access the primary air control damper assembly, thermostatic actuator assembly and the damper release lever. Although these shouldn't need to be replaced, they can be easily. The primary air control damper assembly can be replaced by removing the small spring handle from the front of the unit, then sliding the assembly out. Replace by sliding the new assembly through the same hole and the rod through the front of the stove. Replace the spring handle. The thermostatic actuator assembly can be replaced by using a 5/16" socket to remove the two screws that hold the assembly. Install the new assembly using the same two screws. The damper release lever can be replaced by removing the ½" bolt. When reinstalling the damper be sure it is installed the same as when removed.

OPTIONAL ACCESSORIES

Blower: The wood stove was also designed for use with a convection blower for additional heat circulation. The stove is constructed with side convection channels which allow the room air blower to pick up heat from the hottest regions of the stove and transfer it into the home. The mounting screws for the blower are installed into the rear convection channel at the factory; mounting the blower only requires a 5/16" open end or socket wrench to remove these screws and install the blower. When routing the power cord, take care to keep away from hot areas of the unit and remember that this blower is for use only with the stove. Please see the diagram below for clarification on the room air blower installation. This unit can use the AC-16 (which comes standard with the unit) or the AC-30 upgrade blower. Both are installed using the four factory installed 5/16" screws.

The optional heat circulation blower on this stove requires periodic lubrication; this lubrication should be performed no less than every three months of normal operation. To properly lubricate the blower, use an eye dropper or similar dispensing device to drip 5-7 droplets of SAE 20 oil into the oil port on the side of the blower motor

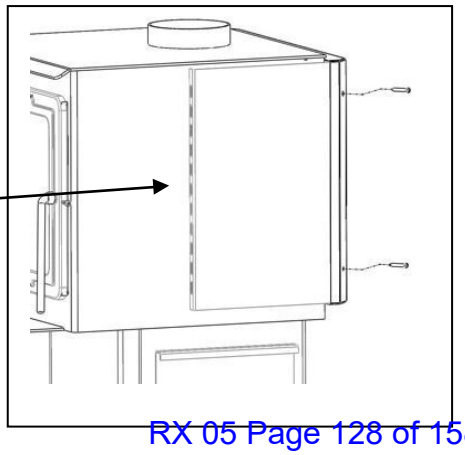


(4) 5/16" head, self-tapping screws (pre-installed in unit).

Warning: Disconnect power from fan before installation.

Side Heat Shield (Part AC-W01SHS):

Install the side heat shield behind the side flange of the rear panel. Align the two mounting holes and secure with the two screws



provided.

TROUBLESHOOTING

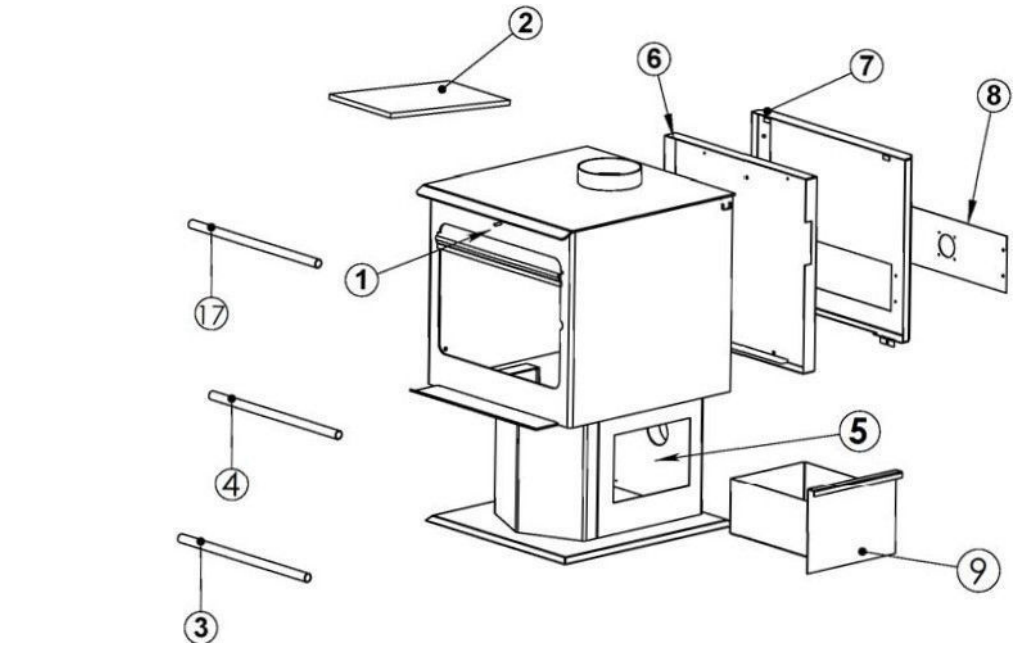
Issue	Cause	Solution(s)
Stove smokes into room	1. Weak Draft	1.1 Be certain chimney is sufficiently tall to meet the 10-3-2 rule.
		1.2 Add additional height to the chimney.
	2. Negative Pressure in the Home	2.1 Add an outside combustion air hookup to the unit.
Fire is hard to start	3. Weak Draft	3.1 Be certain chimney is sufficiently tall to meet 10-3-2 rule.
		3.2 Add additional height to the chimney system.
	4. Cold Chimney	4.1 Heat the flue first by burning crumbled newspaper in the stove.
		4.2 Install an insulated chase around external chimneys.
	5. Downdraft in Chimney	5.1 Be certain chimney is sufficiently tall to meet 10-3-2 rule.
		5.2 Try heating the flue with a hair-dryer to correct the draft.
Glass is dirty	6. Wet or Green Wood	6.1 Only burn wood that is seasoned for at least one year and that is dry and free of ice and snow.
	7. Operating Stove at Low Burn Rate	7.1 Operate the stove at higher burn rates to allow the air-wash system to keep the glass clean.
	8. Wood Loaded Too Close to Glass	8.1 Never load wood so that it is touching the ceramic glass viewing window.
Coals build up in firebox	9. Operating Stove at High Burn Rates	9.1 Reduce combustion air control and allow coals to burn down before reloading.
Fire burns out of control	10. Excessive Draft	10.1 Reduce chimney height.
	11. Air Leakage	11.1 Inspect window and door gaskets and replace if necessary.
	12. Burning Excessively Dry Wood	12.1 Only burn seasoned cord wood. Do not burn kiln dried wood or pallet wood.
Excessive smoke from stack	13. Operating Stove at Low Burn Rate	13.1 Operate the stove at a higher burn rate which will create secondary combustion.
	14. Wet or Green Wood	14.1 Only burn wood that is seasoned for at least one year and that is dry and free of ice and snow.
	15. Not Charring Fresh Wood Load	15.1 Char the fresh wood load until it is completely ignited and active secondary combustion is present in the firebox.

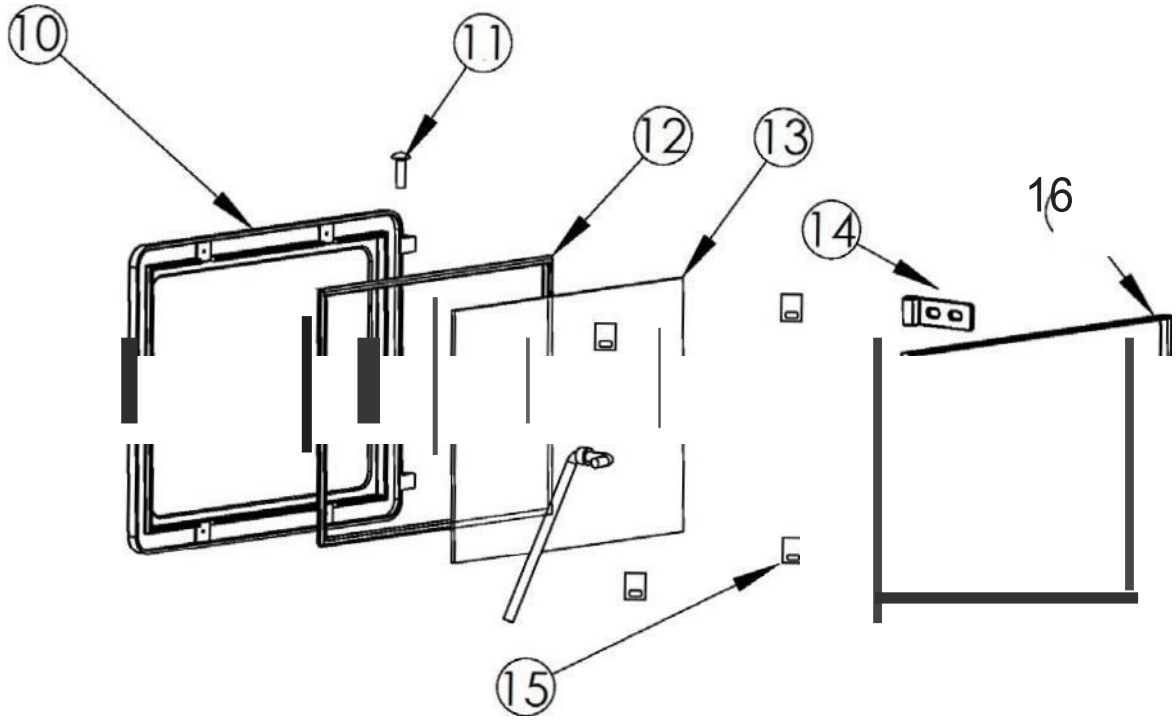
REPLACEMENT PARTS LIST

Diagram No.	Description	Part No.	Per Unit
7	Rear heat shield (BOLT ON)	AC-W01HS	1
6	Rear panel (BOLT ON)	AC-W01RP	1
1	Primary air control damper assembly	AC-W01PDA	1
Not shown	Damper release lever	AC-W01DRL	1
Not shown	Thermostatic actuator assembly	AC-W01TAA	1
9	Ash drawer	AC-ADW01	1
10	Door	CA-W01	1
14	Door hinges	AC-DHW01	2
Not shown	Side heat shields	AC-W01SHS	2
Not shown	Large Upgrade Blower (optional)	AC-30	1
Not shown	Small standard blower	AC-16	1
12	Glass gasket kit 3/4" flat	AC-GGK	1
16	Door gasket kit 3/4" high density	AC-DGKHD	1
3	Front burner tube	AC-W01FBT	1
17	Middle burner tube	AC-W01MBT	1
4	Rear burner tube	AC-W01RBT	1
13	Glass size 12.75” X 16.75”	AC-G50	1
2	Ceramic fiberboard	AC-W01CFB	2
Not shown	Small spring handle Nickel/Brass	AC-SH4N/AC-SH4	1
Not shown	Large spring handle Nickel/Brass	AC-SHN/AC-SH	1
8	Blower back cover	AC-BBC30	1
15	Glass tabs	AC-W01GT	4
11	Hinge pins	AC-HP	2
Not shown	Outside Air Kit (optional)	AC-OAK3	1

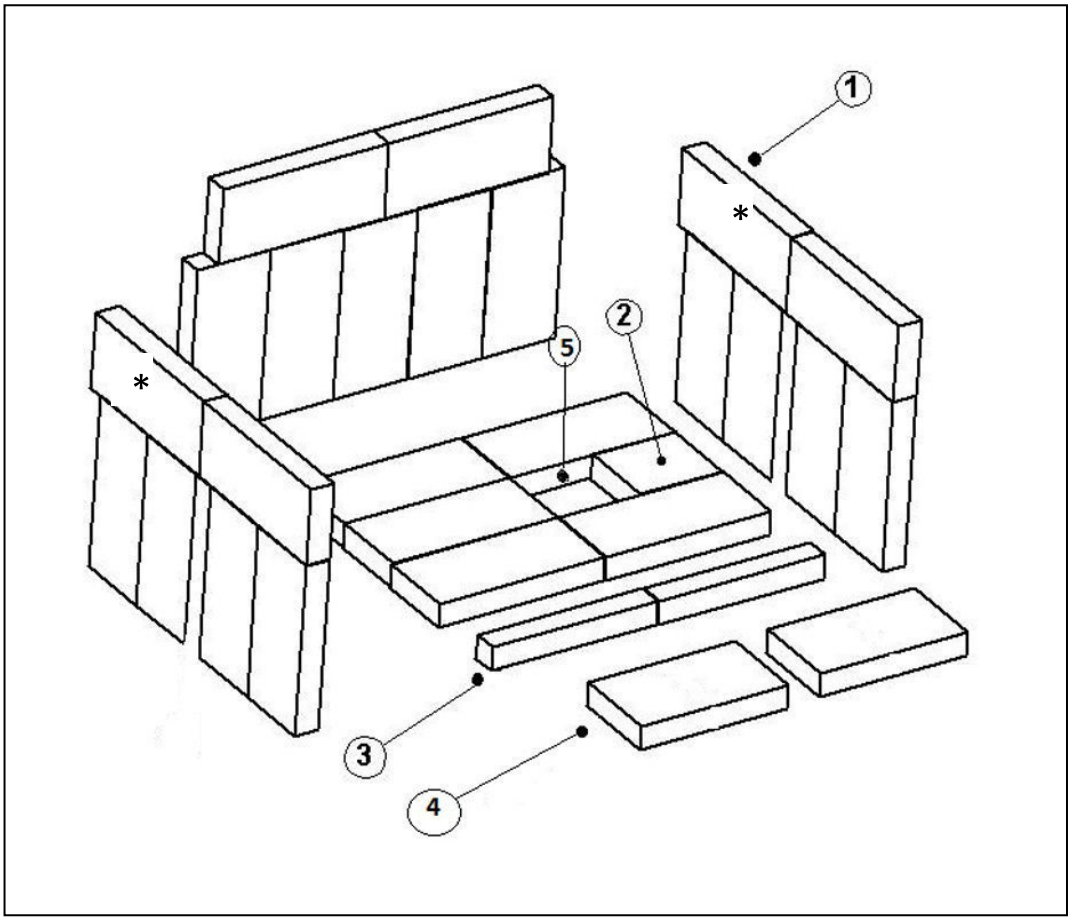
FOR BRICK LAYOUT AND PART NUMBERS PLEASE SEE PAGE 28.

ILLUSTRATED PARTS DIAGRAM





BRICK LAYOUT AND REPLACEMENT



NOTE: The bricks on the sides and rear will need to be installed after delivery

**Top rear bricks on each side may or may not be notched. If notched, order part number AC-SBN1X3.*

DIAGRAM NUMBER	BRICK SIZE	PART NUMBER	QUANTITY PER STOVE
1	9" X 4" X 1.25"	AC-SB	24
2	4.5" X 4" X 1.25"	AC-SB4.5	1
3	9" X 2" X 1.25"	AC-SB9X1.25	2
4	7.75" X 4" X 1.25"	AC-SB7.75	2
5	ASH DUMP PLUG	CA-30ADP	1

Model ☐15-SSW01 ☐50-SHSSW01 ☐50-TRSSW01
Solid Fuel Burning Room Heater; Free Standing Model "SUITABLE FOR MOBILE-HOME INSTALLATION (USA ONLY)"
Tested to UL-1482 & ULC-627-00, EPA METHOD 28A, ASTM E2780, ASTM E2515

Intertek
W/N# xxxxxx

SERIAL NO.	
MFG. DATE	

Manufactured by:
England's Stove Works, Inc.
589 S. Five Forks Rd.
Monroe, VA 24574

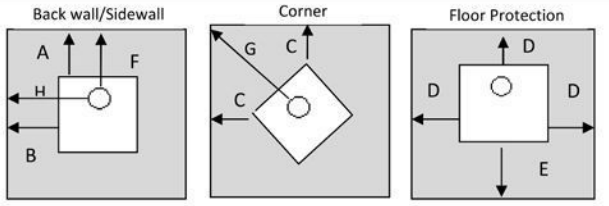
DO NOT REMOVE OR COVER THIS LABEL

- PREVENT HOUSE FIRES – INSTALL AND USE ONLY IN ACCORDANCE WITH THE OWNER'S MANUAL PROVIDED WITH THIS APPLIANCE.
- CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTIONS IN YOUR AREA.

INSTALLATION REQUIREMENTS

- DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.
- USE A RESIDENTIAL TYPE MASONRY OR FACTORY BUILT CHIMNEY LISTED TO UL-103 HT (US) AND ULC-629 (CANADA).
- USE 24 GAUGE MSG BLACK SINGLE WALL CHIMNEY CONNECTOR OR LISTED DOUBLE WALL CHIMNEY CONNECTOR.
- REFER TO LOCAL CODES AND THE CHIMNEY MANUFACTURER'S INSTRUCTIONS FOR PRECAUTIONS REQUIRED FOR PASSING A CHIMNEY THROUGH A COMBUSTIBLE WALL OR CEILING.
- FOR THE US: PLACE ON A NON-COMBUSTIBLE TYPE 1 UL SPARK AND EMBER FLOOR PROTECTOR, WHICH EXTENDS 16.0 IN. TO THE FRONT AND 8.0 IN. TO EACH SIDE OF THE FUEL LOADING OPENING.
- FOR CANADA: PLACE ON A NON-COMBUSTIBLE TYPE 1 ULC SPARK AND EMBER FLOOR PROTECTOR, WHICH EXTENDS 450.0 MM. TO THE FRONT AND 200.0 MM. TO EACH SIDE OF THE FUEL LOADING OPENING.
- ADHERE TO THE LISTED MINIMUM CLEARANCES TO COMBUSTIBLES WHEN USING SINGLE WALL CHIMNEY CONNECTOR. SEE THE OWNER'S MANUAL FOR ADDITIONAL CLEARANCE INFORMATION.
- ONLY OPERATE THIS UNIT WITH THE DOOR CLOSED AND LATCHED TIGHTLY.
- THE MAIN LOADING DOOR CONTAINS A CERAMIC VIEWING WINDOW; DO NOT SLAM THE DOOR OR STRIKE THIS VIEWING WINDOW AT ANY TIME.
- IF THE GLASS IS CRACKED OR BROKEN, REPLACE WITH CERAMIC GLASS ONLY.
- Emission value – 1.956 grams/hr
- U.S. ENVIRONMENTAL PROTECTION AGENCY Certified to comply with 2020 particulate emission standards using crib wood fuel.
- OPTIONAL PART- BLOWER PART NUMBER AC-30 (FASCO) ELECTRICAL RATING 115 V, 60 HZ., 0.8 A
- OPTIONAL PARTS- SIDE HEAT SHIELDS PART NUMBER AC-W01SHS (ESW INC.)
- Refer to Intertek's Directory of Building Products (HTTPS:BPDIRECTORY.INTERTEK.COM) for detailed information.

OPERATION REQUIREMENTS: FOR USE WITH SOLID WOOD FUEL ONLY. DO NOT OVER-FIRE, IF HEATER OR CHIMNEY CONNECTOR GLOWS YOU ARE OVER-FIRING. INSPECT AND CLEAN CHIMNEY FREQUENTLY, UNDER CERTAIN CONDITIONS OF USE, CREOSOTE BUILDUP MAY OCCUR RAPIDLY. DO NOT USE A GRATE OR ELEVATE THE FIRE, BURN WOOD FIRE DIRECTLY ON THE HEARTH. RISK OF SMOKE AND FLAME SPILLAGE, OPERATE ONLY WITH DOOR FULLY CLOSED.
This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instructions in the owner's manual.



A = 7.5 inches (190.5 mm) B = 21.5 inches (546.1 mm) C = 9.5 inches (241.3 mm)
D = 8 inches (200 mm) E = 16 inches (450mm) F = 12 inches (304.8mm)
G = 19 inches (482.6 mm) H = 29 inches (736.6 mm)

CAUTION - HOT WHILE IN OPERATION. DO NOT TOUCH. KEEP CHILDREN, CLOTHING, AND FURNITURE AWAY. CONTACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS.

You may write your unit's Manufacture Date and Serial Number in the blank spaces on this sample tag, for future reference. This sample tag also shows the safety info. such as UL (ULC) testing standard, etc. for your local officials, or anyone else who may need reference information.

LIMITED FIVE (5) YEAR WARRANTY

From the date of purchase to the original owner

The manufacturer extends the following warranties:

Five Year Period:

1. Carbon steel and welded seams in the firebox are covered for five (5) years against splitting.
2. The cast iron door and hinges are covered for five (5) years against cracking.

One Year Period:

1. Electrical components, accessory items, glass and the painted surface of the stove are covered for one (1) year from the date of purchase.

Conditions and Exclusions

1. Damage resulting from over-firing will void your warranty.
2. This warranty does not apply if damage occurs because of an accident, improper handling, improper installation, improper operation, abuse or unauthorized repair made or attempted to be made.
3. The manufacturer is not liable for indirect, incidental, or consequential damages in connection with the product including any cost or expense, providing substitute equipment or service during periods of malfunction or non-use.*
4. All liability for any consequential damage for breach of any written or implied warranty is disclaimed and excluded.
5. This warranty does not cover internal wear parts of the combustion system, including the firebrick lining and gaskets.

****Some states do not allow the exclusion of limitations of incidental or consequential damages, so the above may not apply to you.****

Procedure

Purchaser must give notice of claim of defect within the warranty period and pay transportation to and from a service center designated by the manufacturer. The dealer from which the unit was purchased or the factory, at our option, will perform the warranty service.

Other Rights

This warranty gives you specific legal rights; you may also have other rights, which may vary from state to state.

Please Note: This warranty is null and void if the attached warranty registration AND a copy of the sales receipt is not returned within thirty (30) days from the date of purchase.

Warranty is not transferable.

Important Notice

This registration information **MUST** be on file for this warranty to be valid. Please mail this information within thirty (30) days from the original date of purchase.

Use any of these three easy ways to send your warranty information in!

Mailing Address

England's Stove Works, Inc.
Technical Support Department
P.O. Box 206
Monroe, Virginia 24574

Fax Number

(434) 929-4810 – Twenty-four hours a day.

Online Registration

Visit our warranty registration website at:

http://www.heatredefined.com

(WARRANTY CARD LOCATED ON NEXT PAGE)

WARRANTY REGISTRATION for England's Stove Works®

Purchaser Information

I. Purchased By (Name) _____

II. Address _____

III. City_____State_____Zip Code _____

IV. Telephone Number_____

V. Email Address _____

Dealer Information

VI. Purchased From _____

VII. Address _____

VIII. City_____State_____Zip Code _____

Unit Information

*Refer to the sticker on the back of the manual or box to complete this section.

IX. Model Number_____Purchase Date _____

X. Purchase Price_____

XI. Serial Number_____Mfg. Date_____

Purchase Questions

How did you first hear about our product? (Please check one)

Word of Mouth ____ Burn Trailer Demonstration____ Internet____

Other: _____

Where did you receive information about our product?

Via Telephone____ Dealer (Name of dealer) _____ Internet____

Other: _____

WOOD - Meets the 2015 U.S. Environmental Protection Agency's crib wood emission limits for wood heaters sold after May 15, 2015

PLEASE NOTE:

EPA INFORMATION

The following additions to your owner's manual will enable you to achieve optimal emissions performance from your stove. Important safety tips are also included.

- *Proper Installation* – Please refer to the Installation section of your owner's manual and follow the guidelines listed therein for safety and for optimal emissions performance.

Additional information:

Venting Introduction:

Draft: Draft is the force which moves air from the appliance up through the chimney. The amount of draft in your chimney depends on the length of the chimney, local geography, nearby obstructions and other factors. Too much draft may cause excessive temperatures in the appliance and may damage the catalytic combustor. Inadequate draft may cause backpuffing into the room and 'plugging' of the chimney.
Inadequate draft will cause the appliance to leak smoke into the room through appliance and chimney connector joints.
An uncontrollable burn or excessive temperature indicates excessive draft.
Please be mindful of installation location: Inversion and other air quality issues can arise in valleys or if unit is installed close to neighboring homes.

This wood stove operates on a natural draft system, in which the chimney system pulls air through the stove. This unit must be installed in accordance with the following detailed descriptions of venting techniques; not installing the stove in accordance with the details listed here can result in poor stove performance, property damage, bodily injury or death. Avoid make-shift compromises when installing the venting system. England's Stove Works is not responsible for any damage incurred

due to a poor or unsafe installation.

Be certain that all aspects of the venting system are installed to the venting manufacturer's instructions, particularly the required clearances to combustibles. Also, be certain to use an attic radiation shield to prevent insulation from contacting a chimney which passes through an attic.

The chimney system is the "engine" which drives a wood stove, so it is imperative for proper unit function that the venting system be installed exactly as described in the following section.

If questions arise pertaining to the safe installation of the stove, our Technical Support line (800-245-6489) is available. Contact your local code official to be certain your installation meets local and national fire codes, and if you're uncertain about how to safely install the stove, we strongly recommend contacting a local NFI certified installer to perform the installation.

Venting Guidelines:

ALWAYS install vent pipe in strict adherence to the instructions and clearances included with your venting system.

- **DO NOT** connect this wood stove to a chimney flue which also serves another appliance.
- **DO NOT** install a flue pipe damper

  or any other restrictive device in the exhaust venting system of this unit.
- **USE** an approved wall thimble when passing through a wall and a ceiling support/fire stop when passing through a ceiling.
- **INSTALL** three sheet metal screws at every chimney connector joint.
- **AVOID** excessive horizontal runs and elbows, as both will reduce the draft of the venting system and will result in poor stove performance.
- **INSPECT** your venting system often, to be certain it is clear of creosote, fly-ash and other restrictions.
- **CLEAN** the venting system as detailed in the maintenance section of this manual.
- **ADHERE** to the 10-3-2 rule regarding chimney terminations.
- **INSTALL** single wall chimney connector with the male end **down** to prevent creosote leakage.

Follow double wall chimney connector manufacturer's instructions regarding proper pipe installation.

WARNING: Venting system surfaces get HOT, and can cause burns if touched. Noncombustible shielding or guards may be required

The 10-3-2 Rule: The chimney system must terminate 3.0 ft above the point where it's centerline passes through the roof AND the chimney must terminate 2.0 ft. above part of the dwelling within a 10 ft. radius of the chimney.

- *Operation and Maintenance* – Please refer to the 'Operation' (Operating Instructions) and Maintenance (including Ash Removal/Disposal) sections of your owner's manual and follow the guidelines listed therein for safety *and* for optimal emissions performance.

Additional Information:

Following the instructions in your owner's manual for Building a Fire will ensure a proper fire, as well as helping minimize visible emissions.

More:

- *Fuel loading and re-loading:* Practical Tips for Building a Fire – See your owner's manual for information on loading (and re-loading) your fuel, as well as for fire-starting procedures (i.e. 'Building a Fire').
- *Top-Down Fires:* The US EPA recognizes 'the effectiveness of the top-down approach for starting fires.' A good tutorial for this approach may be found at http://woodheat.org/top-down-steps.html . When building top-down fires, be sure to follow the instructions found in your owner's manual and contact our Technical Support if you have any questions.
- *Fuel Selection:* Once your wood-burning appliance is properly installed, building an effective fire requires good firewood (using the right wood in the right amount) and good fire building practices. The following practical steps will help you obtain the best efficiency from your wood stove or fireplace.

- Season wood outdoors through the summer for at least 6 months before burning it. Properly seasoned wood is darker, has cracks in the end grain, and sounds hollow when smacked against another piece of wood.
- Store wood outdoors, stacked neatly off the ground with the top covered.
- Burn only dry, well-seasoned wood that has been split properly.
- Start fires with newspaper and dry kindling as discussed earlier in the manual.
- Burn hot fires.
- To maintain proper airflow, regularly remove ashes from your wood-burning appliance into a metal container with a cover and store outdoors.

Moisture Meter Information

- Firewood is ready at 10-25% moisture content.
- Newly-cut logs can have a moisture content (MC) of 80% or more, depending on species. Since wood shrinks, and can also split, twist or otherwise change shape as it dries, most wood is dried before being used. Air drying, or 'seasoning,' is the most common method used for cord wood. In most parts of the United States, the minimum moisture content that can be generally obtained in air drying is about 12 to 15 percent. Most air-dried material is usually closer to 20 percent moisture content when used
- To test your firewood, simply push the pins into the wood and wait for a reading. Remember, **don't just stick the meter into the ends of your firewood**. To get the most accurate reading, split the wood and test the center. The center of the log will contain the most moisture.

How Far Should I Drive Non-Insulated Pins into Wood?

- To full depth if possible. However, at moisture levels below 10%, it is usually sufficient to make good, positive contact with the wood. At higher levels of moisture and especially if you have a steep gradient, full penetration is a must.

- ***WHAT FUELS NOT TO USE:***

CAUTION

- **NEVER USE GASOLINE, GASOLINE-TYPE LANTERN FUEL, KEROSENE, CHARCOAL LIGHTER FLUID, OR SIMILAR LIQUIDS TO START OR "FRESHEN UP" A FIRE IN THIS HEATER. KEEP ALL SUCH LIQUIDS WELL AWAY FROM THE HEATER WHILE IN USE. ADDITIONALLY, NEVER APPLY FIRE-STARTER TO ANY HOT SURFACE OR EMBERS IN THE STOVE. DO NOT USE CHEMICALS OR FLUIDS**
  - **TO START THE FIRE.**
- **DO NOT BURN FLAMMABLE FLUIDS SUCH AS GASOLINE, NAPHTHA OR ENGINE OIL.**
- **DO NOT BURN GARBAGE; LAWN CLIPPINGS OR YARD WASTE; MATERIALS CONTAINING RUBBER, INCLUDING TIRES; MATERIALS CONTAINING PLASTIC; WASTE PETROLEUM PRODUCTS, PAINT OR PAINT THINNERS, OR ASPHALT PRODUCTS; MATERIALS CONTAINING ASBESTOS; CONSTRUCTION OR DEMOLITION DEBRIS; RAILROAD TIES OR PRESSURE-TREATED WOOD; MANURE OR ANIMAL REMAINS; SALT WATER DRIFTWOOD OR OTHER PREVIOUSLY SALT WATER SATURATED MATERIALS; UNSEASONED WOOD; PAPER PRODUCTS, CARDBOARD, PLYWOOD OR PARTICLEBOARD. THE PROHIBITION AGAINST BURNING THESE MATERIALS DOES NOT PROHIBIT THE USE OF FIRESTARTERS MADE FROM PAPER, CARDBOARD, SAWDUST, WAX AND SIMILAR SUBSTANCES FOR THE PURPOSE OF STARTING A FIRE IN AN AFFECTED WOOD HEATER. BURNING THESE MATERIALS MAY RESULT IN RELEASE OF TOXIC FUMES OR RENDER THE HEATER INEFFECTIVE AND CAUSE SMOKE.**

- **Safe Wood-burning Practices**

Once your wood-burning appliance is properly installed, follow these guidelines for safe operation:

- Keep all flammable household items—drapes, furniture, newspapers, and books—far away from the appliance.
- Start fires only with newspaper, dry kindling and all natural or organic fire starters. Never start a fire with gasoline, kerosene, or charcoal starter.
- Do not burn wet or green (unseasoned) logs.
- Do not use logs made from wax and sawdust in your wood stove – they are made for open hearth fireplaces. If you use manufactured logs, choose those made from 100 percent compressed sawdust.
- Build hot fires. For most appliances, a smoldering fire is not a safe or efficient fire.
- Keep the doors of your wood-burning appliance closed unless loading or stoking the live fire. Harmful chemicals, like carbon monoxide, can be released into your home.
- Regularly remove ashes from your wood-burning appliance into a metal container with a cover. Store the container of ashes outdoors on a cement or brick slab (not on a wood deck or near wood). See ash removal instructions in your owner's manual.
- Keep a fire extinguisher handy.
- Remember to check your local air quality forecast before you burn.

- *Air Controls:* SEE YOUR OWNER'S MANUAL for information on the Proper Use of Air Controls (in the Operation section).
- *ASH REMOVAL* – Follow your Owner's manual's instructions regarding removal and disposal of ashes.
- *REPLACEMENT of parts that are critical to emissions performance* – Follow your Owner's manual's instructions regarding replacement of gaskets and other parts that are critical to emissions performance.

Remember: "This wood heater needs periodic inspection and repair for proper operation. It is against federal regulations to operate this wood heater in a manner inconsistent with operating instructions in this manual."

More: Burner Tubes – To replace a tube, first be sure that you order the correct tube you need to replace. Then using a 5/16" socket or open end wrench, remove the screw located on the left side of the tube. Be sure to keep the screw. Push the tube to the right then remove the tube (pulling the tube back to the left after that side has been removed from the hole). To replace, reverse the above procedure…make sure to install the tubes in the correct order. (Front to Back)

- **Smoke Detectors**

England's Stove Works, Inc. highly recommends the use of smoke detectors in every room of the house. However, locating a smoke detector directly above this unit can result in nuisance alarms.

CAUTION

This unit is meant to operate only with door closed. Smoke spillage and an inefficient, lazy burn will result from attempting to operate the stove with the door open.

Additionally, using prohibited fuels can create an unsafe situation and can also generate excess carbon monoxide. Carbon monoxide is an odorless, colorless gas which can be deadly.

The use of a carbon monoxide detector is strongly recommended.

- *Compliance:* "This non-catalytic wood heater meets the 2015 U.S. Environmental Protection Agency's crib wood emission limits for wood heaters sold after May 15, 2015."

- *Tamper Warning:* "This wood heater has a manufacturer-set minimum low burn rate that must not be altered. It is against federal regulations to alter this setting or otherwise operate this wood heater in a manner inconsistent with operating instructions in this manual."

- *Warranty:* See your Owner's manual for a Warranty Registration instruction page, as well as instructions for warranty procedures. For parts, warranty replacement procedures may be found at our parts store site: www.heatredefined.com

intertek Total Quality. Assured.	Issue Date	5/9/2018
	Revision Date	NA
	Revision Level	0
Middleton Laboratory Local Operating Procedure	Approved By	Brian Ziegler

This Calibration procedure applies to all Dry Gas Meters in Middleton, Wisconsin Laboratory.

Equipment used: Spirometer

Using the Spirometer: The Spirometer consists of two tanks. The green tank has a U-tube on it to show any pressure (either positive or negative) in the green tank. The sight glass vial with the ruler near it tells what the level of water is in the green tank.

The controls at the Spirometer consist of a water valve and a clamp for the hose. The valve controls the flow of water between the tanks. The clamp controls the up and down movement of the red tank. *NEVER STAND UNDER THE RED TANK WHEN IT IS ELEVATED!!*

When the Spirometer is not in use most of the water is stored in the red tank on the floor.

1. Connect hoses to Dry Gas Meter (DGM) and manometer as shown in figure 1 for leak test.

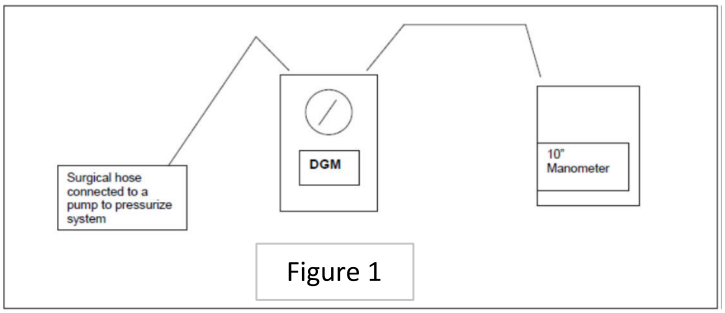


Figure 1

2. With spirometer clamped off pressurize the system by blowing into the hose, which is attached to the inlet port of the DGM. When there is 6 to 8 inches of pressure, clamp off the hose you just blew into. The manometer liquid will rise until pressure is equal in the system then stop. If the manometer does not stop rising there is a leak. Repair the leak as necessary and recheck.

3. Connect as in figure 2 for calibration of the meter. In this case, the manometer is used to monitor the pressure at the DGM. A reading of 2.0 in H2O with the system operating indicates a flow restriction that must be remedied before continuing the calibration.

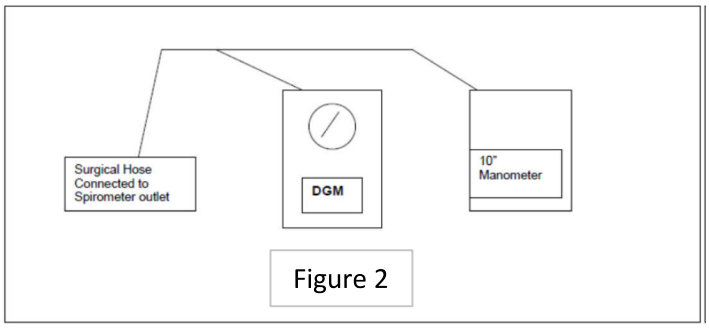


Figure 2

4. Raise the red tank above the green tank. Plug the manometer on the green tank. (Plugging the manometer hose when transferring water in either direction keeps the fluid in the manometer from being forced either out of the hose or into the green tank.) Using the water valve adjust the water in the green tank just enough to be able to adjust the ruler up or down to zero the ruler with the water level. Set the ruler bottom at the top of the meniscus. Unplug manometer slowly on green tank and using the water valve, toggle on and off until the manometer on the green tank shows no pressure at all. The fluid in the two tubes will be level when there is no pressure in the green tank. Leave the clamp open and reset the ruler if necessary. At this point, clamp open, water off, manometer levels the same and the ruler at the top of the meniscus in the water level vial, you are ready to start sampling.

5. Plug the manometer hose on the green tank. Turn the water valve on (to start water flowing into the green tank). (The sample rate is usually set on a "set up" run, as the first run will not be used in the calibrations.) Enter the initial DGM reading into the spreadsheet. Sample 1 cubic foot as near as possible then pinch off hose leading from the Spirometer (this prevents the DGM from being driven backwards) and quickly go out to the Spirometer and close the water valve. While sampling, include the barometric pressure, Spirometer temperature, meter temperature and meter pressure (from the manometer) into the spreadsheet.

6. Without removing the hose clamp at the meter, lower the red tank and adjust the water in the green tank using the water valve so there is no pressure in the green tank. This requires you to unplug the left manometer hose. Do this with care, as there might be enough pressure to either blow the fluid out of the hose or draw it into the green tank. Adjust the pressure in the constant volume tank (green) using the water valve. Normally you have to add water to the constant volume tank to equalize the pressure but if you go too far, it will be necessary to lower the red tank and allow some water out of the green tank. This takes some practice.

After adjusting the pressure in the green tank to zero using the water valve, measure the amount of water in the green tank with the ruler. (Typically around 22 inches ± 1 inch) Interpolate this measurement to the nearest 1/32 of an inch and convert to decimal. This figure is used in the Spirometer Calibration program found where these instructions were located. Enter this number into the spreadsheet and the final DGM number after the run.

7. Perform 5 runs to determine an average. Pass/fail criteria is ±1.0% for the measurement of uncertainty. If not passing, adjust and repeat the test.

Following the successful calibration of this piece of equipment a calibration sticker shall be attached to the instrument.

Measurement Uncertainty is calculated using the following formula: O.M.U. = k*((A.D.)2 + (S.D.)2 + (R.M.U.)2)1/2
O.M.U. = Overall Measurement Uncertainty
A.D. = Average Deviation of the percent difference of all measured results compared to the reference value.
S.D. = Standard Deviation of the percent difference of all measured results compared to the reference value.
k = Confidence Factor (2 for 95% confidence)
R.M.U. = Standard Measurement Uncertainty of Reference Measurement Equipment. R.M.U. is considered as the measurement uncertainty as stated on calibration certificates of equipment, or the tolerance listed in the calibration standard of the test equipment

intertek Total Quality. Assured.	8431 Murphy Drive Middleton, WI 53562	**Calibration Certificate Number**	**1210-MID-12-27**
		Issue Date	12/27/18

Middleton Laboratory Local Calibration Certificate

Asset Number	1210	Asset Description	Dry Gas Mete
Manufacturer	Rockwell	Model Number	DGM-110
Serial Number	974270	Calibration Date	12/27/2018
Procedure	See Procedure Tab	Calibration Due Date	6/27/2019
Ambient Temperature (°F)	63.4	Calibration Location	Middleton Lab
Relative Humidity (%)	35	**As Found Condition**	**In Tolerance**
QA's Name	Christine Schultze	**As Left Condition**	**In Tolerance**
QA's Title	Quality Supervisor		
QA's Signature	Christine M Schultze		

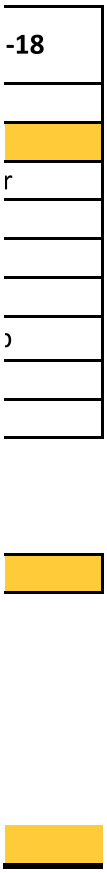
Calibration Data Summary

Measurement of Uncertainty (MU)	Maximum	As Found	As Left	Adjusted?
	0.0100	0.0028	0.0028	No

The above results relate only to the equipment calibrated.

This Calibration Certificate shall not be reproduced except in full, without written approval of the laboratory.

End of Calibration Certificate


-18

intertek Total Quality. Assured.			Calibration Certificate Number	1210-MID-12-27-18
			Issue Date	12/27/18
Middleton Laboratory Local Calibration Data				
Asset Number	1210		Asset Description	Dry Gas Meter
Calibration Date	12/27/2018		Peformed By	Ken Slater
Calibration Due	6/27/2019		Reviewed By	Brian Ziegler
Reference Equipment				
Asset Description - Asset Number	Spirometer - 051		Calibration Due	NA
Asset Description - Asset Number	Hygrometer - 1420		Calibration Due	4/12/2019
Asset Description - Asset Number	Omega Temp Reader - 1312		Calibration Due	1/16/2019
Asset Description - Asset Number	NA		Calibration Due	NA

Barometric Pressure (in Hg)	28.88

Ambient Temp (°F)	63.4

Relative Humidity (%)	35

As Found Data

Run Number	Meter Initial	Barometric Pressure (in Hg)	Spirometer Temp (°F)	Vapor Pressure of H2O (Hg)	Meter Temp (°F)	Meter Pressure (in Hg)	Measurement (in)	Spirometer Volume	Meter Final	Y	
1	363.115	28.88	69.6	0.7220	69.2	4	22.375	1.0170	364.117	0.98889	
2	364.124	28.88	69.3	0.7145	69.3	4	22.75	1.0341	365.146	0.9868	
3	365.153	28.88	69.9	0.7295	69.1	4	22.625	1.0284	366.165	0.98905	
4	366.165	28.88	69.4	0.7170	69.0	4	22.5625	1.0256	367.174	0.99044	
5	367.176	28.88	69.3	0.7145	68.9	4	22.375	1.0170	368.178	0.98916	
								1.0244	Ave	0.98887	
								0.0074	Std Dev	0.00131	
									M of U	0.00284	Pass

As Left Data

Run Number	Meter Initial	Barometric Pressure (in Hg)	Spirometer Temp (°F)	Vapor Pressure of H2O (Hg)	Meter Temp (°F)	Meter Pressure (in Hg)	Measurement (in)	Spirometer Volume	Meter Final	Y	
1	363.115	28.88	69.6	0.7220	69.2	4	22.375	1.0170	364.117	0.98889	
2	364.124	28.88	69.3	0.7145	69.3	4	22.75	1.0341	365.146	0.9868	
3	365.153	28.88	69.9	0.7295	69.1	4	22.625	1.0284	366.165	0.98905	
4	366.165	28.88	69.4	0.7170	69.0	4	22.5625	1.0256	367.174	0.99044	
5	367.176	28.88	69.3	0.7145	68.9	4	22.375	1.0170	368.178	0.98916	
								1.0244	Ave	0.98887	
								0.0074	Std Dev	0.00131	
									M of U	0.00284	Pass

33	0.187	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
34	0.195	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35	0.203	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
36	0.211	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
37	0.219	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
38	0.228	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
39	0.237	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	0.247	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
41	0.256	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
42	0.266	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
43	0.277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
44	0.287	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
47	0.322	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
48	0.334	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
49	0.347	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50	0.360	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
51	0.373	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
52	0.387	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
53	0.402	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
54	0.417	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
55	0.432	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
56	0.448	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
57	0.465	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
58	0.482	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
59	0.499	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
60	0.517	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
61	0.536	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
62	0.555	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
63	0.575	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
64	0.595	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
65	0.616	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
66	0.638	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
67	0.661	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
68	0.684	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
69	0.707	0.7220	0.7145	0.7295	0.7170	0.7145	0.7220	0.7145	0.7295	0.7170	0.7145
70	0.732	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
71	0.757	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
72	0.783	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
73	0.810	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
74	0.838	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
75	0.866	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
76	0.896	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

77	0.926	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
78	0.957	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
79	0.989	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
80	1.022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
81	1.056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
82	1.091	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
83	1.127	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
84	1.163	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
85	1.201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
86	1.241	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
87	1.281	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
88	1.322	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
89	1.364	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
90	1.408	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
91	1.453	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
92	1.499	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
93	1.546	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
94	1.595	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
95	1.645	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
96	1.696	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
97	1.749	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
98	1.803	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
99	1.859	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Certificate Number
A2919100
Issue Date: 08/08/18

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number: C/C

ID Number: 001413

Description:	MASS FLOW METER	Calibration Date:	08/08/2018
Manufacturer:	SIERRA	Calibration Due:	02/08/2019
Model Number:	M50L-AL-DD-2-PV2-V1-5PC	Procedure:	TB 9-6680-293-40 Rev: 4/28/2011
Serial Number:	189158	Temperature:	70 F
Technician:	JEFF BAHMANN	Humidity:	53 % RH
On-Site Calibration: ☐		**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

Reported uncertainties are expressed as expanded uncertainty values at an approximately 95% confidence level using a coverage factor of k=2. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System is accredited to ISO/IEC 17025:2005 and ANSI/NCSL Z540-1-1994. ISO/IEC 17025:2005 is written in a language relevant to laboratory operations, meeting the principles of ISO 9001 and aligned with its pertinent requirements. This calibration is within the current Scope of Accreditation and complies with the requirements of ISO/IEC 17025:2005 and TMI's Quality Manual, QM-1.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

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Measurements not currently on TMI's Scope of Accreditation are identified with an asterisk.

FRANK BAHMANN, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
FL2146	FLUKE	MOLBOX1+A700-A	7/3/2018	7/3/2020
FL6426	DH INSTRUMENTS	1E4-VCR-V-Q	3/8/2018	3/8/2020

TMI Technical Maintenance, Inc.
12530 TELECOM DRIVE, TEMPLE TERRACE, FL 33637
Phone: 813-978-3054 Fax 813-978-3758
www.tmicalibration.com

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Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Flow Accuracy	0.000	-0.300	0.300	0.000	0.000	0.6 mL/min	slm	
Flow Accuracy	2.000	1.700	2.300	1.998	1.998	5.8 mL/min	slm	
Flow Accuracy	4.000	3.700	4.300	3.985	3.985	12 mL/min	slm	
Flow Accuracy	6.000	5.700	6.300	5.982	5.982	17 mL/min	slm	
Flow Accuracy	8.000	7.700	8.300	7.974	7.974	23 mL/min	slm	
Flow Accuracy	10.000	9.700	10.300	9.969	9.969	29 mL/min	slm	

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www.tmicalibration.com

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ANAB ACCREDITED
ISO/IEC 17025
ANSI/NCSL Z540-1
ANSI/NCSL Z540.3
AC-2080

Certificate Number
A3074094
Issue Date: 01/18/19

Certificate of Calibration

Customer: INTERTEK MIDDLETON
8431 MURPHY DR.
MIDDLETON, WI, 53562
608-824-7422

P.O. Number:

ID Number: 001414

Description:	MASS FLOW METER	Calibration Date:	01/18/2019
Manufacturer:	SIERRA	Calibration Due:	07/18/2019
Model Number:	M50L-AL-DD-2-PV2-V1-5PC	Procedure:	TB 9-6680-293-40 Rev: 2/20/2013
Serial Number:	189157	Temperature:	71 F
Technician:	SEAN LEWIS	Humidity:	39 % RH
On-Site Calibration: ☐		**As Found Condition:**	**IN TOLERANCE**
Comments:		**Calibration Results:**	**IN TOLERANCE**

Limiting Attribute:

This instrument has been calibrated using standards traceable to the SI units through the National Institute of Standards and Technology (NIST) or other National Metrological Institute (NMI). The method of calibration is direct comparison to a known standard, derived from natural physical constants, ratio measurements or compared to consensus standards.

Reported uncertainties are expressed as expanded uncertainty values at an approximately 95% confidence level using a coverage factor of k=2. Statements of compliance are based on test results falling within specified limits with no reduction by the uncertainty of the measurement.

TMI's Quality System is accredited to ISO/IEC 17025:2017 and ANSI/NCSL Z540-1-1994. ISO/IEC 17025:2017 is written in a language relevant to laboratory operations, meeting the principles of ISO 9001 and aligned with its pertinent requirements. This calibration is within the current Scope of Accreditation and complies with the requirements of ISO/IEC 17025:2017 and TMI's Quality Manual, QM-1.

Results contained in this document relate only to the item calibrated. Calibration due dates appearing on the certificate or label are determined by the client for administrative purposes and do not imply continued conformance to specifications.

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FRANK BAHMANN, BRANCH MANAGER

Scott Chamberlain, QUALITY MANAGER

Calibration Standards

Asset Number	Manufacturer	Model Number	Date Calibrated	Cal Due
FL2146	FLUKE	MOLBOX1+A700-A	7/3/2018	7/3/2020
FL6426	DH INSTRUMENTS	1E4-VCR-V-Q	3/8/2018	3/8/2020

TMI Technical Maintenance, Inc.
12530 TELECOM DRIVE, TEMPLE TERRACE, FL 33637
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www.tmicalibration.com

ilac-MRA ANAB ACCREDITED ISO/IEC 17025 ANSI/NCSL Z540-1 ANSI/NCSL Z540.3 AC-2080

Certificate of Calibration

Data Sheet

Parameter	Nominal	Minimum	Maximum	As Found	As Left	Uncertainty	Unit	ADJ/FAIL
Flow Accuracy	0.000	-0.300	0.300	0.000	0.000	± 0.83 mL/min	slm	
Flow Accuracy	2.000	1.700	2.300	2.002	2.002	± 5.8 mL/min	slm	
Flow Accuracy	4.000	3.700	4.300	3.988	3.988	± 12 mL/min	slm	
Flow Accuracy	6.000	5.700	6.300	5.968	5.968	± 17 mL/min	slm	
Flow Accuracy	8.000	7.700	8.300	7.939	7.939	± 23 mL/min	slm	
Flow Accuracy	10.000	9.700	10.300	9.936	9.936	± 30 mL/min	slm	

TMI Technical Maintenance, Inc.
12530 TELECOM DRIVE, TEMPLE TERRACE, FL 33637
Phone: 813-978-3054 Fax 813-978-3758
www.tmicalibration.com

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US EPA Minimum Requirements for QA/QC Auditing

This format is used for Inspections at manufacturing facilities on new Residential Wood Heaters, Residential Hydronic Heaters and Forced-Air Furnaces.

Inspector Instructions

- Attach this Inspection Supplement to the standard Intertek WH Periodic Inspection Report.
- One audit form for each Model.
- Client can be asked to disassemble components in order to check dimensions.
- Minimum annual Inspection of each model certified for EPA.

IMPORTANT: Any linear dimension cannot exceed ±1/4 inch (±0.64 cm). Any cross-sectional area for air introduction or catalyst bypass gaps cannot exceed 5%.

Applicant	England's Stove Works
Manufacturer	England's Stove Works
Model	15-SSW01, 50-SHSSW01, 50-TRSSW01
Report No.	103758222MID-001

Firebox Dimensions

Dwg #W01FB	Depth	Width	Height
Specified	17.750"	18.000"	13.75"-12.50"
Actual			

Compliant	Non-Compliant

Fuel Door Opening Size

Dwg #1522 M	Width	Height
Specified	18.000"	13.500"
Actual		

Air Introduction Systems

Dwg #W01Air (Primary) & 1514 M Dogbox Primary Dwg #1530 (Secondary)	Air Inlet Dimensions - Primary		Air Inlet Dimensions - Secondary		
	Length	Width	Length	Width	Hole (dia)
Specified	.75"	3" OD Tubing with 2.87" ID #1 in drawing	18.500-in	0.875-in dia	0.250-in x25
	Dogbox Air #2 on W01Air Dwg	.219" hole			
Actual					

Primary Air Inlet in Firebox
(See Drawing # W01Air)

Secondary Air Inlets in Firebox
(See Drawing #)

Method of Control	

Compliant	Non-Compliant

Baffles

Dwg #AC-W01CFB	Length	Width	Thickness
Specified	15.750-in	8.875-in	0.50-in
Actual			

Location	Above secondary air tubes x2

Compliant	Non-Compliant

Refractory/Insulation

Dwg # Brick Layout Pg 28 Manual	Length	Width	Thickness
Specified	3” - 9.00-in	4.00-in	1.250-in
Actual			

Location	See manual page 28

Compliant	Non-Compliant

Catalyst - NA

Dwg #	Length	Width	Thickness
Specified			
Actual			

Location	

Compliant	Non-Compliant

Catalyst Bypass - NA

Gap Tolerance when closed	

Dwg #	Length	Width	Area
Specified			
Actual			

Location	

Compliant	Non-Compliant

Flue Gas Exit

Dwg # 7135-M	Size
Specified	6.25-in OD
Actual	

Location	Top back

Compliant	Non-Compliant

Door and Catalyst Bypass Gaskets

Dwg #???	Fuel Door	
	Size	Length
Specified	¾”	65.25”
Actual		

Fitment	

Dwg #	Bypass Size - **NA**	
	Size	Length
Specified		
Actual		

Fitment	

Outer Thermal Shielding and Thermal Coverings

Dwg #1506-15	Side Shields	
	Length	Width
Specified	18.359-in	13.937-in
Actual		

Dwg #1506-16 M	Rear Shields	
	Height	Width
Specified	23.203-in	24.762-in
Actual		

Compliant	Non-Compliant

Fuel Feed System (Pellet or Wood Chip Models) - Check Motor Details - NA

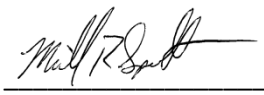
Dwg #	Specified	Actual
Feed Rate		
Auger Motor Design		
Power Ratings		
Auger Angle		

Compliant	Non-Compliant

Forced-Air Combustion System - Combustion Fan - NA

Dwg #	Specified	Actual
Location		
Horsepower		
Fan Blade Size		

Compliant	Non-Compliant

Factory Representative Signature 

Name __Michael Speight____

Date ____04/04/19_____

Intertek Representative Signature _____

Name _____

Date _____

Pellet Stoves
Wood Stoves
Multi-Fuel Stoves
Pellet Grills

P.O. Box 206 Monroe, VA 24574 www.heatredefined.com Phone: (800) 516-3636 Fax: (434) 929-4810

April 5, 2019

Dr. Rafael Sanchez
United States Environmental Protection Agency
1200 Pennsylvania Ave. NW
Room 7149-D
MS:2227A
Washington, DC 20460

Dr. Sanchez,

This letter is to notify you of our request for a certificate of Compliance for our wood stove model 15-SSW01, 50-SHSSW01, 50-TRSSW01.

The CD ROM containing all the engineering drawings and specifications of the components along with the test reports from our testing Agency Intertek will follow via UPS. This stove tested at 1.956 g/hr.

The firebox and firebox components will all be consistently built as per the drawings and test model without changes and therefore should cause no change in emissions or efficiency.

At this time we are not listing anything as Confidential Business Information on this project.

Included in the CD-Rom that you previously received is the documentation for the test reports from Intertek showing the complete test data, calculations and results.

I am including a copy of the manual, as well.

England's Stove Works Inc, conducts a QA program in accordance with section 60.533M. For that program we routinely check 1 out of every 150 stoves being produced with a comprehensive checklist that measures key dimensions in the firebox as well as overall inspection of the product including gaskets to make sure they are being produced consistently on our line. The QA program will be run according to the 3rd party QA standard. In addition, we have contracted Intertek to do random inspections of our facilities and this product to make sure that we are producing this stove to the specifications on file.

I am including a copy of the certificate of conformity for this line of wood heaters.

The tested unit was placed in a sealed wooden crate by Intertek and returned to England's Stove Works Inc, South plant facility located at 100 West Progress Lane, Madison Heights, VA 24572. The unit will be kept in a locked steel cage for 5 years after the certification test.

The wood heater complies and is labeled accordingly to 60.536 and 60.531. The owner's manual is also in compliance with the requirements 60.536. A copy of the owner's manual is included on the CD-Rom sent previously. The public may also view the owner's manual on our website www.heatredefined.com.

England's Stove Works Inc, has entered into a contract with Intertek. They will be the third-party certifier for this unit.

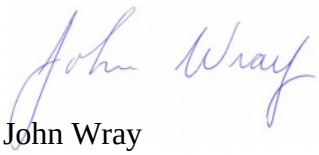
Intertek is allowed to submit any information on behalf of England's Stove Works Inc, regarding this unit. This includes any data that is claimed to be CBI.

England's Stove Works Inc will have a copy of the certification test report and summary on their website and will be available to the public within 30 days after the Administrator issues a certificate of compliance. The report will be available at www.heatredefined.com.

England's Stove Works Inc, is aware that the certificate of compliance cannot be transferred to another manufacturer or model line without written approval by the Administrator.

England's Stove Works Inc, is aware that it is unlawful to sell, distribute or offer to sell or distribute an affected wood heater without a valid certificate of compliance.

Sincerely,



John Wray
R&D Technician
England's Stove Works Inc,
589 South Five Forks Road
Monroe, VA 24574
800-516-3636

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
ENFORCEMENT AND COMPLIANCE
ASSURANCE

MAY 15 2019

Mr. John Wray
Lab Technician
England's Stove Works, Inc.
100 West Progress Lane
Madison Heights, Virginia 24572

Re: 15-SSW01, 50-SHSSW01, and 50-TRSSW01 Wood Heater Models Certification Letter Number 193-19

Dear Mr. Wray:

I am pleased to inform England's Stove Works, Inc. (England's) that the above-referenced models have been approved for certification pursuant to the 2015 New Source Performance Standard (NSPS) for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces at 40 CFR Part 60, Subpart AAA (2015 NSPS) by the United States Environmental Protection Agency (EPA). Certification under the 2015 NSPS is valid through May 28, 2024. This letter serves as your wood heater certification and no separate certification is required. Please refer to the certification letter number above in all future correspondence.

Based on a November 18, 2019, test report prepared by Intertek Building and Construction and the information provided in your April 5, 2019, application, the above-referenced models are certified as meeting the 2015 NSPS. Under the 2015 NSPS and based on Intertek Testing Services NA, Inc.'s April 5, 2019, certification of conformity, the models' emission rate of 1.9 g/hr meets the 2020 NSPS particulate matter emissions limit of 2.0 g/hr. The heat output range and overall heating efficiency for the above-referenced models are 12,617 – 27,546 BTU/hr and 74%, respectively. The carbon monoxide emission rate for this model line is 1.659 g/min.

This certification is valid for the above-referenced models and cannot be transferred to another model line without applying for certification. This certification allows England's to manufacture and sell the above-referenced models through May 28, 2024. Thereafter, England's may not manufacture, advertise for sale, offer for sale, or sell wood heaters under this certification without applying for and obtaining another compliance certification.

All wood heaters manufactured or sold under this certification must comply with EPA labeling requirements found at §60.536. These provisions require each wood heater to have a permanent label affixed to it that includes the month and year of manufacture, model name or number, serial number, certification test emission value, test method, standard met, and compliance certification statement.

In addition, England's must comply with all applicable requirements of the regulation, including:

1. Conducting a third-party certifier-approved quality assurance program which ensures that all units within a model line are similar to the wood heater submitted for certification testing in all respects that would affect emissions and are in compliance with the applicable emission limit, pursuant to §60.533(m);

2. Applying for recertification whenever any change is made to the above-referenced models that affect or is presumed to affect the particulate matter emission rate for the model line, pursuant to §60.533(k)(1);

3. Providing an owner's manual that includes the information listed in §60.536(g)(1) with each affected wood heater model offered for sale;

4. Placing a copy of the certification test report and summary on the manufacturer's website. The test report and summary shall be available to the public within 30 days after the EPA issues a certificate of compliance, pursuant to §60.533(b)(12);

5. Submitting a report to the EPA every 2 years following issuance of a certificate of compliance for each model line. This report must include the sales for each model by state and certify that no changes in the design or manufacture of this model line have been made that require recertification under §60.533(k);

6. Retaining records and submitting reports as required at §60.537; and

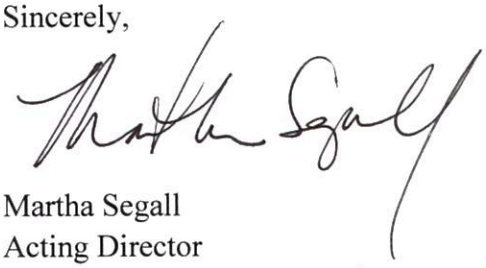
7. Submitting wood heaters for audit testing if selected by the EPA under §60.533(n)(1)(i) and (2)(i).

Failure to comply with these requirements may result in a revocation of this approval and enforcement action, including penalties as specified under the Clean Air Act.

To promote transparency in the implementation of the Wood Heater Program, we suggest that manufacturers submit the Uniform Resource Locator (URL) or web address where the test report is posted to WoodHeaterReports@epa.gov within ten (10) days of posting the test report.

Once EPA has verified that the full non-CBI certification test report has been posted on the manufacturer's website, the Agency will add the above-referenced models to the EPA-Certified Wood Heater List. If you have any questions concerning this letter, please contact Rafael Sanchez of my staff at (202) 564-7028 or via email at sanchez.rafael@epa.gov.

Sincerely,



Martha Segall
Acting Director
Monitoring, Assistance, and
Media Programs Division
Office of Compliance

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ENGLAND'S STOVE WORKS, INC.
PRODUCT EVALUATION

PRODUCT EVALUATED

15-W03 SOLID FUEL ROOM HEATER

EVALUATION PROPERTY

UL 1482-2011, ULC S627-2000, ASTM E2780-2010, ASTM E2515-2017

REPORT NUMBER

104151937MID-004R1

ORIGINAL ISSUE DATE

01/23/20

LAST REVISED DATE

JULY 15, 2020

PAGES

5

DOCUMENT CONTROL NUMBER

SFT-BC-OP-19H

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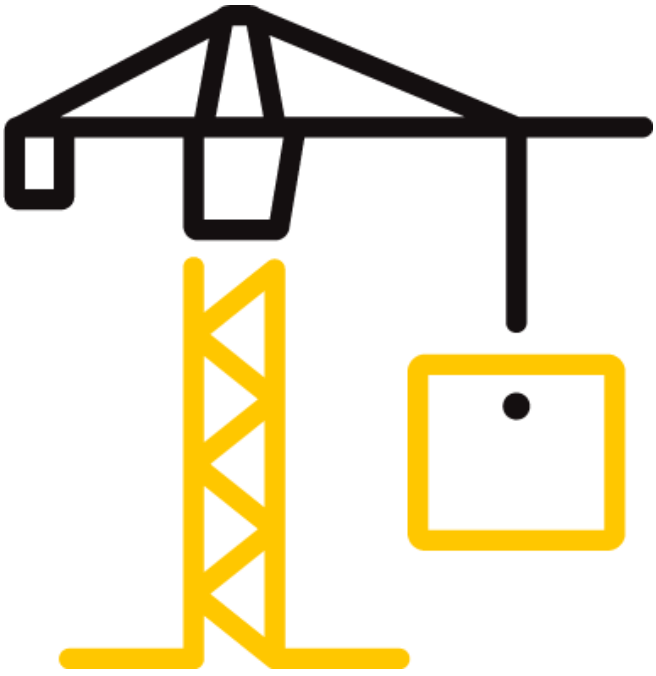

8431 Murphy Drive
Middleton, Wisconsin 53562

Telephone: 608-836-4400
Facsimile: 608-831-9279
www.intertek.com/building

PRODUCT EVALUATION FOR ENGLAND'S STOVE WORKS, INC.
Report No.: 104151937MID-004
Date: 01/23/20

PRODUCT EVALUATION RENDERED TO:	
Company Name:	England's Stove Works, Inc.
Address:	589 South Five Forks Road
	Monroe, VA 24574
Contact Person:	Chris Terrell
Tel:	434-929-0120
Email:	cterrell@englanderstoves.com

Table of Contents

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Facsimile: 608-831-9279
www.intertek.com/building

PRODUCT EVALUATION FOR ENGLAND'S STOVE WORKS, INC.
Report No.: 104151937MID-004
Date: 01/23/20

1 Introduction

Intertek Testing Services NA Inc. (Intertek) is conducting a product evaluation for England's Stove Works, Inc., on models 15-W03, 50-SHW03 and 50-TRW03 Solid Fuel Room Heaters, to evaluate the addition of new similar models. The evaluation is being conducted to determine if the additional models will maintain compliance with UL 1482-2011 Solid-Fuel Type Room Heaters, ULC S627-2000 Space Heaters for Use with Solid Fuels ASTM E2780-2010 Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters and ASTM E2515-2011 Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel.

2 Product and Assembly Description

2.1. Product Description:

The models 15-W03, 50-SHW03 and 50-TRW03 Solid Fuel Room Heaters are constructed of sheet steel. The outer dimensions are 27-inches deep, 30-inches high, and 22-inches wide. The unit has a door located on the front with a viewing glass. A 6-in flue is located on the top rear of the unit.

3 Reference Documents

As part of this evaluation, Intertek has directly or indirectly used the following referenced documents:

- UL 1482-2011 Solid-Fuel Type Room Heaters
- ULC S627-2000 Space Heaters for Use with Solid Fuels
- ASTM E2780-2010 Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters
- ASTM E2515-2011 Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel
- Spec ID No. 48399
- Spec ID No. 48400
- Test report #104151937MID-001

4 Evaluation Method

England's Stove Works, Inc. requested additional similar models to be included in the listing for the model 15-SSW01.

Additional models 15-W03, 50-SHW03 and 50-TRW03 are to be added to the existing listing reports for models 15-SSW01, 50-SHSSW01 and 50-TRSSW01. The only difference between models 15-W03, 50-SHW03 and 50-TRW03 and models 15-SSW01, 50-SHSSW01 and 50-TRSSW01 is cosmetic and is generally the trim around the glass and for the door handle. Models 15-W03, 50-SHW03 and 50-TRW03 have a shorter pedestal below the firebox. Additional testing was performed on model 15-W03 to determine if the shorter pedestal would affect temperatures on the floor below the unit.

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5 Conclusion

Intertek Testing Services NA Inc. (Intertek) has conducted this product evaluation for England's Stove Works, Inc., on models 15-W03, 50-SHW03 and 50-TRW03 Solid Fuel Room Heaters, to evaluate the addition of new similar models. The evaluation was conducted to determine if the additional models will maintain compliance with UL 1482-2011 Solid-Fuel Type Room Heaters, ULC S627-2000 Space Heaters for Use with Solid Fuels ASTM E2780-2010 Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters and ASTM E2515-2011 Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel.

Based on the information contained and referenced herein, it is Intertek's professional judgment based on sound engineering principles that the following is true:

- The addition of models 15-W03, 50-SHW03 and 50-TRW03 have been deemed to be in compliance with the referenced standards. There are only cosmetic differences between all models. All physical dimensions of the firebox and components are the same for all models.
- The reduced height of the pedestal for the models 15-W03, 50-SHW03 and 50-TRW03 did not affect the clearance for floor protection requirements as noted in the original listing report #48399.

INTERTEK TESTING SERVICES NA LTD.

Reported by: _____
Brian Ziegler
Technical Team Leader - Hearth

Reviewed by: Ken Slater
_____
Ken Slater
Associate Engineer - Hearth

8431 Murphy Drive
Middleton, Wisconsin 53562

Telephone: 608-836-4400
Facsimile: 608-831-9279
www.intertek.com/building

6 LAST PAGE & REVISION SUMMARY

DATE	SUMMARY	REPORTER	REVIEWER
January 23, 2020	Original	Brian Ziegler	Ken Slater
July 15, 2020	Report was showing three new models, 15-W03, 50-SHW03 and 50-SHW03. There was a misprint, so the third model was corrected as 50-TRW03.	Brian Ziegler	Ken Slater

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

August 5, 2020

Mr. Chris Terrell
Chief Operating Officer
England's Stove Works, Inc.
Post Office 206
Monroe, Virginia 24574

Re: Updated Certification Letter Number 193-19 for 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03, and 50-TRW03 Non-Catalytic Wood Heater Models

Dear Mr. Terrell:

The United States Environmental Protection Agency (EPA) is in receipt of your July 16, 2020, letter regarding the above-referenced certificate of compliance letter. This certificate currently includes the 15-SSW01, 50-SHSSW01, and 50-TRSSW01 models. England's Stove Works, Inc. (England's) is requesting that the above-referenced certificate be updated to add the 15-W03, 50-SHW03, and 50-TRW03 models. According to England's, the above-referenced models will be manufactured exactly the same as the current certified models except for changes to the door handle, glass trim, and pedestal. England's affirms that the above-referenced design changes will not cause wood heaters within the model line to exceed applicable emission limits.

In accordance with the 2015 Wood Heater Rule, a manufacturer must recertify a model line whenever any change is made in the design that affects or is presumed to affect the particulate emission rate for that model (Sections §60.533(k)(1) and (k)(2)). However, pursuant to the Rule, EPA may waive the recertification requirement if the manufacturer presents adequate rationale, and EPA determines that the change may not reasonably be anticipated to cause heaters in the model line to exceed the applicable emission limits.

Based on a November 18, 2019, test report by Intertek Building & Construction, a January 23, 2020 (revised on July 15, 2020), product evaluation report by Intertek Testing Services NA Inc. (Intertek), a July 16, 2020, Certificate of Conformity by Intertek, and the information provided in your July 16, 2020, letter, EPA has determined that the proposed design changes are unlikely to cause the model line to exceed the emission rate of 1.9 g/hr. An emission rate of 1.9 g/hr meets the 2020 New Source Performance Standard (NSPS) for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces at 40 CFR Part 60, Subpart AAA wood particulate matter emission limit of 2.0 g/hr. Therefore, pursuant to §60.533(k)(1), EPA is waiving certification testing for the 15-W03, 50-SHW03, and 50-TRW03 models, and we have updated the above-referenced certificate number and the Wood Heater Database to include the new models. Please refer to the above-referenced certification letter number in all future correspondence.

This certification is valid for the above-referenced models and cannot be transferred to another model line without applying for certification. This certification allows England's to manufacture and sell the above-referenced models through May 28, 2024. Thereafter, England's may not manufacture, advertise for sale, offer for sale, or sell wood heaters under this certificate without applying for and being issued another compliance certification.

All wood heaters manufactured or sold under this certification must comply with EPA labeling requirements found at §60.536. These provisions require each wood heater to have a permanent label affixed to it that includes the month and year of manufacture, model name or number, serial number, certification test emission value, test method, standard met, and compliance certification statement. In addition, England's must comply with all applicable requirements of the regulation, including:

1. Conducting a third-party certifier-approved quality assurance program which ensures that all units within a model line are similar to the wood heater submitted for certification testing in all respects that would affect emissions and are in compliance with the applicable emission limit, pursuant to §60.533(m);
2. Applying for recertification whenever any change is made to above-referenced models that affect or is presumed to affect the particulate matter emission rate for the model line, pursuant to §60.533(k)(1);
3. Submitting a report to the EPA every two years following issuance of a certificate of compliance for each model line. This report must include the sales for each model by state and certify that no changes in the design or manufacture of this model line have been made that require recertification under §60.533(k);
4. Retaining records and submitting reports as required at §60.537; and
5. Submitting wood heaters for audit testing if selected by the EPA under §60.533(n)(1)(i) and (2)(i).

Failure to comply with these requirements may result in a revocation of this approval and enforcement action, including penalties as specified under the Clean Air Act. If you have any questions concerning this letter, please contact Rafael Sanchez of my staff at (202) 564-7028 or via email at sanchez.rafael@epa.gov.

Sincerely,

Martha Segall

Martha Segall
Acting Director
Monitoring, Assistance, and Media Programs Division
Office of Compliance

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

February 3, 2021

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. Brian Ziegler
Intertek Testing Services NA LTD.
8431 Murphy Drive
Middleton, Wisconsin 53562

Dear Mr. Ziegler,

The State of Alaska recently completed an independent review of over 200 compliance tests submitted to the Environmental Protection Agency (EPA) to support Step 2 certification applications for wood heater appliances. Alaska reviewed these reports to ascertain what newly certified appliances could be accepted into their program. Based on that review, Alaska determined that every test report had deficiencies and, as a result, has not cleared any appliance models for sale in Alaska. Please note that Alaska is a state that is highly dependent on wood heating as a source for home heating and a fine particulate matter ($PM_{2.5}$) nonattainment designation has the North Star Borough in a very difficult situation needing the emissions reductions from certified lower emitting appliances.
(*https://dec.alaska.gov/air/burnwise/manufacturers-vendors/*)

Since the 2015 rulemaking (80 FR 13672; March 16, 2015), EPA has relied on third party certification review and assurances that the test reports coming from your laboratories are accurate and represent all required documentation collected in a manner consistent with regulatory requirements and specific test method criteria. The findings identified by Alaska reveal that there are serious and systematic problems to be addressed in the testing and third-party certification processes.

Staff in the Measurement Technology Group within my division are now working with staff from the Office of Enforcement and Compliance Assurance's (OECA) Office of Compliance (OC) to review the findings from Alaska for current certified appliances as well as provide a more rigorous review of the test reports and other information that accompany all new applications for certification submitted to the Agency. For the review of those certified appliances, we are employing a template spreadsheet similar to the one used by the State of Alaska in their review. We will notify Alaska of where our findings differ from theirs and, if we find inconsistencies between their evaluation process and ours, we will work with them to help them understand the technical basis for our determination. This will be done in an effort to both verify their findings and provide clarity and transparency to the overall review process. To date, we have seen sufficient information to anticipate a number of major findings. This memorandum serves as notice that the EPA will reject submitted test reports that do not meet the regulatory and test method-specific requirements laid out within 40 CFR 60, subparts AAA and QQQQ, and

will also seek corrected test reports where documentation is missing, calculations are incorrect, and/or where other requirements are not demonstrated by the report documentation as being met. Rejection of the test report will result in your client's heater not being certified, which could result in additional costs to the manufacturer. For appliances where the manufacturer has already submitted test reports to the Agency and received certification, following our review and depending on the individual situation, we may require additional information, corrected reports, or new test runs to replace invalidated test runs. If an entire test report is invalidated, the certifications for those models will be revoked.

EPA regulations place the responsibility for compliance with the Wood Heater Rule requirement on each manufacturer, which is why they will be notified of any deficiencies in their testing or certification documentation by OECA. We anticipate that your clients will contact you for information to address any identified deficiencies including any testing or revised reports necessary to demonstrate full compliance. If EPA notifies your clients of unacceptable testing or insufficiently documented test reports, you will also be notified, with a copy to your ISO accrediting bodies, so that you can conduct root cause analyses, document resolutions and new standard operating procedures (SOPs) that address the itemized concerns provided. We expect that future audits will include reviews of your documentation demonstrating how you have addressed these issues and modified your process(es) to prevent future occurrences. If such issues are not resolved, the EPA would proceed to revoke your EPA Approved Lab status. Third-Party Certifiers also have a significant responsibility, and those individuals will be receiving similar letters regarding their ISO Accreditation and Approval status with the Agency.

The testing and certification of these appliances is a key aspect of EPA's wood burning appliance regulatory program. The work done in your labs is more than a pass/fail process for these appliances. Millions of dollars are being spent in airsheds across the country on change-out programs intended to replace older, dirtier appliances with newer, clean burning appliances and the data that you provide your clients in the test reports are used for determining whether or not your clients' appliances are chosen to participate in these programs. These test reports are intended to not only make a pass/fail statement about the appliance's performance during the test, but they **must** include sufficient documentation to provide the Administrator (or a state with rule delegation) with a full data set with which to assess the compliance status of the appliance as tested, from raw data sheets to reported emissions. Alaska had a reasonable expectation that these test reports would be complete and would provide them with the information needed to help them with their decisions. In addition, your clients had a reasonable expectation that the information needed by Alaska to make their decisions could be found in the test report and certification documentation. Other state air programs are also looking at wood burning appliances for change-out programs and replacement criteria. We intend to see that future testing and the documentation included in test reports are all appropriate for determining compliance with the Federal rules, and with respect to helping our regulatory partners implement meaningful programs to protect human health and the environment.

The EPA appreciates your participation in providing your clients with appropriate testing, thoroughly documenting test results, and in helping us implement a program that delivers results to the American public.

For questions about this memorandum, or the process laid out within, please contact Mr. Steffan Johnson (*johnson.steffan@epa.gov*), Leader of the Measurement Technology Group.

Sincerely,

Richard A. Wayland

Richard A. Wayland
Director, Air Quality Assessment Division

cc:
Rochelle Boyd – OAQPS SPPD
Chuck French – OAQPS SPPD
John Dombrowski – OECA OC
Steffan Johnson – OAQPS AQAD
Mike Koerber – OAQPS IO
Penny Lassiter – OAQPS SPPD
Robert Scinta – OECA OC
Martha Segall – OECA OC
Krishna Viswanathan – Region X
Jacqueline Werner – OECA OC

Company Name	Address	Contact	Test Lab Y/N	Third Party Y/N	EPA Approval Expires on:
OMNI-Test Laboratories, Inc. http://www.omni-test.com/	13327 NE Airport Way Portland, Oregon 97230	Alex Tiegs atiegs@omni-test.com (503) 643-3788	Yes	Yes	10/09/2025
Intertek Testing Services NA, LTD. http://www.intertek.com/	8431 Murphy Drive Middleton, Wisconsin 53562	Brian Brunson brian.brunson@intertek.com 608-824-7444	Yes	Yes	10/30/2025
	1829 32nd Avenue Lachine, Quebec H8T-3J1	Claude Pelland claude.pelland@intertek.com (514) 631-3100	Yes	Yes	10/30/2025
PFS-TECO http://www.pfsteco.com/testing	11785 SW Highway 212-Suite 305 Clackamas, Oregon 97015-9050	John Steinert john.steinert@pfsteco.com (503)-650-0088	Yes	Yes	02/05/2023
	1507 Matt Pass Cottage Grove WI 53527	Wayne Terpstra WTerpstra@PFSCorporation.com (319) 217-0969	No	Yes	02/05/2023
Polytest Services, Inc. http://www.polytests.com/	695 B Rue Gaudette St- Jean-sur-Richelieu Quebec, Canada J3B 7S7	Danick Powers dpower@polytests.com (450)-741-3636	Yes	No	10/30/2025
CSA Group www.csagroup.org	178 Rexdale Blvd, Toronto, ON M9W 1R3, Canada	Benjamin Barker Benjamin.Barker@csagroup.org (416) 747-4013	No	Yes	11/03/2025
UL, LLC www.ul.com	12 Laboratory Drive RTP, NC 27709	Travis F. Hardin 919.549.1670 Travis.F.Hardin@UL.com	No	Yes	11/12/2025
Research Institutes of Sweden (RISE) https://www.ri.se/en	Box 857, SE-501 15 Borås, Sweden	Lennart Aronsson lennart.aronsson@ri.se +46 (0)10 516 52 41	Yes	Yes	11/14/2022
ClearStak, LLC www.clearstak.com	99 Canal Street PO Box 109 Putnam, CT 06260	Kelly O'Brien Kelli@clearstack.com (860) 237-8245	Yes	No	11/07/2021
SZU http://www.szutest.cz/en	Engineering Test Institute Hudcova 424/56b, CZ-621 00 Brno Czech Republic	Dr. Michal Dvoracek dvoracek@szutest.cz +420 541 120 510	Yes	Yes	04/17/2022
Danish Technological Institute http://www.dti.dk/	Gregersensvej 1 2630 Taastrup Denmark	Mr. David Tveit dt@teknologisk.dk 45 72 20 20 00	Yes	No	11/22/2022
Guardian Fire Testing Laboratories, Inc. Https://www.firetesting.com	114 Lincoln Avenue Cobleskill, NY 12043	Ms. Laura Hinton lhinton@guardiantestlabs.com 888.680.7974	No	Yes	04/25/2024

Measurement Technology Group

Test Report Review Template – ASTM E3053 & ASTM E2515

Date___4/7/2021_____

Appliance Model ___England Stoves 15 SSW01_____

Test Lab___Intertek Labs_____

Date of Compliance Test___01/23/2020_____

Test Report ID___ 103758222MID-001R1_____

Findings: (highlight one) Acceptable Deficient Invalid

List of major issues found:

Issue	Applicable Method/Rule Section	Note
No conditioning information found in the report. Just states that 50 hours were completed by manufacturer.	M28R (2.1.4) ASTM E2780 (9.1.3), (9.1.4), (9.1.5), (9.1.6) 40 CFR 60.533(b)(5)	No data found in report.
Missing PM Test Data, Runs 1, 2, 3, 5 and 7	40 CFR 60.533(b)(5) 40 CFR 60.534(a)(1)	No PM or run data found for these test
Runs 5 not proportional sampling (filter plugging)	ASTM E2515 (9.8.1)	In order to maintain proportional sampling, the test lab must change the filter and continue testing without aborting the test.
Usable Firebox dimensions and calculations missing.	ASTM E2780 (9.3) 40 CFR 60.533(b)(3) 40 CFR 60.533(b)(5)	Calculations missing from report. No dimension criteria to support volume determination.
Test fuel density not reported	ASTM E2780 Section (9.4.1.3)	This information is missing from the report.
Test fuel moisture content too low	ASTM E2780 Section (9.4.1.2(1))	Several fuel pieces fell below the allowable range of 19-25% moisture.

Report doesn't demonstrate that the low burn rate was achieved.	M28 (8.1.1) via M28R (2.1.1) 40 CFR 60.537(a)(2)	The report does not demonstrate that the test with the 0.923 kg/hr was the lowest achievable by the unit, nor does the report state why a category 1 test could not be conducted. Documentation of a failed test effort to achieve a category 1 test is needed, or clear evidence that the two category 2 tests were conducted at the lowest achievable heat output rate.
Data missing for determining dual train comparison. Discussion on run 7 and 8 which had greater than 7.5% deviation is missing in the summary section.	ASTM E2515 (11.7) 40 CFR 60.533(b)(5)	This discussion should be included in the report. calculations demonstrating that the 0.5 g/kg criteria were met must also be included in the test report.
Should have averaged multiple category tests per the method requirement.	ASTM E2780 (9.5.13)	Where multiple tests were done in a category you must average at least 2 of the tests. If only two were done they must both be included in the average. If 3 were done you can exclude 1 test run.
Manufacturer's instructions to lab missing.	40 CFR 60.534(h) 40 CFR 60.536(g)(1)	Must be provided in the report.

Additional Notes:

The report does not include data for a category 1 test. The report does not clarify why a category 1 could not be met.

The report does include two category 2 tests, however, the data presented does not demonstrate on their own that the lowest burn rate was done. The report needs a discussion on why a category 1 test could not be conducted and the report must clearly demonstrate that the lowest output test is the lowest that could be achieved in normal home use.

8.1.1 Burn Rate Categories. One emission test run is required in each of the following burn rate categories:

Burn Rate Categories

[Average kg/hr (lb/hr), dry basis]

Category 1	Category 2	Category 3	Category 4
<0.80	0.80 to 1.25	1.25 to 1.90	Maximum.
(<1.76)	(1.76 to 2.76)	(2.76 to 4.19)	burn rate.

RUN #4 (01/29/19): Air control set for a category 2 burn rate with a burn time of 312 minutes. The test was loaded in 60 seconds with the door remaining open for 1 minute after the fuel was added. Air shutter fully closed. The fan was set to low position. The results of the test ended as a category 2 burn rate of 1.217 kg/hr.

RUN #9 (02/05/19): Air control set for a category 1 burn rate with a burn time of 387 minutes. The test was loaded in 60 seconds with the door remaining open for 5 minutes after the fuel was added. Air shutter fully closed. The fan was set to low position. The results of the test ended as a category 1 burn rate of 0.923 kg/hr.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF
ENFORCEMENT AND COMPLIANCE
ASSURANCE

August 2, 2021

Mr. John Wray
Lab Technician
England's Stove Works, Inc.
589 South Five Forks Road
Monroe, Virginia 24574

Re: England's Stove Works, Inc., Wood Heater Models 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03, and 50-TRW03; Certificate of Compliance Number 193-19

Dear Mr. Wray:

The United States Environmental Protection Agency (EPA or Agency) has completed a post-certification review of England's Stove Works, Inc. (England's), Certification of Conformity, and November 18, 2019 certification test report, submitted to EPA for the above-referenced wood heater models. As discussed below, this review found that the certification test was not conducted in accordance with the 2015 Wood Heater Rule and applicable test method. As a result, England's Certification of Conformity and certification test are both invalid, serving as the basis upon which EPA may revoke the Certificate of Compliance Number 193-19 (Subject Certificate) for the wood heater models 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03, and 50-TRW03 (Subject WH Models). *See* 2015 Wood Heater Rule at 40 C.F.R. § 60.533(l)(1)(ii) and (vii).

This is not a final Agency action. Before initiating the process to revoke the Subject Certificate, EPA is providing you the opportunity to conduct a valid certification test in accordance with the applicable test method. If you intend to take the opportunity to retest, you must confirm that you intend to retest as described below. Furthermore, you must also confirm that you will cease the advertisement and sale of the Subject WH Models and confirm that you will notify any distributors and retailers of the need to cease the advertisement and sale of the Subject WH Models. The Subject WH Models may not be sold until EPA reviews the resubmitted information and determines that you have submitted a valid certification test and Certification of Conformity demonstrating compliance with the applicable emission standard. If you decline to retest, EPA will formally initiate the revocation process, and you will have the opportunity for a hearing, pursuant to 40 C.F.R. § 60.539.

Identified Problems/Irregularities in Certification Test Report and Applicable Regulatory Basis and/or Test Method

Pursuant to the 2015 Wood Heater Rule, manufacturers must conduct a valid certification test using the prescribed test methods and procedures for each wood heater model. *See* 40 C.F.R. § 60.534.

Primary Identified Problem or Irregularity

Our review of England's November 18, 2019 certification test report found that the certification test was invalid because it was not conducted in accordance with the 2015 Wood Heater Rule and applicable test method. Specifically, the certification test did not use test fuel pieces within the allowable moisture range. The American Society for Testing and Materials (ASTM) Test Method E2780, Section 9.4.1.2(1), states that the average fuel moisture content for each test fuel piece used to construct the test fuel cribs (excluding test fuel spacers) must be between 19 and 25 percent dry basis. However, the Subject WH Models' certification test was conducted using five test fuel pieces with moisture contents between 18.07 and 18.47 percent (Runs 4, 6, and 9). Moisture content outside the specified range can make a significant difference in emissions and efficiency. Therefore, because the certification test did not use test fuel pieces within the allowable moisture content range, EPA has determined that the certification test is invalid.

Additional Problems or Irregularities

EPA's review also found the following issues in the test report, which should be addressed in subsequent reports submitted to EPA.

Test Report Problems or Irregularities	**Regulatory Citation and/or Test Method**	**Information Needed to Address Problems or Irregularities**
Missing Information – Conditioning Data.	EPA M28R Section 2.1.4, ASTM E2780 Sections 9.1.3, 9.1.4, 9.1.5, and 9.1.6.	Conditioning data must be included in the test report demonstrating the device was conditioned at a minimum of 50 hours using a medium burn rate.
Missing Information in the Non-Confidential Business Information (Non-CBI) Test Report – Usable Firebox Dimensions and Volume Calculation Data.	40 C.F.R. § 60.533(b)(5), 40 C.F.R. § 60.537(f), ASTM E2780 Section 9.3.	The test report must include firebox dimensions and volume calculation data.
Missing Information – Particulate Matter (PM) Test Data.	40 C.F.R. § 60.533(b)(5), 40 C.F.R. § 60.534(a)(1).	Valid PM test data must be included for Runs 1, 2, 3, 5, and 7.
Sampling Train Operation - Not Proportional Sampling (Filter Plugging).	ASTM E2515 Section 9.8.1.	The test report did not demonstrate the test laboratory changed the filter and continued testing without aborting the test (Run 5).
Missing Information – Test Fuel Density.	ASTM E2780 Section 9.4.1.3.	The test report must include the average test fuel density, dry basis. Test fuel density shall be in the range of 25 to 36 lb/ft^3.
Compliance Determination Cannot be Made - Failure to Demonstrate and Document Lowest Achievable Burn Rate.	EPA M28 Section 8.1.1 via M28R Section 2.1.1, 40 C.F.R. § 60.537(a)(2).	The test report must include documentation that the Category 1 test at 0.923 kg/hr represents the lowest achievable output rate accessible to a home user and the lowest burn rate for which the test

Test Report Problems or Irregularities	Regulatory Citation and/or Test Method	Information Needed to Address Problems or Irregularities
		was conducted. Documentation of a failed test effort to achieve a Category 1 test is needed, or clear evidence that the two Category 2 tests were conducted at the lowest achievable heat output rate.
Missing Information – Dual Train Comparison.	ASTM E2515 Section 11.7, 40 C.F.R. § 60.533(b)(5).	The test report (summary section) must include a discussion on Runs 7 and 8 regarding dual train deviation. Both runs had a deviation greater than 7.5 percent. Discussion should include calculations demonstrating the 0.5 g/kg criteria was met.
Missing Information – Instructions from the Manufacturer to the Laboratory on the Operation of the Device.	40 C.F.R. § 60.534(h), 40 C.F.R. § 60.536(g)(1).	The test report must document all communication with the laboratory regarding the operation of the device. Any communication or instructions must be consistent with instructions provided in the Owner's Manual.
Burn Rates – Failure to Average Additional Test Runs.	ASTM E2780 Section 9.5.13.	The test report shows multiple test runs within the same Category. In the event of multiple test runs within the same Category, the test lab must average at least two of the tests. For example, if only two were done, they must both be included in the average. If three were done, you may exclude one test run.

Re-Test Information

If you choose to retest, you must submit a written statement, signed by a responsible official of the manufacturer or authorized representative, within ten calendar days of receiving this letter. The signed statement must include the following: (1) your intent to retest the Subject WH Models; (2) confirmation that you will cease advertisement and sales of the Subject WH Models within 21 calendar days of receipt of this letter, and (3) that you will notify any distributors and retailers of the need to cease sales of the Subject WH Models within 21 calendar days of receipt of this letter. The signed statement must be submitted to WoodHeaterReports@epa.gov. The subject line of your email should contain "Wood Heater Proposed Certification Re-Test" and the model name.

If you choose to retest, you must notify EPA of the date that certification testing is scheduled to begin. This notice must be received by EPA at least 30 calendar days before the start of testing. The notification of testing must include:

1. Manufacturer's name and responsible official and physical and email addresses,
2. Approved test laboratory's name and physical and email addresses,
3. Third-party certifier name, and
4. Dates and location of testing.

Once testing is completed, you must submit new CBI and non-CBI versions of the certification test report along with a Certification of Conformity and all other required documentation. EPA will review the new certification test report to determine if a valid certification test was completed. If EPA determines that the new certification test is valid, you will be notified, and you may resume advertisement and sale of the model line. Please submit the notification of testing, new test reports, and Certification of Conformity to WoodHeaterReports@epa.gov. The subject line of your email(s) should contain "Wood Heater Certification Re-Test Information."

Failure to Notify EPA or Retest the Subject WH Models

If you decline to retest, or if we do not hear from you within the identified timeframe, EPA will formally initiate the revocation process and notify you of our intent to revoke the Subject Certificate for the above-referenced Subject WH Models. You will have the opportunity for a hearing pursuant to 40 C.F.R. § 60.539.

If you have any further information EPA should consider with respect to our determination that the certification test for the Subject WH Models is invalid, EPA is extending you, by this letter, an opportunity to advise the Agency, in person, via a conference call, or in writing, of any such information. To request such an opportunity to confer, please contact Bob Scinta of my staff within five (5) calendar days of receipt of this letter at Scinta.robert@epa.gov or 202-564-7171.

This request has been coordinated with EPA's Office of Air Quality Planning and Standards and the Office of General Counsel. If you have any other questions regarding this letter, please contact Rafael Sanchez of my staff at 202-564-7028 or via email at WoodHeaterReports@epa.gov.

Sincerely,

Vizard, Elizabeth
Digitally signed by Vizard, Elizabeth
Date: 2021.08.02 14:46:30 -04'00'

for Anthony J. Miller
Acting Director
Monitoring, Assistance, and Media Programs Division
Office of Compliance
Office of Enforcement and Compliance Assurance

cc:

Richard A. Wayland, OAQPS/AQAD
Steffan M. Johnson, OAQPS/MTG
Jacqueline Robles Werner, OECA/OC
Amy Porter, OECA/OC
Robert Scinta, OECA/OC/MAMPD/Air Branch
Scott Jordan, OGC
Brian Ziegler, Intertek Building & Construction

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

September 30, 2021

Mr. John Wray
Lab Technician
England's Stove Works, Inc.
589 South Five Forks Road
Monroe, Virginia 24574

Re: Notice of Proposed Determination to Revoke Certificate of Compliance Number 193-19 for the 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03, and 50-TRW03 Wood Heater Models

Dear Mr. Wray:

The United States Environmental Protection Agency (EPA or Agency) is providing England's Stove Works, Inc. (England's) notice of our proposed determination to revoke the above-referenced Certificate of Compliance. Pursuant to the 2015 Wood Heater Rule, the revocation will not take place until England's has an opportunity to request a hearing. To request a hearing, you must submit a written request within 30 calendar days following receipt of this notice, as required under 40 CFR 60.539(a)(1)(iii). Revocation of the above-referenced Certificate of Compliance will become effective if England's does not request a hearing within 30 calendar days. The basis for the proposed determination to revoke certification is discussed below.

In a letter dated August 2, 2021, EPA notified England's that a post-certification review found the certification test submitted for the above-referenced models was not conducted in accordance with the 2015 Wood Heater Rule and the applicable test method. Specifically, the Agency found the following problems/irregularities in the certification test report:

Primary Identified Problem or Irregularity

- The certification test did not use test fuel pieces within the allowable moisture range. The American Society for Testing and Materials (ASTM) Test Method E2780, Section 9.4.1.2(1), states that the average fuel moisture content for each test fuel piece used to construct the test fuel cribs (excluding test fuel spacers) must be between 19 and 25 percent dry basis. However, the certification test was conducted using five test fuel pieces with moisture contents between 18.07 and 18.47 percent (Runs 4, 6, and 9).

Additional Problems or Irregularities

- Missing Information – Conditioning Data.
- Missing Information in the Non-Confidential Business Information (Non-CBI) Test Report – Usable Firebox Dimensions and Volume Calculation Data.
- Missing Information – Particulate Matter (PM) Test Data.
- Missing Information – Test Fuel Density.
- Missing Information – Dual Train Comparison.
- Missing Information –Instructions from the Manufacturer to the Laboratory on the Operation of the Device.
- Failure to Demonstrate and Document Lowest Achievable Burn Rate.
- Failure to Average Additional Test Runs.
- Sampling Train Operation - Not Proportional Sampling (Filter Plugging).

As a result of the above-identified problems/irregularities, EPA found both the certification test and the Certification of Conformity to be invalid. This finding is the basis for the proposed determination to revoke the Certificate of Compliance. In our August 2, 2021 letter, we had provided you with the opportunity to conduct a valid certification test in accordance with the applicable test method. In addition, our August 2 letter provided you with an opportunity to confer with the Agency. As a result, subsequent conference calls were held with my staff on August 6 and August 25. During this period of conferring with EPA, we paused the 10-day timeframe by when you needed to provide notice of your intent to retest and stop the advertisement and sales of the above-referenced wood heater models. Therefore, as we have not received notification of your intention to retest and stop sales since the August 25 call and the time by which you were required to provide such notice has passed, we are now formally notifying England's of our proposed determination and initiating the revocation of the above-referenced Certificate of Compliance. *See* 2015 Wood Heater Rule at 40 C.F.R. § 60.533(l)(1)(ii) and (vii).

As stated above, you may request a hearing within 30 calendar days of receipt of this letter notifying England's of EPA's proposed determination to revoke the Certificate of Compliance. The hearing request must be in writing, must be signed by an authorized representative of England's, and must include a statement setting forth with particularity your objection to the proposed determination. 40 C.F.R. § 60.539(b). The hearing request should be sent to WoodHeaterReports@epa.gov. The subject line of your email should contain "Wood Heater Hearing Request" and the model names. If a hearing is not requested within the required timeframe, revocation of the Certificate of Compliance will become effective 30 calendar days following receipt of this letter.

This response has been coordinated with the Office of Air Quality Planning and Standards and the Office of General Counsel. If you have any questions regarding this letter, please contact Rafael Sanchez of my staff at 202-564-7028 or via email at WoodHeaterReports@epa.gov.

Sincerely,

ELIZABETH VIZARD

Digitally signed by ELIZABETH VIZARD
Date: 2021.09.30 13:35:53 -04'00'

For Anthony J. Miller
Acting Director
Monitoring, Assistance, and Media Programs Division
Office of Compliance
Office of Enforcement and Compliance Assurance

cc:

Richard A. Wayland, OAQPS/AQAD
Steffan M. Johnson, OAQPS/MTG
Jacqueline Robles Werner, OC
Robert Scinta, OC/MAMPD
Scott Jordan, OGC

Pellet Stoves
Wood Stoves
Lifestyle Products

P.O. Box 206 Monroe, VA 24574 www.heatredefined.com Phone: (800) 516-3636 Fax: (434) 929-4810

October 28, 2021

Rafael Sanchez, Ph.D.
Wood Heater Program Lead
Air Branch
Monitoring, Assistance, and Media Programs Division
Office of Compliance
U.S. Environmental Protection Agency (EPA)
Room 7149-D
1200 Pennsylvania Ave., NW
MS:2227A
Washington, DC 20460
Ph. 202-564-7028

RE: Notice of Proposed Determination to Revoke Certificate of Compliance Number 193-19 for the 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03 and 50-TRW03 Wood Heater Model

Dear Dr. Sanchez,

This letter is in response to the notice that England's Stove Works received from EPA on or about September 30, 2021. In the letter, EPA states its intention to revoke the Certificate of Compliance Number 193-19 for the 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03 and 50-TRW03 Wood Heater Model.

The primary identified problem or irregularity is that the certification test did not use fuel pieces within the allowable moisture range. During EPA's post-certification review, it was determined that five pieces of test fuel fell outside that allowable range.

England's Stove Works objects to the Administrator's proposed determination. We contend that the certification test was performed by a EPA-certified laboratory, was then reviewed by a EPA-certified third party, and finally was reviewed and approved by EPA itself, as a compliant unit. By revoking the Certificate of Compliance, EPA is unfairly harming England's Stove Works' ability to continue to operate as a small business.

Under 40 CFR 60.539(a)(2), England's Stove Works may request a hearing on this proposed determination. As required by 40 CFR 60.539(b), England's Stove Works is formally submitting in writing a request for a hearing. This is being submitted within the allowable 30-day notice time period.

Sincerely,

Chris Terrell

Chris Terrell,
COO
England's Stove Works, Inc.
434-929-2517

United States
Environmental Protection
Agency

RESIDENTIAL WOOD HEATER 30-DAY NOTIFICATION

INSTRUCTIONS

The manufacturer of an affected wood/pellet heater/central heater model line must notify the U.S. Environmental Protection Agency (EPA) of the date that certification testing is scheduled to begin. The EPA at least 30 days before the start of testing.

This notification must be signed by a responsible representative of the manufacturer or an authorized representative. Once completed, this notification must be submitted to WoodHeaterReports@epa.gov.

Affected residential wood-burning room heaters currently include, but are not limited to, adjustable burn rate stoves, catalytic adjustable burn rate stoves; hybrid adjustable burn rate stoves; single burn rate stoves; and pellet stoves. (40 CFR Part 60, Subpart AAA)

Affected residential wood-burning central heaters currently include, but are not limited to, indoor hydronic heaters ("wood boilers"); outdoor hydronic heaters ("outdoor wood boilers"); and forced-air furnaces ("warm air furnaces"). (40 CFR Part 60, Subpart QQQQ)

Disclaimer: The statutory provisions and the EPA regulations described in this document contain legally binding requirements. This document is not a substitute for those provisions or regulations, nor is it a regulation itself. In the event of a discrepancy, please refer to Part 60 Subparts AAA AND QQQQ, Sections 60.537, and 60.5479. If you have additional questions, please contact Rafael Sanchez at 202-564-7028, Residential Wood Heater Compliance Program Lead, or via email at sanchez.rafael@epa.gov.

MANUFACTURER INFORMATION

Manufacturer's Name:

England's Stove Works, Inc.

Manufacturer's Physical Address:
589 South Five Forks Road, Monroe, VA 24574

Manufacturer's Mailing Address (if different from physical address):
PO Box 206, Monroe, VA 24574

Name and Title of Manufacturer's Responsible/Authorized Representative Submitting this Application:

Chris Terrell COO

Manufacturer's Contact E-mail:
cterrell@englanderstoves.com

Manufacturer's Phone Number:
434-942-4692

Manufacturer's Website Address:
www.heatredefined.com

Manufacturer's Website Address where the test report and owner's manual will be posted, if known:

www.heatredefined.com

AFFECTED WOOD HEATER MODEL INFORMATION

Model Name(s) (as appearing on the certification test report). Please note: the model name and design number must clearly distinguish one model from another. The name and design number cannot include the EPA symbol or logo or name or derivatives such as "EPA":15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03, 50-TRW03

Model Number(s) (as appearing on the certification test report, if applicable): 15-SSW01, 50-SHSSW01, 50-TRSSW01, 15-W03, 50-SHW03, 50-TRW03

Heater Type Check one):	☒Adjustable Burn Rate Wood Heater	☐Pellet Stove	☐Single Burn Rate Heater	☐Hydronic Heater	☐Forced Air Furnace
Hydronic Heater Type (Check one):	☐Full Storage	☐Partial Storage	☐No External Storage	☐Indoor	☐Outdoor
Forced-Air Furnace Type (Check one):	☐Small (less than 65,000 BTU/hr heat output)		☐Large (greater than 65,000 BTU/hr heat output)		
Fuel Tested (Check one):	☒Crib	☐Pellet	☐Cordwood	☐Wood Chips	☐Other:
Certification Step:	☐2015	☒2020 (ALL HEATERS)		Equipped with a catalytic combustor? ☐Yes ☐No	

EPA-APPROVED TEST LABORATORY

Name of EPA-Approved Test Laboratory:
Intertek

Name(s) of Person(s) Authorized and/or Responsible for Conducting Certification Test:

Brian Ziegler – Technical Team Leader - Hearth

Phone: 608-824-7425	**E-mail:** brian.ziegler@intertek.com	**Website:** intertek.com
City: Middleton	**State:** WI	**ZIP Code:** 53562

EPA-APPROVED THIRD-PARTY CERTIFIER

Name of EPA-Approved Third-Party Certifier:
Intertek

Name(s) of Person(s) Authorized and/or Responsible for Reviewing Test Report and/or Issuing Certification of Conformity:
Jean-Phillippe Kayl - Vice President – Global Certification

Phone: 630-481-3114	**E-mail:** jp.kayl@intertek.com	**Website:** intertek.com
City: Arlington Heights	**State:** IL	**ZIP Code:** 60005

COMPLIANCE TEST INFORMATION

Test Method(s): ASTM E2780-2017, EPA Method 28R

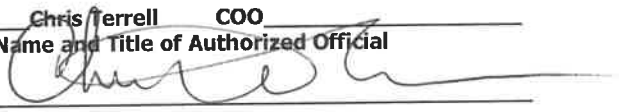
Date(s) of Proposed Test:

January 17 through January 28, 2022

Testing Location (Name and Address):
Intertek
8431 Murphy Drive
Middleton, WI 53562

Technician's Contact Name: **Ken Slater**	**Title:** **Associate Engineer**
Phone Number: **608-824-7423**	**Email Address:** **kenneth.slater@intertek.com**

Chris Terrell COO
Print Name and Title of Authorized Official



Signature

12132021
Date

Telephone Number: 434-942-4692

Email Address: cterrell@englanderstoves.com

Remarks: This is the testing of the previous approved EPA unit. Intertek will follow all guidelines in unsealing the Unit and performing the test.

v1

intertek
Total Quality. Assured.

Project Change Order 265074R0

Reference:	PCOR EPA Testing for Model 15-SSW01	Date:	12/29/2021
Prepared for:	Chris Terrell England Stove Works, Inc. 589 South Five Forks Road MONROE, VA 24574-2821	Prepared by:	Brian Brunson Operations Manager 8431 Murphy Drive Middleton, WI 53562
Phone:	4349290120	Phone: Fax:	608-836-4400 608-831-9279
E-mail:	cterrell@englanderstoves.com	E-mail:	brian.brunson@intertek.com

Testing and/or Evaluation:
The physical tests and/or evaluations required will be carried out in accordance with the previously determined test plan and according to the conditions below:

- Should a product fail, if the failure has no influence on the outcome of other portions of the test plan then testing may proceed through completion of the remaining test plan.
- The criteria listed below may not represent all standards or criteria applicable to your particular material or component. Evaluations to additional standards or criteria are not included and may be quoted separately upon request.
- At the end of testing, our engineer will provide you with a written statement of compliance or a report of non-compliances.
- Retesting due to product failures will be quoted separately.

This project will reference the following criteria or specifications:

$14,400.00

Intertek BP Test/Eval
ASTM E2515 and EPA Method 28R
EPA Emissions testing for Model 15-SSW01

Test Fee: $1,600 (discounted) per Day x 9 Days = $14,400
Setup and Tear Down Fee: $0 (discounted 1 Day)

*Only days used will be billed
**Additional testing days will be billed at $1,600 as an expense

intertek
Total Quality. Assured.

Assembling a report:
After it has been determined that your product has successfully complied with all requirements in the criteria, our engineer assembles the report. This report may contain some or all of the information gathered so far or may include additional information not yet collected. Our engineers will notify you if additional information is needed.
Intertek is committed to helping the environment by consuming less energy and fewer natural resources. All test reports and certificates will be stored and distributed electronically via SpecDirect for participating clients or via e-mail. Additional fees may apply for hard copies requested.

Intertek BP Report **$1,600.00**
Issuance of EPA test report
Report Fee: $1,600

Expenses
Unless specifically detailed within this proposal, expenses required to complete your project are not included and will be invoiced in addition to the fees quoted at cost plus a 25% administrative fee. Expenses may include:

- Travel expenses (unless itemized above)
- International shipments and customs
- Shipping costs (including international import and customs or express shipment of deliverables)
- Local taxes
- Procurement of materials used in the construction of your test sample or assembly (invoiced at cost plus 25%)
- Labor required to construct your sample or assembly (unless itemized above)
- Disposal fees if required will be invoiced at cost in addition to the quoted project fees.

Intertek BP Expense **$0.00**
Expenses
Crib Wood for Testing Estimate

Test Fuel Fee: $1,000 (estimated)

*Actual will be billed

Grand Total: $16,000.00

Invoicing
Intertek will issue invoices upon delivery of test data, reports, project status updates, or for projects lasting more than 30 days billing may occur on billable hours or tasks completed in that specific month at the rate indicated within this proposal.

intertek
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Payment Terms
Unless credit has been established, a 100% deposit of quoted fees (plus estimated expenses) will be required prior to your project start date. To apply for credit terms, please submit credit references or contact us for a Credit Application. Upon review, our credit department may extend terms of Net 30 Days or 50% Deposit. (US Customers Only) To pay by credit card, go to pay.intertek.com/USA20 and reference quote number 265074R0.

Project Cancellations:
Postponements or cancellations will be accepted if sufficient written notice is given to Intertek (preferably two weeks). In the event of a cancellation within two business days of your scheduled project start date, a $1,500 cancellation fee plus any incurred expenses may be invoiced.

To authorize this change, please complete and return to the fax or e-mail address above. The terms and conditions of your original quote or contract noted above, as well as any noted terms and conditions within, apply to this change.

Authorized by (print name): CHRIS TERRELL

Signature:

Date Authorized: 12 29 2021

If this Project Change Order increases funding of your project, please indicate your invoicing preferences below or to pay by credit card go to pay.intertek.com/USA20 and reference quote number 265074R0.

_____ Existing Purchase Order Updated*
_____ New Purchase Order Created* - New PO#: _____
X England Stove Works, Inc. does not require a Purchase Order
*Please submit a copy of the revised or new Purchase Order

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Burn Wise

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EPA-Approved Test Labs and Third-Party Certifiers for Residential Wood Heaters

EPA is committed to ensuring that new wood stoves and other wood burning devices comply with Clean Air Act standards to reduce health-harming pollution.

In light of information from states and other stakeholders provided in late 2020 and early 2021, the agency is taking a number of actions to address concerns about the methods and manner in which new wood stoves are being tested for compliance with the 2015 New Source Performance Standards under the Clean Air Act.

Since the 2015 rule, EPA has relied on the Third-Party certification review and assurances that the test reports coming from test laboratories are accurate and represent all required documentation collected in a manner consistent with regulatory requirements and specific test method criteria. Findings identified recently by stakeholders indicate that there may be serious and systematic problems to be addressed in the Third-Party Certification process.

In February 2021, EPA sent letters <https://epa.gov/burnwise/residential-wood-heaters-new-source-performance-standards-communication-laboratories-and> to the laboratories and the third-party verifiers notifying them that EPA was taking actions to ensure that the testing and certification of wood burning appliances is being conducted appropriately.

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These actions will take time and continued engagement with stakeholders. Please check back to this website for additional information.

Improving Testing and Certification

- After discussion with the State of Alaska, EPA sent letters <https://epa.gov/burnwise/residential-wood-heaters-new-source-performance-standards-communication-laboratories-and> to each EPA-Approved Test Laboratory and EPA-Approved Third-Party Certifier putting them on notice that EPA is reviewing all of the test reports identified by Alaska and others and that we expect that the labs and certifiers will work to provide their clientele with updated and appropriate reports.
- We also expect that they will adjust their standard operating procedures to ensure that such deficiencies are not found in future test reports.
- Also in February 2021, EPA approved a new, broadly applicable test method for wood stoves, known as the Integrated Duty Cycle (IDC) test method <https://epa.gov/sites/production/files/2021-04/documents/atm_140_rev4_april_9_2021_signed.pdf>, in response to a request filed by the State of Alaska. Any manufacturer may use this test method to demonstrate compliance with the New Source Performance Standards.

Reviewing Certification Submissions

- EPA is reviewing the more than 240 currently certified wood heater test reports identified in the March 2021 NESCAUM (Northeast States for Coordinated Air Use Management) report and will take actions, as appropriate, to make sure that only compliant devices are available on the market for the public.
- In addition, EPA is increasing the integrity of its review of all test reports for new woodstove certification applications to ensure that they are compliant before they go on the market.

Improving the Test Method

- EPA is undertaking a multi-year project to develop improved compliance measurement methods for testing new woodstoves which better reflect real-world conditions.

- The agency is working with states and other stakeholders across industry and laboratories to collect and review data and solicit feedback on the testing prior to proposal of the new test method.

Documents

- List of Wood Fired Appliance Test Report Deficiency Items - Subpart AAA - Wood Heaters and Pellet Heaters April 16, 2021 (PDF) <https://epa.gov/sites/production/files/2021-04/documents/epa_wood_heat_test_report_corrective_action_list_v1_rev1_apr_15_2021.pdf>
- February 3 and February 25, 2021 letters from US EPA to EPA-Approved Third Party Certifiers for Residential Wood Heaters and Residential Wood Burning Appliance Laboratories. <https://epa.gov/burnwise/residential-wood-heaters-new-source-performance-standards-communication-laboratories-and>
- EPA Approved Test Labs and Third Party Certifiers April 07,2021 (pdf) <https://epa.gov/sites/default/files/2021-04/documents/epa_approved_test_labs_and_third_party_certifiers_april_2021.pdf> (04/07/2021)

Burn Wise Home <https://epa.gov/burnwise>

What You Can Do <https://epa.gov/burnwise/learn-you-burn-wood-what-you-can-do>

Wood Smoke Resources in Your State <https://epa.gov/burnwise/wood-smoke-resources-your-state>

Wood Smoke and Your Health <https://epa.gov/burnwise/wood-smoke-and-your-health>

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Education and Outreach <https://epa.gov/burnwise/learn-how-burn-wood-right-way-and-share-message>

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Follow.

LAST UPDATED ON APRIL 16, 2021

From:	Almase, Jennifer
To:	Barnwell, Matt
Subject:	FW: England"s Stove Works, Inc.
Date:	Thursday, November 18, 2021 4:59:53 PM

Jennifer Almase
Attorney-Advisor | Office of Administrative Law Judges
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W. | Mail Code 1900R
Washington, D.C. 20460
Telephone: 202-564-1170
Email: almase.jennifer@epa.gov
Pronouns: she/her/hers

From: Scinta, Robert <scinta.robert@epa.gov>
Sent: Monday, November 15, 2021 8:24 PM
To: Wright, MichaelB <Wright.MichaelB@epa.gov>; Miller, Anthony <Miller.Anthony@epa.gov>; Angeles, Mary <Angeles.Mary@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Almase, Jennifer <Almase.Jennifer@epa.gov>; Lischinsky, Robert <Lischinsky.Robert@epa.gov>
Subject: RE: England's Stove Works, Inc.

Hello Mike,

The company began testing today, so I believe it will take several days (this week) to complete the test. Rafael can correct me if I'm wrong but, after that, it typically takes at least a couple of weeks for the lab to complete the report and for the company to send the data to us. We would then need some time, probably a week, to review the data. Assuming they passed the test, we would issue a letter revoking the old certificate and issuing the company a new certificate. All things considered, it would probably take a month total to get to the point where we can issue the new certificate. That would be around mid-December.

Bob

Robert Scinta, P.E.
Chief, Air Branch
Monitoring, Assistance, and Media Programs Division
Office of Compliance, Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency
Tel: 202-564-7171

From: Wright, MichaelB <Wright.MichaelB@epa.gov>
Sent: Monday, November 15, 2021 11:06 AM
To: Miller, Anthony <Miller.Anthony@epa.gov>; Angeles, Mary <Angeles.Mary@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>; Scinta, Robert <scinta.robert@epa.gov>
Cc: Almase, Jennifer <Almase.Jennifer@epa.gov>; Lischinsky, Robert <Lischinsky.Robert@epa.gov>
Subject: RE: England's Stove Works, Inc.

Hi Anthony,

If the company submits new test results today, what's the timeline for EPA's review and decision regarding that testing? If it is acceptable to EPA, what would be the next steps?

Kind regards,

Mike
Michael B. Wright
Supervisory Attorney-Advisor
Office of Administrative Law Judges
202-564-3247
wright.michaelb@epa.gov

From: Miller, Anthony <Miller.Anthony@epa.gov>
Sent: Monday, November 15, 2021 10:57 AM
To: Angeles, Mary <Angeles.Mary@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>; Scinta, Robert <scinta.robert@epa.gov>
Cc: Wright, MichaelB <Wright.MichaelB@epa.gov>; Almase, Jennifer <Almase.Jennifer@epa.gov>; Lischinsky, Robert <Lischinsky.Robert@epa.gov>
Subject: RE: England's Stove Works, Inc.

Good morning Mary,

Yes, the team has drafted a letter. We are going through it this morning and hope to have it to you by end of the day or early tomorrow.

One question for you:

1. Is there a list of folks we should cc on the transmittal letter? In other words, should we include the manufacturer and any representation they have or just keep it to EPA internal?

Thank you,
Tony

Tony Miller, P.E.
Pronouns: he/him/his
Director (Acting), Monitoring, Assistance, and Media Programs Division
Office of Compliance, Office of Enforcement and Compliance Assurance

U.S. Environmental Protection Agency
Tel: 303-312-7161

Do you miss our interactions? Me too! Let's take the scheduling difficulties out of the equation - Sign up for us to have virtual coffee! https://calendly.com/tmill/virtual-coffee

From: Angeles, Mary <Angeles.Mary@epa.gov>
Sent: Monday, November 15, 2021 8:47 AM
To: Sanchez, Rafael <Sanchez.Rafael@epa.gov>; Miller, Anthony <Miller.Anthony@epa.gov>; Scinta, Robert <scinta.robert@epa.gov>
Cc: Wright, MichaelB <Wright.MichaelB@epa.gov>; Almase, Jennifer <Almase.Jennifer@epa.gov>
Subject: England's Stove Works, Inc.

Hi Rafael, Anthony: Any new developments re the transmittal of this case to the OALJ? As you indicated in our meeting Wed., the manufacturer will be re-testing emissions from its product today, November 15th, and submitting the results to EPA for consideration as soon as possible. Will that still proceed? At any rate, I think it's best the case be transmitted to us as soon as possible since the expedited 60-day turnaround would have started from the date of receipt of the request for hearing. I have copied Michael Wright, supervisory attorney, if he has any comments. Thank you all.

Best,
Mary Angeles (she/ella)
Office of Administrative Law Judges

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