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Testing for Safety : Requirements and Test Procedures for Solid Fuel-burning Central Heating Appliances and Combination Oil and Solid Fuel- burning Central Heating Appliances

Southern Maine Vocational Technical Institute

Energy Testing Laboratory of Maine

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ETLM Standard No. 78-1

TESTING FOR SAFETY

Requirements and test procedures for
solid fuel-burning central heating appliances
and combination oil and solid fuel-burning
central heating appliances.

Energy Testing Laboratory of Maine
Southern Maine Vocational Technical Institute
South Portland, Maine 04106

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FORWARD

This standard was promulgated by the Energy Testing Laboratory of Maine for the purpose of establishing a criteria for examining, evaluating and testing central heating appliances, firing wood, coal and/or oil.

This standard may prove useful to manufacturers when considering to apply for product approval, approving agencies when considering product approval and inspection agencies when performing product evaluations.

This standard represents the judgement of the Energy Testing Laboratory of Maine based upon good engineering practices which would be consistant with the use of the equipment.

This standard makes no attempt to establish or determine heat outputs or efficiency ratings.

This standard takes into consideration certain product components which may have already been tested and/or listed by a recognized testing laboratory.

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GLOSSARY

TERMS RELATING TO CHIMNEYS, VENTS, AND HEAT PRODUCING APPLIANCES.

ACCESSIBLE. When applied to a fixture, connection, appliance, or equipment shall mean having access thereto, but which may require the removal of an access panel, door, or similar obstruction.

ACCESSIBLE, READILY. Capable of being reached easily and quickly for operation, adjustment, or inspection, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc.

AIR, COMBUSTION. The air required to provide for the complete combustion of fuel and usually consisting of primary air, secondary air, and excess air.

AIR SHUTTER. An adjustable device for varying the size of the air inlet or inlets regulating primary or secondary air.

AIR SHUTTER, AUTOMATICALLY OPERATED. An air shutter operated by an automatic control.

AIR SHUTTER, MANUALLY OPERATED. An air shutter manually set and locked in the desired position.

APPLIANCE. An appliance is utilization equipment, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, cooking, heating, refrigeration, etc.

APPLIANCE CASING (JACKET). An enclosure forming the outside of the appliance.

APPLIANCE FLUE. The flue passages within an appliance.

ASH. Solid residue which remains after combustion is complete.

ASH RECEPTACLE DOOR. A door below the grade level providing access to the ash receptacle.

BAFFLE. An object placed in an appliance to change the direction of or retard the flow of air, air-fuel mixtures, or flue gases.

BASE. The main supporting frame or structure of an assembly, exclusive of legs.

BLOWER. A fan used to force air under pressure into an affected area.

BODY. The principal structure of an appliance, including supporting frame.

BOILER. A closed vessel for heating water or a liquid or for generating steam or vapor by direct application of heat. It is usually an indirect-fired fuel-burning or electrically-heated appliance.

BOILER, HOT WATER SUPPLY. A low-pressure hot water boiler having a volume exceeding 120 gallons, or a heat input exceeding 200,000 BTU's per hour (58.6 kw) or an operating temperature exceeding 200°F that provides hot water to be used externally to itself.

BOILER, LOW PRESSURE. A boiler for generating steam at pressures not in excess of 15 psig or for furnishing water at a temperature not in excess of 250°F at pressures not in excess of 160 psig.

BURNER, AUTOMATICALLY IGNITED. A burner equipped so that main burner fuel may be turned on and ignited automatically.

BURNER, MECHANICAL DRAFT TYPE. A burner which includes a power-driven fan, blower or other mechanism as the primary means for supplying the air for combustion.

BURNER, NATURAL DRAFT TYPE. A burner which depends primarily upon the natural draft created in the chimney or venting system to induce the air required for combustion into the burner.

CENTRAL HEATING APPLIANCE. A stationary heating appliance comprising the following classifications: boilers, central furnaces, floor furnaces, and wall furnaces. A floor-mounted unit heater to be connected to a duct system is classified also as a central heating appliance.

CENTRAL WARM AIR HEATING SYSTEM. A heating system consisting of a central furnace connected to a supply system and a return system. (See also, Central Warm Air.)

CENTRALIZED OIL DISTRIBUTION SYSTEM. A system of piping through which oil is supplied from a remote central supply tank or tanks to one or more buildings, mobile homes, recreational vehicles, or other structures.

CHIMNEY. (See also Gas Vent and Venting System.) One or more passageways, vertical or nearly so, for conveying flue gases to the outside atmosphere.

a. FACTORY BUILT CHIMNEY. A chimney composed of listed factory-built components assembled in accordance with the terms of listing to form the completed chimney.

b. MASONRY CHIMNEY. A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units or reinforced portland cement concrete, lined with suitable chimney flue liners built in accordance with applicable Building Code requirements.

c. METAL CHIMNEY. A field-constructed chimney of metal made in accordance with applicable Building Code requirements.

CHIMNEY CONNECTOR. The pipe which connects a fuel-burning appliance to a chimney.

CLEARANCE. The distance between a heat-producing appliance, chimney, chimney connector, vent, vent connector, or plenum, and other surfaces.

COMBUSTIBLE MATERIAL. Material made of or surfaced with wood, compressed paper, plant fibers, plastics, or other material that will ignite and burn, whether flameproofed or not, or whether plastered or unplastered.

COMBUSTION. Combustion, as used herein, refers to the rapid oxidation of fuel accompanied by the production of heat and light.

COMBUSTION CHAMBER. That portion of an appliance within which combustion occurs.

COMBUSTION DETECTOR. That part of a primary safety control which is responsive directly to flame properties.

COMBUSTION PRODUCTS. Effluents resulting from the combustion of a fuel including the inerts, but excluding excess air.

CONTROL. A device designed to regulate the fuel, air, water, or electrical supply to the controlled equipment. It may be automatic, semiautomatic, or manual.

CONTROL, AUTOMATIC. A control having a self-acting or self-regulating mechanism that performs a required act at a predetermined point in an operation.

CONTROL, FAN. An automatic control responsive to changes in temperature, intended to control the operation of the fan on forced-air appliance.

CONTROL, LIMIT. An automatic safety control responsive to changes in fluid flow or level, pressure, or temperature and which is normally set beyond the operating range for limiting the operation of the controlled equipment by shutting off the energy supply.

CONTROL, OPERATING. A control, other than a safety control or interlock, to start or regulate burner firing according to load demand and to stop or regulate firing on satisfaction of demand or upon reaching normal temperature or pressure in the appliances being fired. Operating controls may also actuate auxiliary equipment.

CONTROL, PRIMARY SAFETY (COMBUSTION SAFEGUARD). A safety control responsive directly to flame properties, sensing the present or absence of flame and, in event of ignition failure or unintentional flame extinguishment, causing safety shutdown.

a. RECYCLING TYPE. A primary safety control for automatically lighted burners which, upon accidental flame failure during a normal firing cycle and the subsequent shutoff of main burner fuel, will provide, after a pre-established shutdown period and under a normal starting program, one attempt to automatically light the main burner.

b. NONRECYCLING TYPE. A primary safety control which, upon accidental flame failure during a normal firing cycle, causes a safety shutdown.

c. RELIGHT TYPE. A primary safety control providing interrupted ignition for automatically lighted burners which, upon accidental flame failure during a normal firing cycle, will cause the ignition energy to be restored in not more than 0.8 seconds; then, if the main burner flame is not established, causes a safety shutdown.

CONTROL, SAFETY. Automatic controls (including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety-control system) which are intended to prevent unsafe operation of the controlled equipment.

DAMPER. A valve or plate for controlling draft or the flow of gases including air.

DAMPER, AUTOMATICALLY OPERATED. A damper operated by an automatic control.

DAMPER, FLUE GAS. A damper located on the downstream side of the combustion chamber of a fuel-burning appliance, usually in a flue passage of the appliance or in the chimney or vent connector.

DAMPER, MANUALLY OPERATED. An adjustable damper manually set and locked in the desired position.

DRAFT. The pressure differential which causes the flow of air or gases through a chimney, gas vent or venting system.

a. MECHANICAL DRAFT. Draft produced by a fan or an air or stream jet. When a fan is located so as to push the flue gases through the chimney or vent, the draft is forced. When the fan is located so as to pull the flue gases through the chimney or vent, the draft is induced.

b. NATURAL DRAFT. Draft produced by the difference in the weight of a column of flue gases within a chimney or vent and a corresponding column of air of equal dimension outside the chimney or vent.

DRAFT REGULATOR, BAROMETRIC. A device built into a fuel-burning appliance or made a part of a chimney connector or vent connector, which functions to reduce excessive draft through an appliance to a desired value by admitting ambient air into the appliance chimney, chimney connector, vent or vent connector.

ELECTRICAL CIRCUITS.

a. LINE-VOLTAGE CIRCUIT. A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those low-voltage and isolated limited secondary circuits.

- b. LOW-VOLTAGE CIRCUIT. A circuit involving a potential of not more than 30 volts and supplied by a primary battery or by a standard Class 2 transformer, or by a suitable combination of transformer and fixed impedance which, as a unit, complies with all the performance requirements for a Class 2 transformer. (A circuit derived from a source of supply classified as a line-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low voltage nor an isolated secondary circuit.

FLUE. The general term for a passage through which flue gases pass from the combustion chamber to the outer air.

- a. APPLIANCE FLUE. The flue passage within an appliance.
- b. CHIMNEY FLUE. The passage in a chimney for conveying the flue gases to the outside atmosphere.
- c. DILUTION FLUE. A passage designed to effect the dilution of flue gases with air before discharge from the appliance.

FLUE COLLAR. That portion of an appliance designed for attachment of a chimney or vent connector or a draft hood.

FLUE GASES. Combustion products from fuel burning appliances plus excess air.

SOLID FUEL - WOOD OR COAL

FUEL OIL. Any hydrocarbon oil as specified by ASTM D396, or the Canadian Government Specification Board, 3-GP-28, and having a flash point not less than 100°F.

FURNACE, CENTRAL WARM-AIR. A self-contained indirect-fired or electrically heated appliance designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.

- a. FORCED-AIR TYPE CENTRAL FURNACE. A central furnace equipped with a blower which provides the primary means for circulation of air.
- b. GRAVITY-TYPE CENTRAL FURNACE. A central furnace depending primarily on circulation of air by gravity.
- c. GRAVITY-TYPE CENTRAL FURNACE WITH INTEGRAL FAN. A central furnace equipped with a fan as an integral part of its construction and operable in gravity systems only.

The fan is used only to overcome the internal resistance to airflow.

d. GRAVITY-TYPE CENTRAL FURNACE WITH BOOSTER FAN. A central furnace equipped with a booster fan which does not materially restrict free circulation of air by gravity flow when such a fan is not in operation.

HEAT EXCHANGER. A chamber in which heat resulting directly from combustion of fuel, or heat from a medium such as air, water or steam is transferred through the walls of the chamber to air passing through the exchanger, or in which heat from electric resistors is transferred to the air.

HEAT RECLAIMER (CHIMNEY CONNECTOR TYPE). A heat exchanger intended to be installed in a chimney connector between a heating appliance and the chimney to transfer heat from the flue gases through metal to air or water.

INDIRECT-FIRED APPLIANCE. A fuel-burning appliance in which products of combustion (flue gases) are not mixed in the appliance with the medium (e.g., air) being heated.

LOW-WATER CUTOFF. A device arranged to shut off fuel or electrical energy when water level in a boiler falls to a predetermined low level.

MANUFACTURER. The company or organization which evidences its responsibility by affixing its name or nationally registered trademark or trade name to the appliance concerned.

NONCOMBUSTIBLE MATERIALS. Materials which will not ignite and burn, such materials consisting entirely of steel, iron, brick, tile, concrete, slate, asbestos, glass or plasters, or combinations thereof.

PIPING. The word "piping" refers to either pipe or tubing, or both.

a. PIPE. Refers to a rigid conduit of iron, steel, copper, brass, aluminum or plastic.

b. TUBING. Refers to a semirigid conduit of copper, steel, aluminum or plastic.

PLENUM. An air compartment, part of a distributing system, to which one or more ducts are connected.

a. FURNACE SUPPLY PLENUM. A furnace plenum attached directly to or an integral part of, the supply outlet of the furnace.

b. FURNACE RETURN PLENUM. A furnace plenum attached directly to, or an integral part of the return-air inlet of the furnace.

STOKER. An automatically operated coal burner.

VALVE, RELIEF. A valve designed to forestall the development of an unsafe condition by relieving excessive pressure, temperature or vacuum.

VENTING SYSTEM (FLUE GASES). A continuous open passageway from the flue collar or draft hood of a fuel burning appliance to the outside atmosphere for the purpose of removing flue gases.

Note: A venting system for exhausting flue gases usually is composed of a gas vent, Type L vent or a chimney and vent or chimney connector(s) if used, assembled to form the open passageway.

WATER HEATER. An indirect-fired fuel burning or electrically heated appliance for heating water to a temperature not more than 200°F, having an input not greater than 200,000 BTU or 58.6 kw per hour and a water containing capacity not exceeding 120 U.S. gallons.

A. SCOPE

A.1 This standard covers low heat producing solid fuel burning and combination fuel oil and solid fuel burning appliances intended to be used for residential heating.

A.2 The oil burning equipment used on the combination appliances shall be installed in accordance with the National Fire Protection Pamphlet #31, "Standard for the Installation of Oil Burning Equipment". All field wiring shall be done in accordance with the National Electric Code. Persons should contact the authority having jurisdiction before installing this equipment.

B. GENERAL

B.1 These appliances and their components shall be examined for compliance to the requirements for construction. They shall also be tested for performance and use. Testing shall cease when any appliance and/or its component fails to meet these requirements or when it satisfies these requirements. The Energy Testing Laboratory will notify the manufacturer or his agent of such.

B.2 These requirements and test procedures cover central heating appliances firing wood and/or coal whether manually, semi-automatically or automatically operated oil burners firing oil no heavier than No. 2 fuel oil, or a combination thereof, and which are designed for use on residential steam, hot water or warm air systems.

B.3 The test procedures also cover the following:

1. Oil burners when used on combination units.
2. Control systems whether electrically or thermostatically operated.
3. Accessory components whether electrically, thermostatically or manually operated.
4. Automatically operated solid fuel burners such as, coal stokers, wood chip or pellet burners, etc.

B.4 The solid fuel burning features shall comply with the intent of UL 727.

B.5 Every solid fuel burning appliance shall be provided with a barometric draft control which is permanently set to limit the draft for which the appliance is designed, whichever is lower and whichever draft will accommodate the solid fuel and the case of combination solid fuel, fuel oil appliances, the fuel oil firing without necessitating adjustment of the draft control.

B.6 Every solid fuel burning and combination appliance shall be capable of being installed in accordance with the requirement of the current N.F.P.A. Codes 211, 89M and 31, available from the National Fire Prevention Association, 470 Atlantic Avenue, Boston, Massachusetts.

C. CONSTRUCTION

C.1 Every solid fuel burning appliance shall have the means for venting the products of combustion directly to the outdoors.

C.2 Every solid fuel burning appliance shall have provision for fuel charging and the safe removal of ashes.

C.3 The firing and ash pit doors and combustion air dampers shall be well fitted, capable of being tightly closed, and so constructed that distortion will not occur under condition of normal use.

C.4 Every solid fuel burning appliance shall be equipped with a regulator to control the rate of combustion which may be a manually operated combustion air gate or damper.

C.5 The combustion air control shall not jam or bind or be put out of adjustment during condition of normal use, and shall shut off the combustion air supply in the event of regulator failure or linkage failure and shall provide for manually closing.

C.6 Every solid fuel fired appliance shall have provisions for an adjustable supply of combustion air above the fuel head.

C.7 Every coal burning appliance shall be equipped with grates below the normal fuel head.

C.8 Flue pipe dampers shall not be used that restrict more than 80% of the square inch area of the pipe.

C.9 The heat exchanger, combustion chamber casing and accessibility features shall comply with UL 727.

C.10 The electrical and non-electrical controls and components shall be located, protected and constructed so that their vulnerability to physical damage during normal solid fuel charging or ash removal is minimal.

C.11 The heat exchanger, combustion chamber, and protective liners shall be rugged enough to withstand, without significant damage, the conditions of use, fuel charging and ash removal.

C.12 If any heat insulation or refractory is likely to become displaced or removed from its intended position during normal use of the appliances, additional tests shall be conducted to determine that such displacement will not create unacceptable performance or hazard.

C.13 The fuel charging door and the ash pit door shall be provided with a positive latch to hold the door in a closed position.

C.14 Every solid fuel fired appliance on which the burning rate is automatically regulated shall be provided with a safety limit control which will automatically shut off the combustion air in the event of excessive temperature or pressure as shown in the following in addition to any operating control.

1. In a warm air furnace of the:
 - a. gravity type, a temperature in excess of 350°F at the bonnet, or
 - b. forced type, a temperature in excess of 250°F in the plenum
2. In a low pressure steam boiler, a pressure in excess of 15 PSIG.
3. In a low pressure water boiler, a temperature in excess of
 - a. 220° at outlet for a boiler intended for an open system, or
 - b. 250° at outlet for a boiler intended for a closed system.

D. SOLID FUEL BURNING FURNACES

D.1 Every hand fired forced air solid fuel burning furnace shall be equipped with an automatic combustion regulator to control the rate of combustion and to prevent temperatures in the outlet air plenum from exceeding 250°F.

D.2 Every forced air furnace using solid fuel shall be equipped with an automatic control to operate the circulating fan at a temperature below 250°F.

D.3 Every forced air furnace using solid fuel, and equipped with a mechanical draft fan to supply combustion air shall be equipped with a safety limit control to stop the mechanical draft fan when temperatures in outlet air plenum reaches 250°F.

E. SOLID FUEL BURNING BOILER

E.1 The pressure vessel of the solid fuel boiler shall be ASME rated or equivalent.

E.2 Every solid fuel fired steam or hot water boiler shall be equipped with an ASME rated safety valve or relief valve or pressure and temperature relief valve. The valve rating shall be greater than the input in B.T.U. per hr. of the boiler.

Note: Section relieving valve test boiler, Sec. J.15.

E.3 Every solid fuel fired steam and hot water boiler shall be provided with a suitable low water cut off device.

Refer: Fusible plug and over heat control non-electric.

F. STOKERS

F.1 In addition to the preceding, and insofar as it is practical, each stoker shall be equipped with a means of preventing firing rates which would cause excessive temperatures on the surrounding construction or components of a stoker-equipped appliance, when a component on the stoker or appliance malfunctions or fails.

F.2 Stoker parts exposed to fire shall be of at least cast gray iron.

F.3 Every stoker shall be equipped with:

- A. at least an automatic control to regulate the normal operation of the stoker.
- B. a device for maintaining a minimum fire including outfire protection, where the coal input rate is less than 75 lbs. per hr., and
- C. a device to stop the stoker in the event of overheating of the fuel feed tube. A warning alarm may be included.

F.4 The controls required by C.14 shall cut off the combustion air supply on the stoker or stoker fired appliances.

G. COMBINATION SOLID FUEL/FUEL OIL FIRED APPLIANCES

G.1 The fuel oil burning features shall comply with UL 727.

G.2 Provisions shall be made to automatically close the combustion air damper on the solid fuel chamber, whenever the oil burner is started unless it is proved that sparks will not exit through the air shutter when the burner is fired.

G.3 The construction shall be such that contamination or damage to the oil burner from the solid fuel burning operation shall not occur.

G.4 The solid fuel charging door shall be interlocked to shut off the oil burner where flames or the products of combustion emit from the solid fuel charging opening when this door is opened while the oil burner is firing.

G.5 The appliance shall be provided with a means to prevent the rollout of the products of combustion, flames, ashes or embers when the firing or de-ashing doors are opened.

H. MARKING

H.1 Every solid fuel burning appliance shall be plainly marked in a permanent manner with the following:

- a) Manufacturer's name
- b) Model number of the appliance
- c) The electrical rating, where applicable in accordance with N.F.P.A. 70, and National Electric Code.
- d) The identity of the chimney where a specific chimney is required.
- e) The specific identity of each special major component where such are required, for example, a flue connector, a combustion air duct, etc.

H.2 Every solid fuel burning furnace shall be plainly marked in a permanent manner on or near the fuel charging door with the following:

- a) Identify the fuel to be used i.e., "Burn Wood Only or Coal Only".
- b) Unsafe to fire with wood or coal as applicable above, in the firing chamber, where there are no physical limitations to restrict greater loading and the reference demarcation shall be of a permanent nature and readily identifiable.
- c) Load carefully or damage will result.
- d) Do not use chemicals or fluids to start fire.

- e) Do not burn gargage, gasoline, naphtha or engine oil.
- f) The procedure to be followed in the event of a runaway fire.
- g) Clean heat exchanger, flue pipe.
- h) Instructions on the procedure to be followed for operating the furnace without electrical power. These instructions should be emphasized by location, color or lettering size.
- i) Cautions regarding the storage of fuel or combustibile materials within the installation clearances of the appliance.
- j) "Unsafe to adjust flue draft higher than xx inches W.C."
- k) For combination units: "Do not attempt to light a fire when there is oil vapor present."
- l) The installation clearances and for combination units, either a direction to refer to the clearances shown on the nameplate for the oil furnace, or a duplication of clearances on each nameplate, using the maximum minimum values for the solid fuel or oil fired sections of the furnace, and the type of floor, i.e. combustibile or non-combustibile.
- m) The size and description of a mounting base, where such a base is not provided with the appliance, but required for installation on a combustibile floor.
- n) "Refer to Owner's Manual etc."

H.3 For stokers, in a permanent manner, the basic operating and maintainance instructions.

H.4 Where specific components, such as chimneys, mounting bases, etc., are required, each such component shall be marked to show the model number in a location visible after installation.

I. INSTRUCTIONS.

I.1 The name and address of the manufacturer.

I.2 The model number of the appliance.

I.3 The identity including the model numbers of any specific components comprising the appliance, such as chimney, mounting base, etc.

I.4 The necessity for adhering to the installation clearances and restrictions.

I.5 The advisability of installing a warm air furnace in a central location in relation to the outlet registers and the use of large warm air ducts, for improved heat distribution during electrical power failures.

I.6 The type of solid fuel recommended, is to be specified, together with a statement that the appliance is not to be used with an automatic stoker, unless so certified.

I.7 The applicable data required by Sec. H.2.

I.8 The statement "Do not burn garbage, gasoline, naphtha or engine oil."

I.9 Recommendations on how to store solid fuel and cautions not to place within furnace installation clearances, or within the space required for charging and ash removal.

I.10 The limitations for the maximum solid fuel charge shall be specified if physically possible to overcharge.

I.11 The chimney shall be specified as a type suitable for solid fuel, with the warning that it and the flue pipe must be clean and in good condition.

I.12 The maximum flue draft setting for the draft regulator shall be given, with the warning that if this setting is exceeded, a power failure situation could cause a solid fuel fire to burn out of control.

I.13 Directions shall be given as to the correct combustion air damper adjustment with a caution that this should not be altered for increased firing for any reason.

I.14 Cleanout instructions shall indicate that solid fuel burning furnaces require that heat exchangers and flue pipes to be cleaned more frequently because the soot and ash accumulations are more rapid with solid fuel burning. It should be pointed out that the consequences of not cleaning are poor efficiency and a possibility of a soot fire. Directions are to be given for the procedure to follow if there is a soot fire.

I.15 Directions shall be given on how to operate as a gravity furnace if there is a prolonged power failure. These instructions should be emphasized.

I.16 Instructions regarding the necessity for providing adequate combustion air around the furnace.

I.17 Instructions on solid fuel firing shall be given to indicate that combustion air is required above the fuel bed, and that a small intense fire is preferable to a large smouldering one to reduce the amount of creosote.

I.18 For Combination Units: Instructions on the procedure for adjusting the oil burner, i.e. with the openings into the solid fuel furnace, open, or closed, as applicable.

I.19 For Stokers: The operating, maintenance and trouble shooting instructions and any necessary cautions.

I.20 The method on installation and physical supporting of any special chimneys.

I.21 The specific details covering any mounting bases required for installation on combustible floors, where a specific base is not provided as part of the appliance.

I.22 Any assembly instructions where the appliance is shipped in a partly assembled condition.

I.23 SAVE THESE INSTRUCTIONS

J. SOLID FUEL FIRING TEST

J.1 The appliance shall be installed at the minimum clearances and equipped as recommended by the manufacturer in his installation instructions.

J.2 Starting the fire: The fire shall be started using newspaper and kinkling to build a base which will sustain the fires of section J.3 and J.4.

J.3 Test Fire Wood: The appliance shall be filled to the level recommended by the marking on it, with hard wood, in random fashion. The hardwood shall be 5" to 8" in diameter, 16" to 20" long or the length recommended by the manufacturer with the moisture content approaching but not exceeding 25% (approx. the interior of air dried wood).

J.4 Test Fire Coal: The appliance shall be filled to the level recommended by the marking on it with anthracite coal of the stove classification.

J.5 The fuel for fires, coal, wood, shall be replenished to sustain a full fuel bed, after the starting fire has depleted. Where required to attain temperature stabilization, the fuel shall be replenished as often as necessary to maintain a constant full bed fire for the length of time required to conduct the test.

J.6 The tests shall be conducted in the sequence specified herein, with both coal and wood unless the marking restricts the appliance to wood burning only. If these tests are interrupted part way through, the complete test sequence shall be repeated in order to obtain consistency of test fire development.

J.7 Combustion Test:

1. For warm air furnaces, the air circulation blower shall be adjusted for the minimum circulation air throughout. The resulting air temperature rise shall be as recommended by the manufacturer, but at least 40°F. with test fires of Sec. J.3 and J.4 and with an external static pressure of 0.20 in W.C.
2. For Hot Water Boilers: The flow of water shall be adjusted at the outlet to obtain an outlet water temperature of $180^{\circ} \pm 10^{\circ}\text{F.}$

For Steam Boilers: The flow of feed water shall be regulated to maintain a constant water level in the boiler, and the steam discharge rate shall be adjusted to maintain the maximum steam pressure as specified by the manufacturer.

J.8 After the test fire using wood or coal has been developed, the appliance shall be operated normally with the safety limit and operating controls in the circuit, and adjusted to their maximum settings and minimum differentials and at normal fuel draft according to the manufacturer's instructions.

The test shall be continued until the temperature stabilizes and the following shall be determined:

1. The flue gas products, CO₂, CO, smoke and the flue gas temperatures.

2. Measurements of the inlet and outlet temperature and flow rate of the heated medium.

J.9 The tests of Sec. J.8 shall be repeated to determine the effects of overfire air and higher draft settings (to the maximum recommended in the Installation Instructions) on the heat release rate and combustion products.

J.10 Limit Test & Normal Temperature Test: Operating under the conditions specified in J.8 and at maximum recommended draft at the flue collar, the operating controls shall be made ineffective, the circulating medium shall be restricted, (the external static pressure is to be maintained on warm air furnaces) until the limit control reacts to reduce the firing rate.

The limit control shall then be by-passed, and the outlet temperature of the heated medium maintained (by adjusting the medium flow restrictions) until the temperature achieved at limit cut-out is obtained. This outlet temperature shall be maintained until appliance and enclosure temperatures stabilize. Temperatures shall not exceed these permitted by Table 1, and the temperatures on the vertical surfaces of the casing, excluding flue collars, firing and ash removal doors shall not exceed Table 1, handle temperature shall not exceed Table 2.

J.11 Power Failure: With the heated medium flow restrictions still in place as set in Table J.10 the electrical power to the appliance shall be disconnected. The fire shall be at a full bed maximum intensity at the time of power interruption, but shall not be replenished thereafter. The temperatures shall not exceed those permitted by Table 3.

J.12 Extended Power Failure Operations: Operating under the conditions specified in J.11, the manufacturer's recommendations for operation under extended "power failed" conditions shall be implemented, and without any electrical power supply, the fire shall be replenished as often as necessary until the temperatures on the appliance and the surrounding construction stabilize or diminish. The temperatures shall not exceed those permitted by Table 1.

After power failure tests, a check should be made to prove that the limit control is still functioning correctly.

J.13 In solid fuel fired forced circulating air furnaces, the temperatures shall not exceed those permitted by Table 3 under each of the following conditions, when firing at the conditions specified in J.8.

- a. circulating fan failure
- b. blocked circulating air inlet
- c. blocked circulating air outlet

J.14 Flash Fire: The limit control shall be restored to the circuit and adjusted to its maximum setting. A flash fire shall be built on a substantial bed of embers remaining from a prior test.

A flash fire consists of burning dimension spruce lumber, nominal 2 x 2 in. in lengths up to 20 inches long, surface moisture content approaching but not exceeding 19%, piled at random into the firebox to the level indicated on the marking on the furnace, replenished only to permit a full bed fire at the first cycle of the limit control. Temperatures shall not exceed those permitted by Table 3.

J.15 Relieving Valve Test - Boilers: The safety valve, relief valve or the pressure temperature relief valve shall be capable of relieving, without significant increase in the pressure of the heated water, when the outlet is closed while the boiler is fired in accordance with J.14. The boiler shall be refuelled onto a bed of embers, and the combustion air regulating damper shall be fixed in normal full fire open position before the start of this test.

J.16 Heat Exchanger Burnout Test: (Warm Air Furnaces Only)
This test may be conducted to determine whether a fire, external to a warm air furnace, could result from a heat exchanger burnout, at the laboratory's discretion or unless requested by manufacturers.

A hole of approximately 1 square inch shall be made in the solid fuel heat exchanger where the circulating air blower delivers a positive pressure to the exterior surface. The hole should be located at a point where it could reasonably be expected that a burnout would occur.

The circulating air blower shall be adjusted as specified for the maximum air flow and external static pressure. The furnace shall be fired with a wood or coal test fire as specified in J.3 or J.4, without additional replenishing. The maximum enclosure temperatures that are attained shall not exceed those permitted by Table 3.

The above test shall be repeated once with a larger sized hole which may be at a different location.

J.17 Strength Tests: The hearth, grate or floor of the firebox shall withstand a uniform static load of 100 lbs., per sq. ft. without permanent distortion or damage.

K. TESTS FOR COMBINATION OIL AND SOLID-FUEL FIRED APPLIANCES.

K.1 The combustion characteristic of the oil-fired portion of the appliance shall comply with the performance requirements of UL Standards 296 and 726 as applicable except that the overfire pressure shall be adjusted to that measured when the solid-fuel overfire air damper and combustion air damper are open.

They would be open to the position they would be in when the room thermostat for the solid fuel furnace was demanding heat unless these openings are automatically closed when the appliance transfers to oil firing. The openings shall be closed for the purposes of the oil-firing tests in UL 296.

K.2 The oil burner combustion and ignition shall comply with UL 296 when tested at the maximum draft specified for the solid-fuel furnace or boiler and with the solid-fuel charging door, the overfire air damper, the combustion air damper, and the ashpit door closed as tightly as the furnace components will normally allow.

K.3 Oil burner combustion and ignition shall be safe and reliable when tested with the solid fuel charging door and/or the solid fuel combustion air damper is wide open, and only a momentary spillage or emission of combustion products shall be acceptable. Alternately, a safe shutdown of the oil burner shall be deemed to comply with the requirement.

K.4 The appliance shall be installed, and the solid-fuel test firing conducted according to Section K with the following changes or additional tests:

K.4.1. The requirements of Sec. J.7.1. shall be replaced by the following:

For warm air furnaces, the circulating air blower shall be adjusted to provide an $85^{\circ} \pm 5^{\circ}\text{F.}$ air temperature rise at the specified static pressure and at the lowest specified fuel oil input rate.

K.5.2. Immediately after "Extended Power Failure Operation", Sec. K.12 the oil burner operating control shall be by-passed, in order to fire the oil burner. If necessary, the circulating medium shall be restricted, while maintaining the external static pressure until the temperature shall not exceed those permitted by Table 1.

K.5.3. During the "flash fire", Sec. J.14 when the solid-fuel fire has been developed to its brightest, the oil burner operating control shall be adjusted to fire the oil burner.

(1) If oil burner ignition occurs, the means for ignition provided on the oil burner shall then be disconnected, and with PRECAUTIONS FOR POSSIBLE DELAYED IGNITION the oil burner shall be started and permitted to run for a few seconds. After a purging period between attempts to ignite, the duration of the oil burner running time shall gradually be extended to the nominal flame failure response timing (safety switch timing) of the combustion safety control.

If ignition of fuel oil by the solid-fuel fire occurs, it shall not damage the appliance or any components, nor result in any burning or glowing particles being emitted from the appliance.

(2) If oil burner ignition does not occur, the solid-fuel fire shall be permitted to diminish in brightness until the oil burner ignition can be achieved. Then, the ignition failure test shall be conducted.

(3) When the flash fire begins to decline, the limit control shall be by-passed, and the oil burner fired for 5 minutes, the fuel oil supply then shut off, and the "flame failure response time" determined. The "flame failure response time" of the oil burner combustion control shall not exceed that permitted by UL 296.

L. STOKERS

L.1 Various modes of malfunction or failure within the limitations of Sec. F.1 of the components of a stoker or a stoker-equipped appliance shall be evaluated to determine that excessive temperatures on the components of the appliance or stoker, or on the surrounding, do not occur.

MATERIALS

The minimum thickness of metal, including coatings where shown, shall be as follows:

Aluminum-alloy sheets0.016 inch (0.41mm)

Unprotected-steel sheets0.042 inch (1.07mm)

Painted or porcelain enameled sheets0.032 inch (0.81mm)

Cast iron0.125 inch (3.18mm)

Galvanized-steel sheets not less than G60 coating class in accordance with ASTM A525-710.018 inch (0.46mm)

Stainless-steel sheets0.012 inch (0.30mm)

Aluminum-coated steel sheets not less than 0.40 ounce of aluminum per square foot (0.12 kg of aluminum per m²)0.018 inch (0.46mm)

TABLE 1

MATERIALS	DEGRESS	
	C	F
A. Metals		
1. Aluminum alloys		
a. 1100 (2S)	183	330
b. 3003 (3S)	239	430
c. 2014, 2017, 2024, 5052 ^b	294	530
2. Aluminum-coated steel, heat-resistant type ^c	572	1030
3. Carbon steel - Coated with Type A19 deramic	572	1030
4. Galvanized steel ^d	267	480
5. Low-carbon steel, cast iron ^e	461	830
Stainless steel -		
a. Types 302, 303, 304, 321, 347	686	1235
b. Type 316	667	1200
c. Type 309S	867	1560
d. Types 310, 310B	894	1610
e. Type 430	728	1310
f. Type 446	961	1730

^a The specified maximum temperature rises apply to parts whose failure may cause the product to be unsuitable for use.

- b These and other alloys containing more than 1 percent magnesium shall not be used when the reflectivity of the material is employed to reduce a fire hazard.
- c When the reflectivity of aluminum coated steel is employed to reduce a fire hazard, the maximum allowable temperature rise is 830°F (461°C).
- d The specified maximum temperature rises shall apply when the galvanizing is required as a protective coating or the reflectivity of the surface is employed to reduce a fire hazard.
- e The specified maximum temperature rises shall not apply to parts of No. 8 gage (3.86mm) or heavier steel and 3/16 inch (4.8mm) thick or heavier cast iron employed for the hearth and to other parts of No. 12 gage (2.36mm) or heavier steel, and 1/8 inch (3.2mm) thick or heavier cast iron when:
 - (1) The part is not the only enclosure and
 - (2) Failure of the part will not expose adjacent combustible construction to the fire in the fire chamber.
- f The specified maximum temperature rise shall not apply to parts of 1/4 inch (6.4mm) or heavier steel and 5/16 inch (7.9mm) thick or heavier cast iron.

TABLE 2

SURFACE TEMPERATURE OF HANDLE

<u>Material</u>	<u>Temperature, Degrees</u>	
	F	C
Metallic	122	50
Glass	172	78
Plastic ^a	185	85
Wood	302	150

^a

Includes plastic with a metal plating not more than 0.005 inch (0.13mm) thick; and metal with a plastic or vinyl covering not less than 0.005 inch (0.13mm) thick.

TABLE 3

MATERIAL -	DEGREES	
	C	F
A. Metals		
1. Aluminum alloys -		
a. 1100 (2S)	239	430
b. 3003 (3S)	294	530
c. 2014, 2017, 2024, 5052 ^b	350	630
2. Aluminum coated steel, heat-resistant type ^c	708	1275
3. Carbon steel - Coated with type A19 ceramic	628	1130
4. Galvanized steel ^d	350	630
5. Low-carbon steel, cast iron ^e	517	930
Stainless steel -		
a. Types 302, 303, 304, 321, 347	767	1380
b. Type 316	748	1345
c. Type 309S	950	1705
d. Types 310, 310B	975	1755
e. Type 430	808	1455
f. Type 446	1042	1875

^a The specified maximum temperature rises apply to parts whose failure may cause the product to be unsuitable for use.

^b These and other alloys containing more than 1 percent magnesium shall not be used when the reflectivity of the material is employed to reduce a fire hazard.

^cWhen the reflectivity of aluminum coated steel is employed to reduce a fire hazard, the maximum allowable temperature rise is 830°F (461°C).

^dThe specified maximum temperature rises shall apply when the galvanizing is required as a protective coating or the reflectivity of the surface is employed to reduce a fire hazard.

^e The specified maximum temperature rises shall not apply to parts of No. 8 gage (3.86mm) or heavier steel and 3/16 inch (4.8mm) thick or heavier cast iron employed for the hearth and to other parts of No. 12 gage (2.36mm) or heavier steel, and 1/8 inch (3.2mm) thick or heavier cast iron when:

(1) The part is not the only enclosure, and

(2) Failure of the part will not expose adjacent combustible construction to the fire in the fire chamber.

^fThe specified maximum temperature rise shall not apply to parts of 1/4 inch (6.4mm) or heavier steel and 5/16 inch (7.9mm) thick or heavier cast iron.

