

UL 462

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Heat Reclaimers for Gas-, Oil-, or Solid Fuel-Fired Appliances



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September 30, 1993

Standard for

Heat Reclaimers for Gas-, Oil-, or Solid Fuel-Fired Appliances

UL 462, Second Edition

Accompanying this transmittal notice is a copy of the second edition of UL 462.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

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SEPTEMBER 30, 1993

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UL 462

Standard for

**Heat Reclaimers For Gas-, Oil-, or Solid
Fuel-Fired Appliances**

First Edition – September, 1991

Second Edition

September 30, 1993

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

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F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover heat reclaimers which are intended to recover a portion of heat from the flue gases of gas-, oil-, or solid fuel-fired appliances for the purpose of heating space or water. They are for installation on the vent or chimney connectors of the appliances which are for attachment to a Type B or Type L vent or a metal or masonry chimney. The heat reclaimers are covered for the maximum flue gas temperature marked on the heat reclaimer, which does not exceed 1000°F (538°C).

1.2 The heat reclaimers are intended for installation by a qualified agency in accordance with the manufacturer's instructions and the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211 or with the National Fuel Gas Code, NFPA 54/ANSI Z223.1.

1.3 These heat reclaimers intended for connection to an electrical supply are to be rated 240 volts or less, and are for installation in accordance with the requirements for ordinary locations in the National Electrical Code, NFPA 70.

1.4 Heat reclaimers which include plumbing connections are to be installed in accordance with the applicable plumbing codes.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the standard was developed, and that involves a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.1.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits and shall be used only under those specific conditions for which they have been recognized.

2.2 Units of measurement

2.2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 For the purpose of this standard, the following definitions apply.

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

3.3 COMBUSTIBLE MATERIAL, COMBUSTIBLE PRODUCTS, NONCOMBUSTIBLE MATERIALS – These terms, as used in this standard, are defined in the Standard Glossary of Terms Relating to Chimneys, Vents, and Heat-Producing Appliances, NFPA 97M.

3.4 DRAFT DIVERTER – (Also referred to as a Draft Hood.) A device built into a gas burning appliance or made a part of the vent connector from an appliance, which is intended to:

- a) Provide for the ready escape of the flue gases from the appliance in the event of no draft, back draft, or stoppage beyond the draft diverter,
- b) Prevent back draft from entering the heating appliance, and
- c) Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

3.5 DRAFT REGULATOR, BAROMETRIC – A device which functions to maintain a desired draft in the oil-fired appliance by automatically reducing the chimney draft to the desired value.

3.6 ELECTRICAL CIRCUITS:

- a) High-Voltage Circuit – For the purpose of this standard, a circuit involving a potential of not more than 240 volts and having circuit characteristics in excess of those of a low-voltage or an isolated limited secondary circuit.
- b) Low-Voltage Circuit – A circuit involving a potential of not more than 30 volts alternating current (ac) [42.4 volts peak or direct current (dc)] and supplied by a primary battery or by a standard Class 2 transformer, or by a 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 high-voltage circuit, using 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 limited secondary circuit.)
- c) Safety-Control Circuit – A circuit involving one or more safety controls.

3.7 SOLID FUEL-FIRED APPLIANCE – A heating appliance which has a freestanding fire chamber assembly of the circulating or direct radiation type. Solid fuel units are for attachment to a residential type chimney available for use with low-heat appliances and may be used to burn solid fuels commonly used in fireplaces. These units may be thermostatically controlled.

3.8 VENT CONNECTOR – The pipe which connects a gas-burning appliance to a vent.

4 Installation Instructions

4.1 Printed installation instructions shall accompany each heat reclaimer. A copy of these installation instructions is to be used as a guide in the examination and test of the heat reclaimer in accordance with the requirements in this standard. For the examination and tests a printed edition is not required.

4.2 The installation instructions shall include instructions and information for installation, maintenance, and operation of the heat reclaimer. At least the following information shall be included:

a) A statement specifying that the installation of the heat reclaimer shall be made only by a qualified agency. A description of the qualified agency shall be included, indicating that the qualified agency for the installation of heat reclaimers is one who is engaged and is responsible for or is thoroughly familiar with the installation and operation of the appropriate fuel-burning appliances and heat reclaimers, who is experienced in such work, familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction.

b) The type of appliance (room heater, water heater, boiler, central furnace) on which the heat reclaimer may be installed. This shall include the type of fuel, such as gas, oil, coal, wood, and the like.

c) A step-by-step procedure for inspection of the appliance before installing the heat reclaimer to determine that the appliance is operating properly and that it is properly vented. For a gas-fired appliance the instructions shall be patterned in accordance with Appendix H of the National Fuel Gas Code, NFPA 54/ANSI Z223.1.

d) Instructions that the temperature of the flue gases be determined before installing the heat reclaimer. The instructions shall specify that the heat reclaimer shall not be installed if the temperature is less than 300°F (149°C) and if it exceeds the temperature for which the heat reclaimer is rated. A step-by-step method for measuring the flue gas temperature shall be included.

4.3 The installation instructions for the heat reclaimer shall include at least the following:

a) Installation clearances to adjacent combustibles in integral inches.

b) For a heat reclaimer provided with a blower, orientation of the heat reclaimer with respect to the adjacent construction.

c) Location of the heat reclaimer on the vent systems with respect to barometric draft regulators, draft diverters, and flue outlet of the appliance. For a heat reclaimer that may be installed on a gas-fired appliance equipped with a draft hood the instructions shall specify that the heat reclaimer shall be installed as close to the draft hood as practicable, and without modification of the draft hood.

- d) Any limitations as to the positioning, vertical or horizontal mounting, and the location of the heat reclaimer with respect to the related appliance, other vented appliances and the venting system. These should include a statement that the heat reclaimer shall be installed in a venting system or section of a venting system serving only a single appliance.
- e) Instructions for accomplishing the mechanical and electrical connections required, including statements, as applicable, that all electrical supply cord connections shall comply with the requirements of local authorities having jurisdiction and all other electrical and plumbing connections shall be in accordance with the applicable codes.
- f) Instructions for securement of the heat reclaimer to the adjacent structural members of the building.
- g) Instructions for visual inspection of the venting system after installation of the heat reclaimer to determine that the venting system has proper horizontal pitch.
- h) Operating instructions for the heating appliance after installation of the heat reclaimer to determine that the heating appliance operates properly and the venting of the heating appliance is not restricted. The instructions shall specify that a flue temperature measurement be taken after the reclaimer is installed to verify that the exiting temperature of the flue gases is not below 300°F (149°C). For a gas-fired appliance equipped with a draft hood or draft diverter these should include a detailed description of a spillage test at the relief opening after 5 minutes of main burner operation.
- i) Cleaning instructions: these shall include the method and frequency of cleaning and instructions for installation of special flue pipe fittings for collection and removal of soot, if applicable.
- j) For a heat reclaimer intended for installation with a commercial or industrial type appliance or an oil burning residential type appliance, the maximum flue gas temperature of the appliance with which the heat reclaimer may be installed if this flue gas temperature is lower than 930°F (517°C) above room ambient temperature. See Table 24.2.
- k) Unless a heat reclaimer that includes a heat exchanger for heating water is provided with a temperature and pressure protective device that complies with the requirements for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22, the installation instructions shall include the following or equivalent.

"Install temperature- and pressure-protective equipment required by local codes, but not less than a combination temperature- and pressure-relief valve certified as meeting the Requirements for Relief Valves and Automatic Gas Shut Off Devices for Hot Water Supply Systems, ANSI Z21.22, by a nationally recognized testing laboratory that maintains periodic inspection of production."

CONSTRUCTION

5 Components

5.1 See 2.1.1 – 2.1.4 for requirements covering the construction and use of components on the heat reclaimers covered by this standard.

6 Assembly

6.1 All components necessary for the intended function of the heat reclaimer shall be included with the product.

6.2 A joint in the metal surface of a heat reclaimer which forms a passageway for the flue gases shall be tight, as attained by being welded, lock-seamed, riveted, bolted, or equivalent means. A joint shall not depend primarily on cement for tightness.

6.3 A heat reclaimer shall be provided with means other than vent or chimney connection for support of the assembly when it is installed.

6.4 A heat reclaimer for oil- and solid fuel-fired appliances shall include means for cleaning the passageways for flue gases without having to disassemble the heat reclaimer.

6.5 With respect to 6.1.4, an independently removable access panel that can be removed and replaced by use of conventional tools without moving the heat reclaimer from its installed position is not considered disassembly. When closed, this access panel shall form a tight seal to prevent leakage of flue gases.

6.6 A heat reclaimer shall be constructed so there is no reduction in the total free venting area as compared to the cross-sectional area of a chimney or vent connector pipe on which the heat reclaimer is to be installed. Also, it shall not significantly impede the flow of vent gases. This is to be determined by tests in accordance with Draft Loss Test, Section 27.

6.7 Unless a heat reclaimer that is intended to heat water is limited for installation on a water heating appliance and connected to the appliance such that the temperature of the water is regulated and limited by the controls on the appliance, it shall be provided with means to limit the temperature of the water flowing through the heat reclaimer to 210°F (99°C). See 26.2.1 – 26.2.2.

6.8 If a heat reclaimer is provided with a temperature-operated control for operation of the blower or a pump motor and the control is required to achieve conformance with 6.1.7, the temperature operated control shall comply with the Standard for Limit Controls, UL 353.

6.9 The heat exchanger of a heat reclaimer intended to heat water shall be of sufficient strength to withstand the Hydrostatic Strength Test as described in Section 28.

7 Materials

7.1 The outer casing or jacket of a heat reclaimer shall be made of steel or equivalent material, reinforced or formed if necessary, so that it is not likely to be damaged through handling in shipment, installation, and use. Sheet metal casings shall be made of steel having a minimum thickness of 0.020 inch (0.51 mm) if uncoated, or 0.023 inch (0.58 mm) if galvanized, or of nonferrous sheet metal having an average thickness of not less than 0.029 inch (0.74 mm), and all surfaces shall be protected against corrosion. The finish on the outer casing or jacket of the heat reclaimer shall not be damaged by heat during any of the tests.

7.2 A flueway of a heat reclaimer shall be constructed of cast iron or galvanized sheet steel having thickness of at least 0.032 inch (0.8 mm) for a heat reclaimer up to 16 inches (406 mm) in diameter, whereby the flue collar size determines the size of the heat reclaimer. For a heat reclaimer greater than 16 inches diameter the flueway of the same materials shall be at least 0.056 inch (1.42 mm) thick. Materials which provide equivalent rigidity, strength, durability and resistance to corrosion may be used.

7.3 A flue collar forming part of a heat reclaimer serving as a means of attachment to the vent or chimney connector pipe shall have the rigidity, heat resistance, and corrosion resistance at least equivalent to that of galvanized sheet steel having a thickness of not less than specified in Table 7.1.

Table 7.1
Minimum thickness of flue collars

Diameter of flue collar, Inches (mm)	Minimum wall thickness, Inch (mm)
Less than 6 (152)	0.019 (0.48)
from 6 (152) to 10 (254)	0.023 (0.58)
over 10 (254) up to 16 (406)	0.029 (0.74)
over 16 (406)	0.056 (1.42)

7.4 A radiation shield or baffle employed to prevent temperatures greater than those specified in Table 24.2 for electrical components shall be so constructed, formed, and supported, for the intended positioning and to prevent distortion or sagging in service. It shall be protected against corrosion and the finish shall not be damaged by heat when the heat reclaimer is tested under these requirements if the deterioration of the finish may cause temperatures greater than those specified in Table 24.2 on parts which it is intended to shield.

7.5 Alloys containing more than 1 percent magnesium shall not be used if the reflectivity of the material is employed to reduce the risk of fire.

8 Electrical Enclosures

8.1 General

8.1.1 Uninsulated live high-voltage parts shall be enclosed or guarded so that unintentional contact by persons during intended use of the equipment is not likely. This applies also to such parts located in a compartment into which access is required for intended care of the heat reclaimer, such as resetting controls, replacing filters, lubrication, cleaning, or the like.

8.1.2 The enclosure shall prevent the emission of molten metal, burning insulation, flaming particles, or the like, through openings onto combustible material.

8.1.3 Among the factors taken into consideration when judging the acceptability of an enclosure are:

- a) Mechanical strength,
- b) Resistance to impact,
- c) Moisture absorptive properties,
- d) Flammability,
- e) Resistance to corrosion, and
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under all conditions for use.

For a nonmetallic enclosure or part of an enclosure, all these factors are considered with respect to thermal and chemical aging.

8.1.4 Sheet metal for the individual enclosure of electrical components shall comply with Table 8.1 or 8.2, as applicable.

Table 8.1
Minimum thickness of sheet metal for enclosures —
carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness in inches (mm)	
Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Maximum width ^b Inches (cm)	Maximum length Inches (cm)	Uncoated (MSG)	Metal coated (GSG)
4.0 (10.2) 4.75 (12.1)	Not limited 5.75 (14.6)	6.25 (15.9) 6.75 (17.1)	Not limited 8.25 (21.0)	0.020 ^d (0.51) (24)	0.023 ^d (0.58) (24)
6.0 (15.2) 7.0 (17.8)	Not limited 8.75 (22.2)	9.5 (24.1) 10.0 (25.4)	Not limited 12.5 (31.8)	0.026 ^d (0.66) (22)	0.029 ^d (0.74) (22)
8.0 (20.3) 9.0 (22.9)	Not limited 11.5 (29.2)	12.0 (30.5) 13.0 (33.0)	Not limited 16.0 (40.6)	0.032 (0.81) (20)	0.034 (0.86) (20)
12.5 (31.8) 14.0 (35.6)	Not limited 18.0 (45.7)	19.5 (49.5) 21.0 (53.3)	Not limited 25.0 (63.5)	0.042 (1.07) (18)	0.045 (1.14) (18)
18.0 (45.7) 20.0 (50.8)	Not limited 25.0 (63.5)	27.0 (68.6) 29.0 (73.7)	Not limited 36.0 (91.4)	0.053 (1.35) (16)	0.056 (1.42) (16)

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes: (1) a single sheet with single formed flanges (formed edges), (2) a single sheet that is corrugated or ribbed, and (3) an enclosure surface loosely attached to a frame, for example, with spring clips

^b The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

Table 8.2
Minimum thickness of sheet metal for enclosures –
aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, Inch (mm)
Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Maximum width ^b Inches (cm)	Maximum length Inches (cm)	
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	0.023
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.25 (24.1)	(0.58)
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	0.029
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)	(0.74)
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	0.036
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)	(0.91)
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	0.045
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)	(1.14)
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	0.058
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)	(1.47)
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	0.075
20.0 (50.8)	25.0 (63.5)	45.0 (114.3)	55.0 (139.7)	(1.91)

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has sufficient torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes: (1) a single sheet with single formed flanges (formed edges), (2) a single sheet that is corrugated or ribbed, and (3) an enclosure surface loosely attached to a frame, for example, with spring clips

^b The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

8.1.5 Steel enclosures shall be protected against corrosion by painting, plating, or other equivalent means.

8.1.6 If insulating material other than electrical insulation is provided within the enclosure, consideration is given to the burning characteristics and combustibility of the material and the proximity of an ignition source.

8.1.7 All intended mounting positions of the heat reclaimer are to be considered when determining if it complies with the requirement of 8.1.2 and 8.1.6.

8.2 Doors and covers

8.2.1 A cover or access panel of an enclosure for uninsulated live parts shall be provided with means for securing it in place.

8.2.2 A hinged or pivoted panel or cover shall be positioned or arranged so that it is not subject to falling or swinging due to gravity or normal vibration in such a manner as to cause injury to persons by the panel or cover, or by the hazardous moving parts or uninsulated live parts that are accessed due to opening of the cover.

8.2.3 The equipment shall be so arranged that an overcurrent protective device such as a fuse, the intended protection functioning of which requires renewal, can be replaced, and manual-reset devices can be reset without removing parts other than a service cover or panel and a cover or door enclosing the heat reclaimer. See 8.2.6.

8.2.4 A required protective device shall be inaccessible from outside the heat reclaimer without opening a door or cover, except that the operating handle of a circuit breaker, the operating button of a manually operable motor protector, the reset button of a manually resettable temperature switch, and similar parts may project outside the heat reclaimer enclosure.

8.2.5 A fuseholder shall be so constructed, installed, or protected that adjacent uninsulated high-voltage live parts within 4 inches (102 mm), other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. An insulating barrier of vulcanized fiber or similar material employed for this purpose shall be not less than 0.028 inch (0.71 mm) in thickness.

8.2.6 The door or cover of an enclosure shall be hinged if it gives access to fuses or any motor overload protective device, the intended protective functioning of which requires renewal, or if it is necessary to open the cover in connection with the intended operation of the protective device such as resetting a manual reset overload protective device.

Exception: A hinged cover is not required if the only fuses enclosed are:

- a) Control-circuit fuses of 2 amperes or less, provided the fuses and control-circuit loads, other than a fixed control-circuit load, such as a pilot lamp, are within the same enclosure, or*
- b) Extractor-type fuses each with its own enclosure, or*
- c) Fuses in low-voltage circuits.*

8.2.7 Hinged covers, where required, shall not depend solely upon screws or other similar means requiring the use of tools to hold them closed, but shall be provided with a catch or spring latch.

8.2.8 A spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the door in place and would require some effort on the user's part to open it is considered to be a means for holding the door in place as required in 8.2.7.

8.2.9 A door or cover giving direct access to fuses in other than low-voltage circuits shall shut closely against a 1/4-inch (6.4-mm) rabbet or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the wall of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A construction which provides equivalent protection, such as a fuse enclosure within an outer enclosure or a combination of flange and rabbet may be used.

8.2.10 Strips used to provide rabbets, or angle strips fastened to the edges of a door, shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

8.3 Openings

8.3.1 During the examination for conformance with the requirements of 8.3.3, 8.3.4, and 8.3.5, a part of the enclosure, including air filters, which may be removed without the use of tools, is to be removed.

8.3.2 The acceptability of openings in an enclosure shall be determined on the basis of possible emission of flame, burning particles and molten metal and accessibility of bare live parts and film-coated wire in accordance with 8.3.4 – 8.3.13.

8.3.3 An opening in an enclosure to provide clearance around a dial, knob, lever, or handle shall not allow the entrance of a rod having a diameter of 9/64 inch (3.6 mm) at any setting or position of the dial, knob, or the like. The probe illustrated by Figure 8.1 shall not contact uninsulated live part or film-coated wire through such opening.

8.3.4 Except as permitted in 8.3.3 and 8.3.6 – 8.3.9, the enclosure shall have no openings other than:

- a) Not more than four unused holes intended for mounting various components inside the enclosure. The largest dimension of each such opening shall not be greater than 5/32 inch (4.0 mm) (No. 8 screw diameter).
- b) Not more than four holes 1/8 inch (3.2 mm) or less in diameter for the escape of air or drainage of paint during the painting process if they are located as close to the corners of the enclosure as possible.

8.3.5 Ventilating openings in an enclosure shall be judged on the basis of the necessity for their existence and their size and location in accordance with the following:

- a) A ventilating opening shall be necessary to prevent the attainment of excessive temperatures on parts of the heat reclaimer, as demonstrated by a heating test with such opening(s) blocked.
- b) Openings shall not be located in the bottom of the enclosure.
- c) The location of the ventilating openings shall conform with the requirements of 13.2.6.
- d) If an enclosure houses fuses, or any portion of a circuit breaker other than the operating handle, ventilating openings shall not be provided unless the construction affords containment of electrical fault disturbances equivalent to that provided by the requirements in 8.3.1 and 8.3.2.
- e) The compartment or that part of an enclosure which contains field-wiring splices in the high-voltage circuit shall not be provided with ventilating openings.
- f) There shall be no emission of flame or molten material, or other risk of fire, during all tests, such as transformer burnout and burnout of relays with blocked armature.
- g) An opening shall not permit entrance of a 3/4-inch (19.1-mm) diameter rod.

The technical drawing illustrates the design of a rocket motor assembly through three primary views:

- Front View (Left):** Shows the longitudinal profile of the motor. Key features include a top section with a 3.5 mm radius, a central throat area with a diameter of 16 mm, and a base flange with a diameter of 50 mm. Sectional lines A-A are indicated at two points along the upper body.
- Side View (Right):** Provides a detailed view of the nozzle and grain segments. It shows a total height of 234 mm and various segment heights (e.g., 30 mm, 60 mm, 90 mm). The nozzle exit diameter is 25.4 mm. An approximate 30° angle is noted at the very tip.
- Cross-Section A-A (Top Left):** A circular cross-section showing internal structural details and hatching patterns.
- Bottom View (Bottom):** A plan view of the base flange, which has a 78 mm outer diameter and a 25 mm radius fillet connecting it to the main body.

All dimensions are specified in millimeters.