

UL 1777

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Chimney Liners

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for
Chimney Liners, UL 1777

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Revisions: This Standard contains revisions through and including August 20, 1998. UL is in the process of converting its Standards for Safety to the Standard Generalized Markup Language (SGML). SGML – an international standard (ISO 8879-1986) – is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on the page. Significant benefits that will result from UL's use of SGML are increased productivity, reduced turnaround times, and data and information consistency, reusability, shareability, and portability. The changes noted in these revised pages are needed to modify the format and layout of this Standard to allow it to be converted to SGML. These editorial changes are now in effect.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The new and revised requirements are substantially in accordance with UL's Bulletins on this subject dated December 8, 1997 and May 29, 1998. These bulletins are now obsolete and may be discarded.

The revisions dated August 20, 1998 include a reprinted title page (page 1) for this Standard.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

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 set of revised requirements.

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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.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of or reliance upon this Standard.

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 metallic and nonmetallic chimney liners intended for field-installation into new or existing masonry chimneys that are used for the natural draft venting of Category I gas-fired, Type L vented oil-fired, and solid-fuel-fired residential-type appliances in which the maximum continuous flue-gas outlet temperatures do not exceed 1000 °F (538 °C).

Revised 1.1 effective August 20, 1999

1.2 Chimney liners are intended to be installed in existing masonry chimneys with or without a liner of fire-clay tile, or to be used as a substitute for masonry fire-clay tile flue liners in new chimneys.

1.3 Chimney liners are intended to be installed in accordance with the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211; and codes such as the BOCA National Mechanical Code, the Standard Mechanical Code, and the Uniform Mechanical Code.

1.4 Chimney liners as covered by these requirements are not intended for use with Category II, III, or IV gas burning appliances as defined by the National Fuel Gas Code, NFPA 54, or other appliances that result in condensation of corrosive acids on the liner of the chimney, or that create positive pressures in the chimney system.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as required to maintain the level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard is not judged to comply with this Standard. Where appropriate, revision of requirements are proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

2 Units of Measurement

2.1 If a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

3 Glossary

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

3.2 APPLIANCE, HEATING – A chimney-connected, fuel-burning device.

3.2.1 CATEGORY I GAS-FIRED APPLIANCE – A gas appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Added 3.2.1 effective August 20, 1999

3.3 CERTIFIED CHIMNEY SWEEP – A chimney sweep certified by a nationally endorsed chimney sweep organization.

3.4 CHIMNEY CONNECTOR – The flue pipe that connects a fuel-burning appliance to a chimney.

3.5 CHIMNEY, MASONRY – A field constructed chimney of solid masonry units, bricks, stones, or reinforced portland-cement concrete, lined with chimney flue liners built in accordance with applicable building code requirements.

- 3.6 CHIMNEY, TEST – An assembly used to investigate chimney liners consisting of a single thickness of brick or other equivalent minimum construction, as specified in this standard.
- 3.7 DAMPER, FIREPLACE – A plate located at the top of a masonry fireplace, used to stop the flow of air or restrict the flow of flue-gas air mixtures from inside the structure in which the fireplace is located to the outside.
- 3.8 DIRECT CONNECTION SYSTEM – A means to route combustion products from the outlet of an appliance through the damper area and to the chimney liner.
- 3.9 FIREPLACE, MASONRY – A field-constructed assembly constructed in accordance with the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211-1988, and in accordance with codes such as the BOCA National Mechanical Code, the Standard Mechanical Code, and the Uniform Mechanical Code.
- 3.10 LINER, CHIMNEY – A system to be used in conjunction with a chimney that is constructed from metallic or nonmetallic materials that are factory made or mixed, and that is assembled in the field to form a complete, functional means for conveying products of combustion to the outside.
- 3.11 NATURAL DRAFT – The draft created by an appliance that operates at neutral or negative pressure, as measured at the outlet of the appliance.
- 3.12 PRODUCT – The term "product" as used in these requirements refers to all chimney liners or any part thereof covered by these requirements, such as a wall penetration assembly, unless specifically noted otherwise.
- 3.13 QUALIFIED PERSON – A trained installer who has successfully completed a thorough, company-sponsored training course and who is familiar with the use of the product and the risks associated with improper installation procedures.
- 3.14 WALL PENETRATION ASSEMBLY – A device used to provide a means for routing a chimney connector through a combustible wall to a masonry chimney.

4 Components

- 4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component.
- 4.2 A component is not required to comply with a specific requirement that:
- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard; or
 - b) Is superseded by a requirement in this standard.
- 4.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.
- 4.4 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.

CONSTRUCTION

5 Materials

5.1 Parts used in a chimney lining system shall be of noncombustible, corrosion-resistant materials. Metals shall not be used in combinations at any location within the assembly that results in galvanic action.

5.2 The minimum thickness of materials, including any coatings, shall be as specified in Table 5.1.

Exception No. 1: The minimum thickness of materials employed as a protective covering over insulation, not subject to contact with flue gases, is not required to be as specified in Table 5.1. See Abrasion Test, Section 24.

Exception No. 2: The minimum thickness of materials determined to comply with the Comparative Corrosion Exposure Test For Aluminum Liners, Section 27A, or the Comparative Corrosion Exposure Test For Stainless Steel Liners, Section 27B, is not required to be as specified in Table 5.1.

Revised 5.2 effective August 20, 1999

**Table 5.1
Thickness of materials**

Description	Minimum thickness	
	Inch	(mm)
Aluminum alloys (1100, 3003)	0.012	(0.30)
Aluminum-coated steel, Type T1-40 (regular [0.40 ounces per square foot (0.12 kg/m ²)])	0.018	(0.46)
Cast iron	0.125	(3.17)
Galvanized steel (G90 Coating designation)	0.018	(0.46)
Porcelain-enameled steel	0.032	(0.81)
Stainless steel	0.012	(0.30)
Steel, uncoated or painted	0.053	(1.35)
Cast or fired refractory	0.40	(10.2)

Revised Table 5.1 effective August 20, 1999

5.3 A flue-gas conveying conduit of a chimney liner intended for use with solid-fuel-fired or oil-fired appliances shall be Type 304, 316, 430, or 446 stainless steel or stainless steel having at least equivalent properties, porcelain-coated steel, or cast or fired refractory. Porcelain-coated steel and cast or fired refractory shall comply with the requirements in Sections 28, Resistance to Action of Acids Test for Nonmetallic Flue-Gas Conduits, and Section 29, Freezing and Thawing Test for Water Absorptive Nonmetallic Materials, as applicable.

Revised 5.3 effective August 20, 1999

5.3.1 A flue-gas conveying conduit of a chimney liner intended for use with Category I gas-fired appliances shall be 1100 or 3003 aluminum, Type 304, 316, 430 or 446 stainless steel or stainless steel having at least equivalent properties, porcelain-coated steel, or cast or fired refractory.

Added 5.3.1 effective August 20, 1999

5.4 An unreinforced outer casing of a chimney liner shall be of galvanized steel, aluminum-coated steel, Series 300 or 400 stainless steel, or equivalent material. The minimum thickness of these materials shall be as specified in Table 5.1.

5.5 Other parts of a chimney liner subject to contact by flue gases or flue-gas air mixtures at or beyond the terminus of the flue-gas conveying conduit (such as caps) shall be of material equivalent to the flue-gas conveying conduit as specified in 5.3 and 5.3.1.

Revised 5.5 effective August 20, 1999

5.6 An outer casing or other structural part exclusive of the flue-gas conveying conduit:

- a) The deterioration or corrosion of which would result in the collapse of the chimney liner or otherwise increase the risk of injury to persons; or
- b) That is subject to condensation,

shall be of stainless steel, galvanized steel, or aluminum-coated steel. Galvanized steel or aluminum-coated steel shall comply with the requirements in 5.7. Stainless steel shall be in accordance with Table 5.1.

Exception No. 1: This requirement does not apply to the flue-gas conveying conduit. See 5.3 and 5.3.1.

Exception No. 2: This requirement does not apply to parts subject to contact by flue-gas or flue-gas air mixtures at or beyond the terminus of the flue-gas conveying conduit. See 5.5.

Revised 5.6 effective August 20, 1999

5.7 Galvanized steel used for outer casings, structural parts, or other components or subassemblies shall have a zinc coating complying with the coating designation G90 (former coating class 1.25 commercial) in Table 1 of the Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, ASTM A525-86, with not less than 40 percent of the zinc on any side, based on the minimum single spot test in ASTM A525-86. The weight of zinc coating shall be established in accordance with the Tests for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90-81. Aluminum-coated steel shall be of Type T1-40 (regular) [0.40 ounce per square foot (0.12 kg/m²)].

5.8 Components of a chimney liner, or subassemblies, not covered by the requirements for flue-gas conduits or outer casings shall be of materials and thicknesses as specified in Table 5.1, or the equivalent.

5.9 The corrosion resistance of a painted part made of steel not less than 0.053 inch (1.35 mm) thick, or of cast iron not less than 0.125 inch (3.18 mm) thick, and for use only in the interior of buildings, is equivalent to that required by 5.7. Paint coatings shall remain intact at the maximum temperatures obtained on the part during the tests specified in these requirements.

5.10 Except for binder materials, thermal insulation material shall be noncombustible.

5.11 Thermal insulation shall not come into contact with the products of combustion.

5.12 Thermal insulation located within the living space shall not be exposed.

5.13 Thermal insulation that is not self-supporting shall be applied to solid surfaces so that the insulation does not sag. An adhesive or cement that is depended upon to adhere insulation to chimney liner parts shall retain its adhesive qualities at any temperature the adhesive is capable of attaining when tested in accordance with these requirements and at 0 °F (minus 18 °C).

5.14 A water-absorbing insulating material shall not be subject to wetting by condensation or rain when installed as intended.

5.15 Thermal insulation shall incorporate a binder, or be constructed of material that is woven or otherwise formed to retain its shape upon removal of a portion of the chimney or chimney liner.

5.16 Aluminum alloys containing more than 1.0 percent magnesium shall not be used when the reflectivity of the material is utilized to reduce the risk of fire.

6 Assembly

6.1 A chimney liner shall consist of all the parts and materials required for the intended assembly of a complete chimney lining system. Each part of the assembly shall be constructed for ready attachment of one to the other without requiring alteration by the installer, such as by cutting, threading, drilling, welding, or similar tasks.

Exception No. 1: An assembly or component part intended to be cut to length or to be fitted by the installer shall not be provided unless means are furnished for joining any altered part to a companion part or assembly. All fasteners required to complete the assembly shall be provided with the product by the manufacturer.

Exception No. 2: Drilling shall not occur unless:

- a) *The drilling operation does not weaken the assembly; and*
- b) *The size of the required drill bit is specified and the instructions clearly describe the location(s) to be drilled, such as by the use of drawings, descriptions, or templates.*

6.2 Two or more parts or subassemblies that bear a definite relationship to each other in the intended application shall:

- a) Be arranged and constructed to permit them to be incorporated into the complete assembly without requiring alteration or alignment and only in the correct relationship with each other; or
- b) Be assembled and shipped from the factory as one unit.

6.3 Each part, such as a chimney liner section, tee section, cleanout door assembly, and chimney top closure cap shall be completely assembled by the manufacturer at the factory.

Exception: A cementitious chimney liner, or one incorporating other material requiring field mixing, is not required to be completely assembled by the manufacturer at the factory.

6.4 A chimney liner shall be capable of attachment to chimney connectors having diameters of integral inches.

6.5 A chimney liner shall be sized such that standard sized chimney brushes are capable of being used to clean the lining system.

Exception: Nonstandard sizes and shapes of chimney liners shall not be used unless the manufacturer supplies a brush sized to clean the lining system, or the specific size is readily available, and the maintenance instructions specify the method of ordering the brush.

6.6 A chimney liner shall not incorporate loose-fill type insulation between the masonry chimney and liner material unless the insulation binder keeps the fibers or particles together within the assembly.

6.7 When a chimney liner is intended for installation in an offset chimney, parts required for maintaining the clearance between the liner and the masonry chimney shall be provided by the manufacturer, as well as the parts required to install the liner in the offset chimney.

6.8 A chimney liner shall incorporate spacers as a permanent part of the assembly to locate and retain the liner centrally within the masonry chimney.

Exception No. 1: Spacers are not required to be a permanent part of the assembly when:

- a) The installation process includes a poured-in place or pumped-in place insulating material;*
- b) The liner is temporarily spaced centrally within the masonry chimney during the installation process; and*
- c) The installation instructions or training manual specify the methods to be used during installation to centrally locate the liner assembly.*

Exception No. 2: Spacers are not required to be incorporated when performance is demonstrated by tests in which, when the test chimney is as close to a corner as construction allows, the chimney liner is installed and demonstrates direct contact with two sides of the test chimney.

Exception No. 3: Spacers are not required to be supplied with a rigid chimney liner when the chimney liner is centrally located within the chimney by means of the supports provided at the top and bottom of the chimney.

6.9 A rigid metallic chimney liner shall incorporate means to provide for expansion of the parts in the system so as not to create stress on parts within the assembly. Means shall be provided to prevent liner sections from telescoping into one another.

7 Chimney Caps

7.1 A cap shall be provided to resist the entrance of debris and rain into the flue-gas conveying conduit of the chimney liner, and into any space where exposed thermal insulation is located. See Rain Test, Section 30.

Exception: A cap is not required to be provided, when a cap is commercially available that:

- a) Has been found to comply with the Rain Test, Section 30, and with the requirements for the material from which the cap is formed, see 6.5; and*
- b) The use of such cap is specified in the installation instructions or training manual.*

7.2 A cap shall be constructed so that leaves and debris fallen or blown onto it are not retained so as to obstruct flue-gas or cooling-air passages. A cap shall be constructed to resist the accumulation of soot that obstructs the flue-gas or cooling-air passages.

7.3 A cap shall be removable and replaceable by the use of simple hand tools (screwdriver, wrench, or pliers) to allow for chimney cleaning in accordance with the installation and maintenance instructions without bending or deforming the chimney liner, or parts thereof.

8 Chimney Top Covers

8.1 A metallic or nonmetallic cover to close off the top of the chimney space not occupied by the chimney liner shall be provided by the manufacturer.

Exception: A field constructed assembly shall not be used unless the installation instructions or training manual clearly specify the materials to be used and methods of fabrication and installation of the assembly.

8.2 A chimney top cover/cap assembly shall resist the entrance of debris and rain into the masonry chimney and lining system. See Rain Test, Section 30.

9 Joints

9.1 Parts of a chimney liner shall be joined and secured so that they do not disengage when tested in accordance with these requirements.

9.2 Screws, rivets, or similar fasteners used to join chimney liner parts together shall be used in such a manner as to not impose stresses on the assembly, when tested in accordance with these requirements (see 13.2 and 13.3). Screws shall not be used to secure chimney liner flue passage sections together. The following considerations apply when rivets are used to secure chimney liner flue passage sections together:

- a) At least three rivets shall be employed at each joint between liner sections.
- b) The rivets shall have corrosion resistance at least equivalent to that of the chimney liner material.
- c) The proper type and number of rivets shall be supplied with the chimney liner.
- d) Holes for the rivets shall be prepunched or predrilled in at least the outer portion of each chimney liner section. Holes in chimney liner sections that are predrilled or prepunched at the factory to accept rivets in field installation shall be sized to accept the specified rivet size (allowing standard rivet hole tolerances). Chimney liner sections that are predrilled or prepunched in both inner and outer sections shall be aligned at the factory to provide for correct field installation.
- e) The chimney liner sections shall have inherent means to prevent telescoping that rely on other than the fastening means.
- f) The chimney liner shall incorporate means to permit expansion (pipe length growth).

9.3 When screws are employed to join assemblies during installation, the assemblies to be joined shall provide for use of screws without being punched or drilled, except as referenced in 6.1. When cement is employed for this purpose, the cement shall be a quick-setting type. Cement, screws, and instructions shall be furnished. A screw shall not extend into a flue-gas passage.

9.4 A joint shall not retain condensation nor permit condensation to flow from the interior to the exterior of the flue-gas conveying conduit.

9.5 A joint between sections of flue-gas conduit, fabricated in accordance with the manufacturer's instructions, shall not permit passage of a 1/32-inch (0.81-mm) diameter rod.

9.6 A joint or section of a chimney liner shall not reduce the capacity of the chimney liner to the extent that it interferes with venting.

9.7 A chimney liner joint that is exposed to the outside shall be provided with means to direct the flow of rain or moisture to the exterior of chimney liner sections.

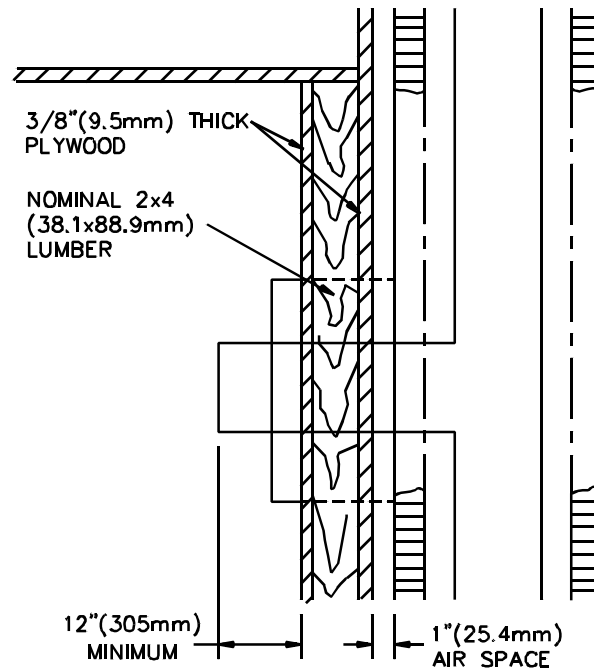
10 Wall Penetration Assemblies

10.1 A wall penetration assembly shall be provided with the chimney liner to comply with maximum temperature limits specified in these requirements. The assembly shall be constructed so as to fit within the framed stud opening around the entrance to the chimney as specified in the installation instructions or training manual, and be provided with means to retain the assembly in contact with the chimney. The horizontal dimension of the installed assembly, referenced to the masonry chimney surface, shall project into the room not less than 12 inches (305 mm), as measured from the innermost wall surface. See Figure 10.1. Separate parts shall be supplied to accommodate thicker walls. The construction shall not void firestopping provided for a concealed space when installed in accordance with the manufacturer's installation instructions or training manual.

Exception No. 1: A wall penetration assembly is not required when the installation instructions or training manual and maintenance instructions require the use of an assembly and illustrate the minimum clearances required for wall penetration assemblies specified in the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, NFPA 211-1988.

Exception No. 2: A wall penetration assembly is not required to be provided by the manufacturer when the installation instructions or training manual and maintenance instructions require the use of a wall penetration assembly that is in accordance with the construction, material, and test requirements for the assembly specified in these requirements.

Figure 10.1
Wall penetration assembly



S3227A

11 Radiation Shields

11.1 A radiation shield provided as part of a wall penetration assembly to comply with the maximum temperature limits for wall penetration assemblies specified in these requirements shall:

- a) Be an integral part of the tee section or wall penetration assembly; and
- b) Provide a continuous barrier for a horizontal distance, referenced to the surface of the masonry chimney, of not less than 12 inches (305 mm).

The assembly shall fit into a framed stud opening specified in the installation instructions or training manual.

12 Tee Sections and Support Assemblies for Metallic Chimney Liners

12.1 A tee section or support assembly shall be constructed to have the strength, rigidity and durability to resist damage during installation and use. See Vertical Support Test for Metallic Chimney Liners, Section 20.

PERFORMANCE

13 General

13.1 When a chimney liner is tested in accordance with these requirements, temperatures on the chimney liner parts (including on a wall penetration assembly), on combustible construction enclosing the masonry chimney, and on combustible construction adjacent to the chimney connector shall be maintained within the limits specified.

13.2 After being subjected to the tests specified in Sections 16 – 18C, as applicable, a product shall be capable of being further used. The chimney and chimney liner shall be free of cracks, distortion, or other damage. The chimney and chimney liner are to be visually inspected (including the use of a video camera, if necessary) to determine that damage has not occurred.

Revised 13.2 effective August 20, 1999

13.3 Test results indicating compliance with the requirements in 13.2 include the following:

- a) No part of the product has become damaged or permanently distorted to an extent that it or the masonry chimney will not continue to function as intended.
- b) Joints in liner sections, and between adjacent liner sections that are intended to be joined together, have not opened.
- c) The effectiveness of any required protective coating or finish on metal parts has not been reduced.
- d) A cementitious or ceramic material has not cracked in a manner allowing portions of the liner to become dislodged by poking the liner with a sharp instrument or by the process of cleaning the chimney to the extent that the serviceability of the chimney liner is impaired. (See Torsion Test for Flexible Metal Liners, Section 26, and Sweep Test, Section 23.)
- e) Cracks are not observable in porcelain enamel used as a required protective coating when the surface is examined under a microscope of 60 magnification.

- f) The reflectivity of a surface has not been impaired if the reflectivity is utilized to reduce the risk of fire.
- g) Burning or scaling of metal parts is not evident upon visual observation.

Exception: Scaling of the chimney liner flue material that does not impair the function of the chimney liner is acceptable after exposure to the Temperature Tests, Sections 18 – 18C.

- h) The effectiveness of insulating material has not been reduced.
- i) Bricks used in the test assembly shall not have loosened due to expansion of the test assembly to a degree that diminishes the overall structural integrity of the chimney.

Revised 13.3 effective August 20, 1999

13.4 Thermal insulation shall comply with the following:

- a) Insulating material shall remain in its intended position prior to, during, and following tests on the chimney liner.
- b) Products resulting from the loosening, combustion or volatilization of any combustible binder shall not be discharged inside the building.

Exception: Wall penetration assembly insulating materials are not required to be discharged to the terminus outside the building.

- c) The thermal conductivity of the insulating material shall not be increased.
- d) The thermal insulation shall not show evidence of softening, melting, disintegrating, losing binder, or other malfunction or deterioration.

14 Test Installation

14.1 The following factors are to form the basis of the performance tests of a product:

- a) Size and type (rigid, flexible metallic, nonmetallic) of chimney liner.
- b) Minimum distance (filled or unfilled) between chimney liner and masonry chimney.
- c) Height in feet (m) of chimney to be lined.
- d) Use of offsets in the lining.
- e) Use of air movement to cool the assembly.

14.2 A chimney liner incorporating insulating material is to be tested with representative samples of the insulating materials used in production. For these purposes, the particle size, densities, mixing proportions of the ingredients, and chemical and physical properties of the ingredients are to be verified prior to installation of the insulating material into the test assembly.

14.3 A chimney liner incorporating water in a cementitious mixture is to be cured for not less than 20 days after the chimney liner is installed, prior to conducting the temperature tests.

14.4 The chimney liner is to be installed in a test chimney at the minimum clearance space between the liner and masonry chimney as specified in the installation instructions or training manual.

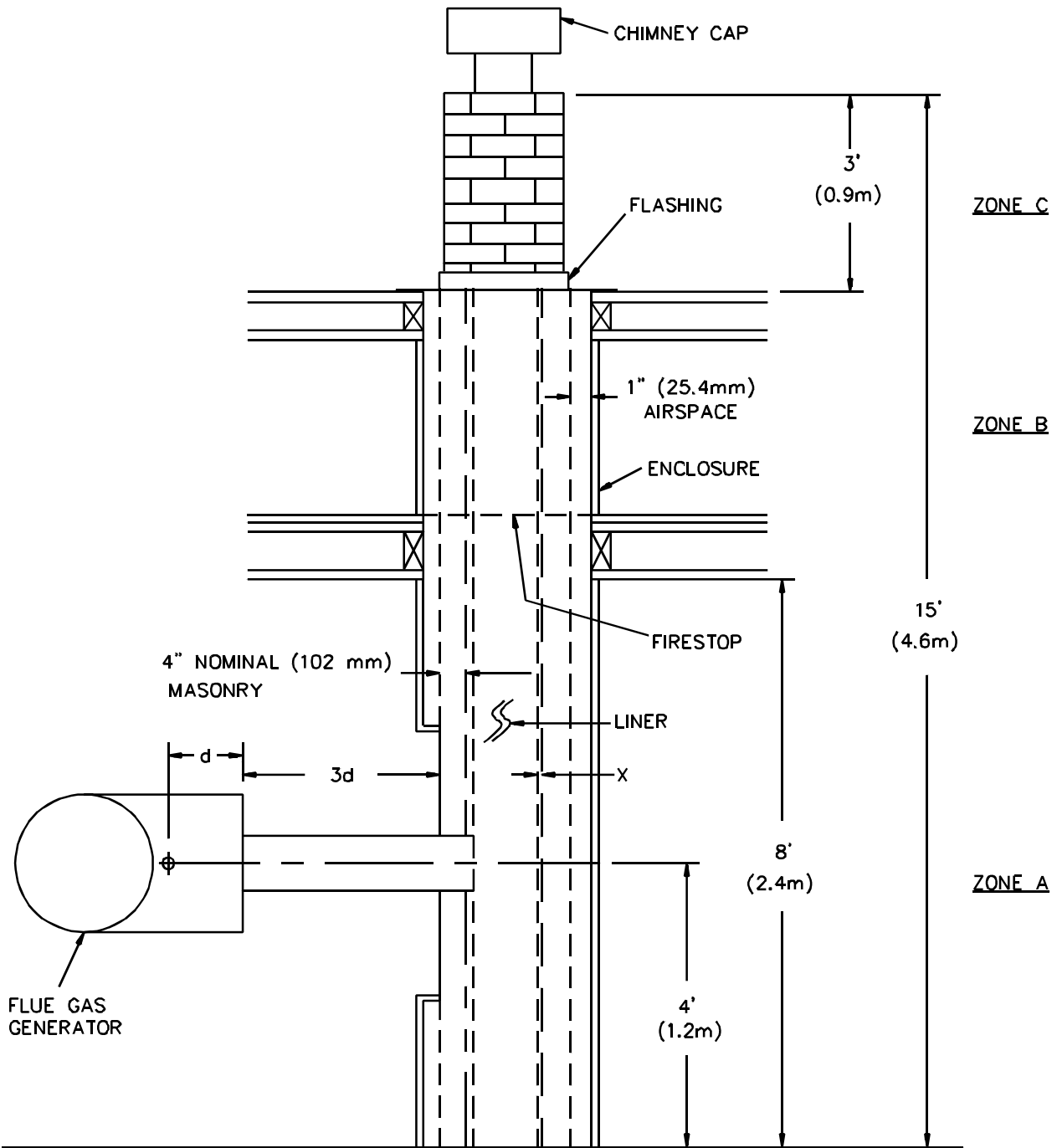
14.5 The test chimney is to be constructed of nominal 2-1/4 by 3-1/2 by 8 inches (57 by 89 by 203 mm) solid clay brick, arranged in a square shape (for round and square-shaped liners) or a rectangular shape (for oval or rectangular liners). The inside dimensions of the test chimney are to be those required to obtain the minimum clearances specified in the installation instructions between the chimney liner and the chimney. The chimney mortar is to be made of portland cement and sand, with vertical and horizontal joints $3/8 \pm 1/8$ inch (9.5 ± 3.2 mm) thick. Mortar lines are to be flush with the inside and outside surfaces of the brick. The height of the chimney is to be at least 15 feet (4.6 m). When the design indicates that in one or more tests higher temperatures are developed with an increased height, tests are to be conducted with the height producing the highest temperature condition, and not employing a height greater than the maximum specified by the manufacturer. See Figures 14.1 and 14.2.

14.6 When the chimney liner is not provided with spacers or insulation to locate the liner centrally within the chimney (see 6.8), temperature tests are to be additionally conducted with the chimney liner offset in one corner of the masonry chimney such that the flue liner is tangential to two of the inside walls of the test chimney.

14.7 Chimney liners are to be tested using an 8-inch (203-mm) diameter size. When smaller sizes are produced and utilize less clearance space between the liner and masonry than the 8-inch (203-mm) diameter liner, tests are to be conducted on as many sizes as required to determine compliance with these requirements. If sizes larger than 8-inch (203-mm) diameters are produced, tests are to be conducted using the size and clearance space expected to produce the highest temperature rise. If an 8-inch (203-mm) diameter size chimney liner is not produced, tests are to be conducted on the size produced that is closest to 8 inches (203-mm), and with additional tests for smaller and larger sizes conducted on the basis described above.

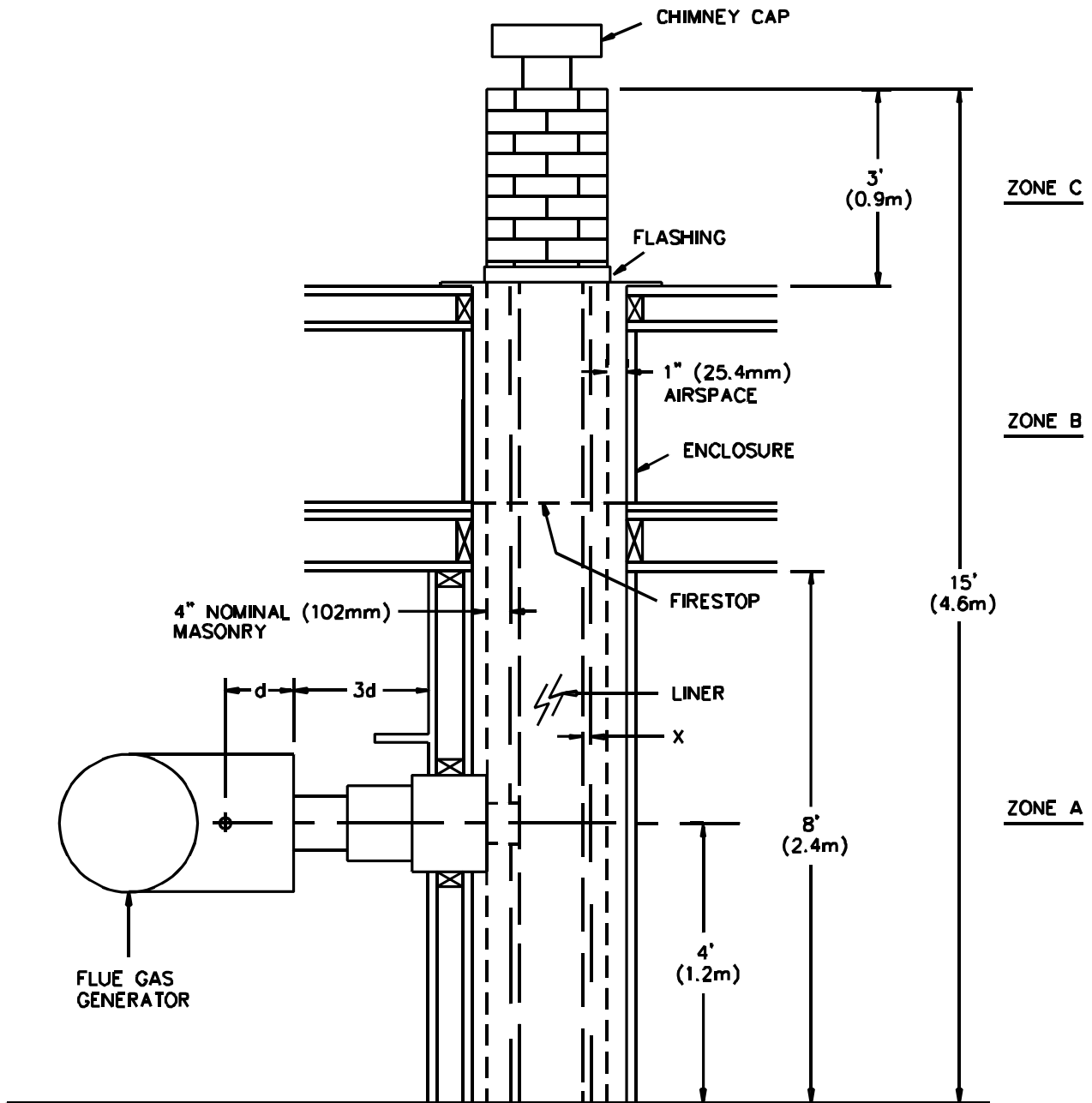
14.8 The test structure is to be erected within a room having ventilation capable of maintaining the buildup of carbon monoxide to less than 50 parts per million throughout the period of any tests. The room is to be free of extraneous drafts and the chimney and liner are to exhaust into the same space or into a space freely communicating with the space from which the combustion air is taken. The room is to be such that during any one test the room temperature does not increase by more than 20 °F (11 °C) above the room temperature recorded at the beginning of the test.

Figure 14.1
Test chimney without wall penetration assembly



S3228A

Figure 14.2
Test chimney with wall penetration assembly



S3306

Figure 14.2 revised August 20, 1998

14.9 When a chimney liner provides for taking air from an occupied space and exhausting such air to the outside of a building to cool the chimney liner, all the openings in the parts as assembled intended to provide such air flow and which would be within an occupied space of the building are to be sealed closed during the tests.

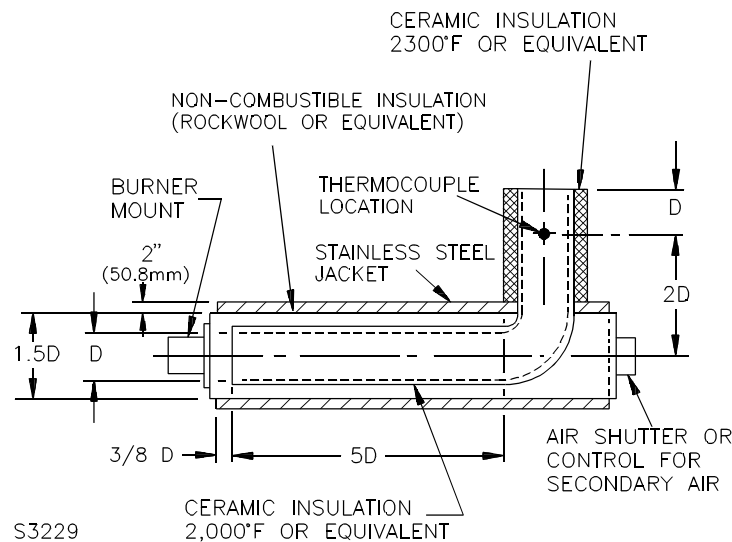
14.10 A test chimney liner is to consist of an assembly composed of standard chimney liner sections or materials and other required parts to complete the installations specified in the manufacturer's installation instructions or training manual. When joining parts are used, the test assembly is to include such parts. A chimney cap is to be used, even when not provided by the manufacturer.

14.11 A wall penetration assembly, if supplied with the product, is to be installed in accordance with the installation instructions. If a wall penetration assembly is not provided with the product, the type of assembly specified in the installation instructions or training manual is to be installed. If a wall penetration assembly is not available, for test purposes only, tests are to be conducted using the clearances to combustible wall framing specified in the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, NFPA 211-1988.

14.12 A gas-fired flue-gas generator as illustrated in Figure 14.3 is to be used to supply flue gases to the chimney liner being tested. The generator is to produce the flue gases at the specified test temperatures when fired at the test input specified in Table 14.1 for solid-fuel-fired appliances, Table 14.2 for oil-fired appliances, and Table 14.3 for gas-fired appliances.

Revised 14.12 effective August 20, 1999

Figure 14.3
Flue-gas generator



**Table 14.1
Flue-gas generator inputs (for solid-fuel-fired appliances)**

Equivalent nominal diameter of chimney liner		Minimum input to flue-gas generator Btu per hour (kW)					
Inches	(mm)	Column 1		Column 2		Column 3	
		Temperature test for solid-fuel-fired appliances – 1000°F (538°C) flue gases, Section 16		Temperature test for solid-fuel-fired appliances – 1400°F (760°C) flue gases, Section 17		Temperature test for solid-fuel-fired appliances – 2100°F (1125°C) flue gases, Section 18	
6	(150)	48,500	(14.2)	59,200	(17.4)	175,000	(51.2)
7	(180)	65,800	(19.3)	80,500	(23.6)	237,000	(69.4)
8	(200)	86,200	(25.3)	106,000	(31.1)	310,000	(91.0)
9	(230)	109,000	(31.9)	133,000	(39.0)	392,000	(115.0)
10	(250)	135,000	(39.6)	165,000	(48.4)	486,000	(142.4)
12	(300)	195,000	(57.2)	238,000	(69.8)	699,000	(205.0)

Revised Table 14.1 effective August 20, 1999

**Table 14.2
Flue-gas generator inputs (for oil-fired appliances)**

Equivalent nominal diameter of chimney liner		Minimum input to flue-gas generator			
Inches	(mm)	Column 1		Column 2	
		btu/hr	(kW)	btu/hr	(kW)
		Temperature test for oil-fired appliances – 570°F (299°C) flue gases, Section 18A		Temperature test for oil-fired appliances – 1700°F (927°C) flue gases, Section 18B	
3	(75)	15,400	(4.51)	28,500	(8.35)
4	(100)	27,500	(8.06)	43,100	(12.63)
5	(125)	43,000	(12.60)	67,500	(19.78)
6	(150)	61,600	(18.05)	97,000	(28.42)
7	(180)	84,000	(24.60)	132,500	(38.80)
8	(200)	109,600	(32.10)	172,800	(50.60)

Added Table 14.2 effective August 20, 1999

Table 14.3
Flue-gas generator inputs (for Category I gas-fired appliances)

Equivalent nominal diameter of chimney liner		Input to flue-gas generator	
Inches	(mm)	Btu per hour	(kW)
		Temperature test for category I gas-fired appliances – 470°F (243°C) flue gases, Section 18C	
3	(75)	6,350	(1.86)
4	(100)	11,300	(3.31)
5	(125)	17,600	(5.16)
6	(150)	25,300	(7.41)
7	(180)	34,500	(10.11)
8	(200)	45,200	(13.24)
9	(230)	57,100	(16.73)
10	(250)	70,500	(20.66)
12	(300)	101,000	(29.59)

Added Table 14.3 effective August 20, 1999

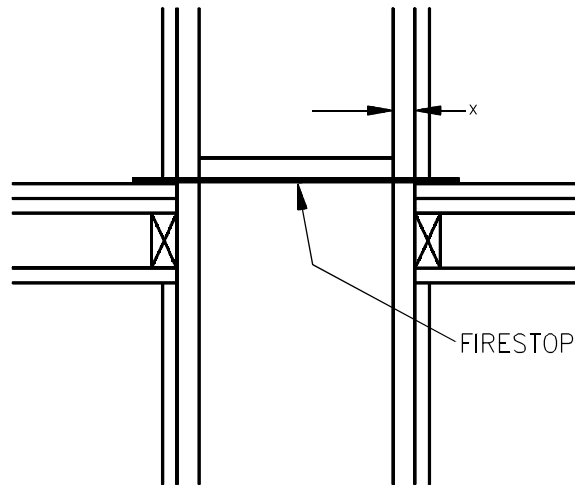
14.13 A premix type burner assembly^a, capable of supplying an air-gas mixture, with not less than 70 percent primary combustion air (70 percent of premixed theoretical air), to a flame retention burner nozzle tip is to be used. Combustion is to be complete within the horizontal straight length of the flue-gas generator combustion chamber. The insulation flue-gas generator outlet is to be connected to the inlet of the test chimney by means of a stainless steel pipe having a diameter equivalent to that of the chimney inlet. The connection is to be made so as to provide an uninsulated flue-gas passage length equivalent to three chimney liner diameters along the pipe centerline from the generator outlet to the point of entry into the chimney.

Exception: A burner assembly other than a premix type shall not be used unless the assembly is designed for and operated to supply the gas and air in a stoichiometric mixture to the flue gas generator.

^a An Eclipse brand is capable of being used for this purpose.

14.14 The chimney into which the chimney liner is inserted is to be fully enclosed on all sides for its full height from the floor of the test structure to the ceiling, and from the attic floor to the bottom of the roof structure with 3/8-inch (9.5-mm) thick plywood and is to be closed at the attic level by a firestop, and at the roof level by a roof flashing. The chimney enclosure material is to be placed around the chimney on the basis of clearance from the enclosure of 0 or 1 inch (0 or 25 mm) as specified by the manufacturer's installation instructions, as measured between the outer surface of the masonry chimney wall and the interior surfaces of the enclosing material. These clearances are designated by the dimensions "X" in Figures 14.4 and 14.5. The dimension "X" is to be 1 inch (25 mm) on all four sides, or 0 inch on all four sides.

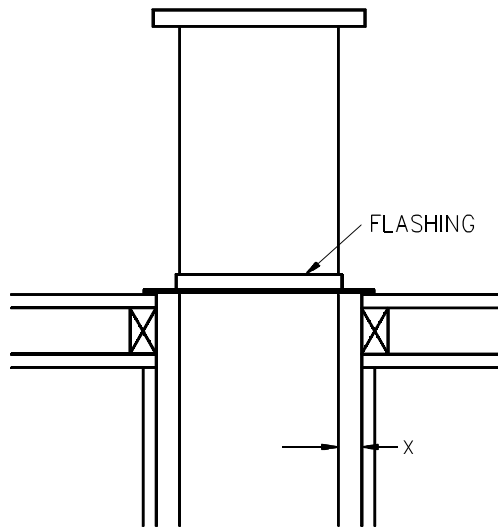
Figure 14.4
Test chimney ceiling firestop



X = 0 or 1 inch (0 or 25.4 mm),
as specified in installation instructions

S3230B

Figure 14.5
Test chimney roof flashing



X = 0 or 1 inch (0 or 25.4mm),
as specified in installation instructions

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14.15 The test enclosure material at the ceiling joist level is to be of trade size 2 by 10 or 8 inches [nominal 1-1/2 by 9-1/4 or 7-1/4 inches (38.1 by 235 or 184 mm)] lumber, forming a box at 1 inch (25 mm) clearance to the chimney. The test enclosure at the roof-joist level is to be of trade size 2 by 6 inches [nominal 1-1/2 by 5-1/2 inches (38.1 by 140 mm)] lumber forming a box at 1 inch (25 mm) clearance to the chimney. See Figures 14.4 and 14.5. All ceiling, floor, and roof material is to be cut flush with the inside of all framed joist openings.

14.16 The ceiling is to consist of one thickness of 3/4-inch (19.1-mm) thick plywood. Plywood at the top of the attic joist is to consist of two layers of plywood, each 3/4-inch (19.1 mm) thick. One layer of 3/4-inch (19.1 mm) thick plywood is to be placed on either side of the roof joist. The plywood at these levels is to extend around the chimney enclosure at least 2 feet (0.61 m) in each direction, measured from the chimney enclosure surface. See Figures 14.1 and 14.2.

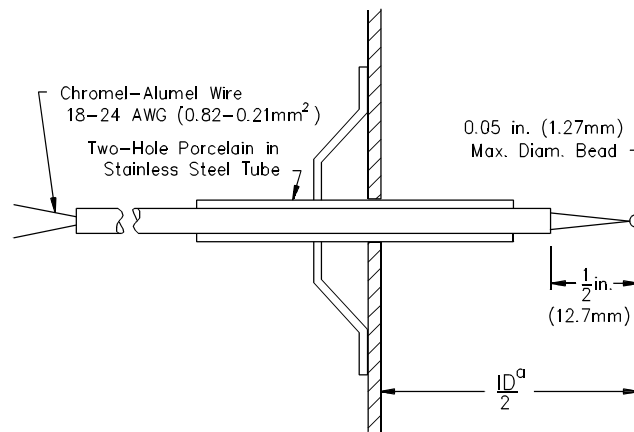
14.17 All wall and ceiling surfaces at the inlet to the chimney, all studs, joists, and headers used, and all plywood surfaces are to be painted flat black on the side facing the test assembly.

14.18 All joints and openings between spacers or supports and the test enclosure, all joints in a test enclosure, and all joints intended to be sealed for field installation are to be sealed with plastic-coated or film-faced pressure-sensitive tape lapping the joint by a minimum of 1 inch (25 mm) on each side. The peel adhesion characteristics of the tape on fibrous (wood) combustible enclosure materials shall comply with the Test Method for Adhesion of Pressure - Sensitive Tape to Fiberboard at 90 Degree Angle and Constant Stress, ANSI/ASTM D2860-83, at elevated temperatures of 150 °F (66 °C).

15 Temperature Measurement

15.1 Flue-gas temperatures are to be determined for the tests in Sections 16 – 18 by a thermocouple, such as illustrated by Figure 15. 1. The thermocouple is to be located within the insulated outlet of the flue-gas generator as illustrated in Figure 14.3. The thermocouple is to be Type K (chromel-alumel) of No. 18 – 24 AWG (0.82 – 0.21 mm²) wire with an untwisted welded bare bead junction not more than 0.050 inch (1.27 mm) diameter.

Figure 15.1
Flue-gas thermocouple and support bracket



^aID = Internal Diameter of Flue Pipe

S2255

Figure 15.1 revised August 20, 1998

15.2 The flue-gas thermocouple is to be inserted at the center of the insulated generator outlet using the entry tube parallel to the long generator axis.

15.3 The gas burner then is to be operated as specified in the Temperature Tests, Sections 16 – 18C, and the dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple described in 15.2 is as specified for the individual tests by using the flue-gas generator input specified in Tables 14.1, 14.2, or 14.3 for the size of the liner being tested.

15.4 revised and combined with 15.3 effective August 20, 1999

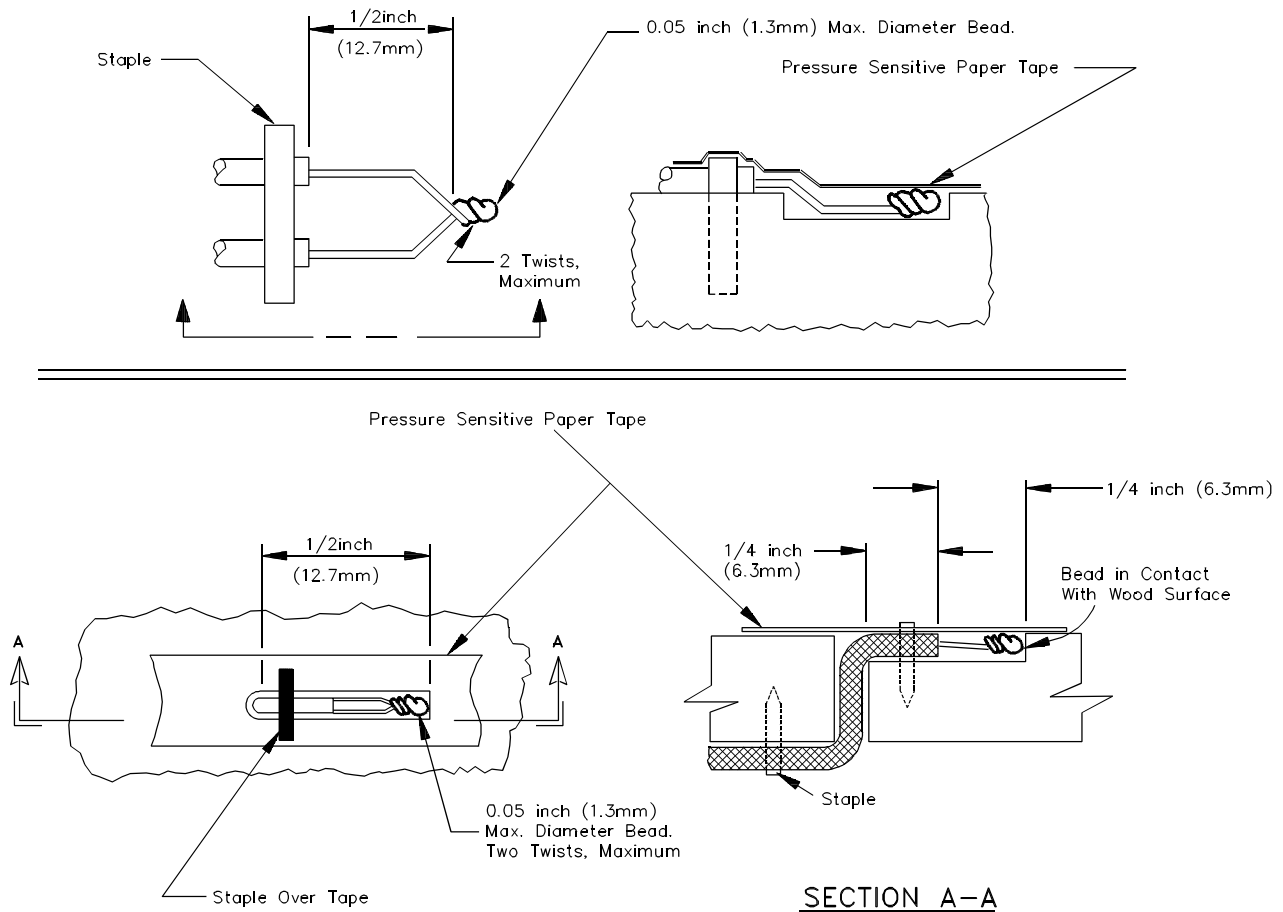
15.4 **Revised and combined with 15.3 effective August 20, 1999**

15.5 Temperatures, other than those of flue-gases and metal surfaces, are to be measured using either Type K (chromel-alumel) or Type J (iron-constantan) thermocouples not larger than No. 24 AWG (0.21 mm²). Thermocouples are to be:

- a) Attached to test enclosure elements having a surface adjacent to the chimney and onto roof areas adjacent to the chimney so as to have 1/2 inch (12.7 mm) of wire exposed; and
- b) Secured to wood surfaces by staples placed over the insulated portion of the wires.

The thermocouple insulation and tip are to be depressed for a length of 1/2 inch (12.7 mm) into the wood so as to be flush with the wood surface at the point of measurement and held in thermal contact with the surface at that point by the use of flat black pressure-sensitive paper tape. See Figure 15.2.

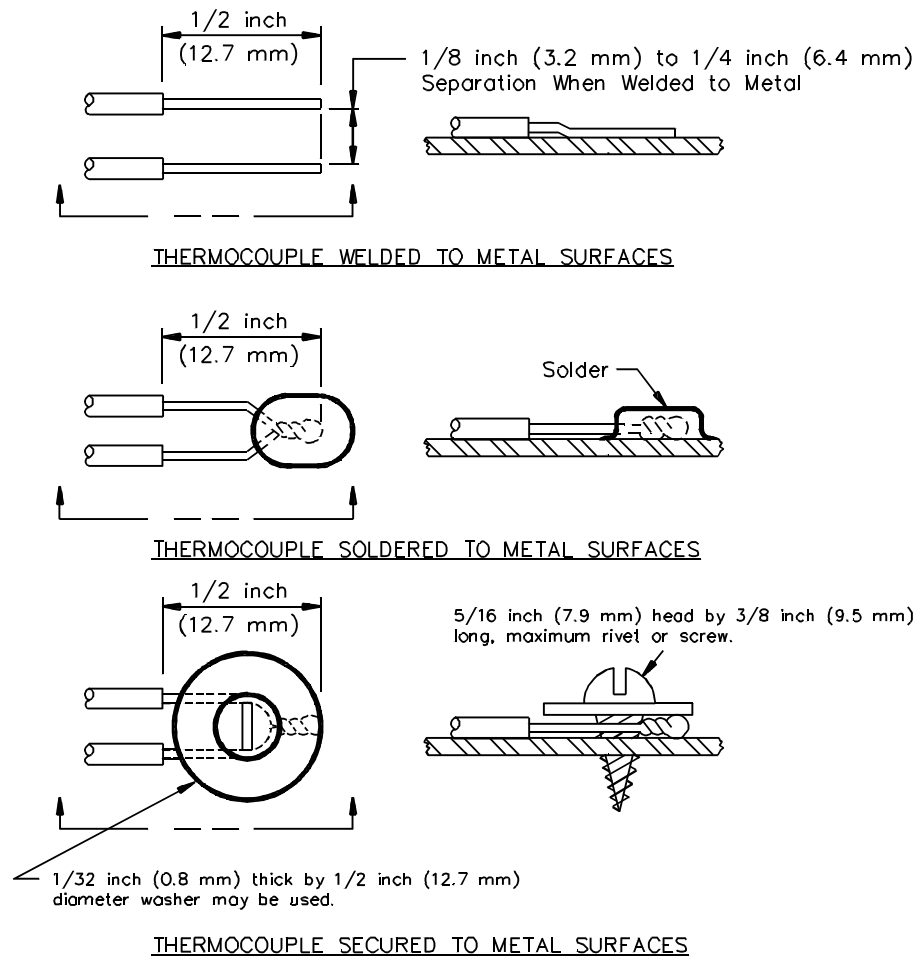
Figure 15.2
Thermocouple installation methods on wood surfaces



S2256

15.6 Temperatures attained by surfaces of parts of the chimney liner are to be obtained by means of thermocouples applied to the parts. Thermocouples are to be attached to metal surfaces by screws, rivets, silver soldering, brazing, or welding of the tip to the metal surface. See Figure 15.3. Thermocouples to be attached to surfaces of nonmetallic or nonwood parts are to have junctions and at least 1 inch (25 mm) of the lead wires imbedded flush with the surface of the material. Furnace cement is to be smoothed over such indentations to maintain thermal contact. Such thermocouples are to be located at points attaining maximum temperatures. Additional thermocouples are to be placed at other locations that are in contact with or subject to radiation from surfaces of the chimney.

Figure 15.3
Thermocouple installation methods on metal surfaces



S2257

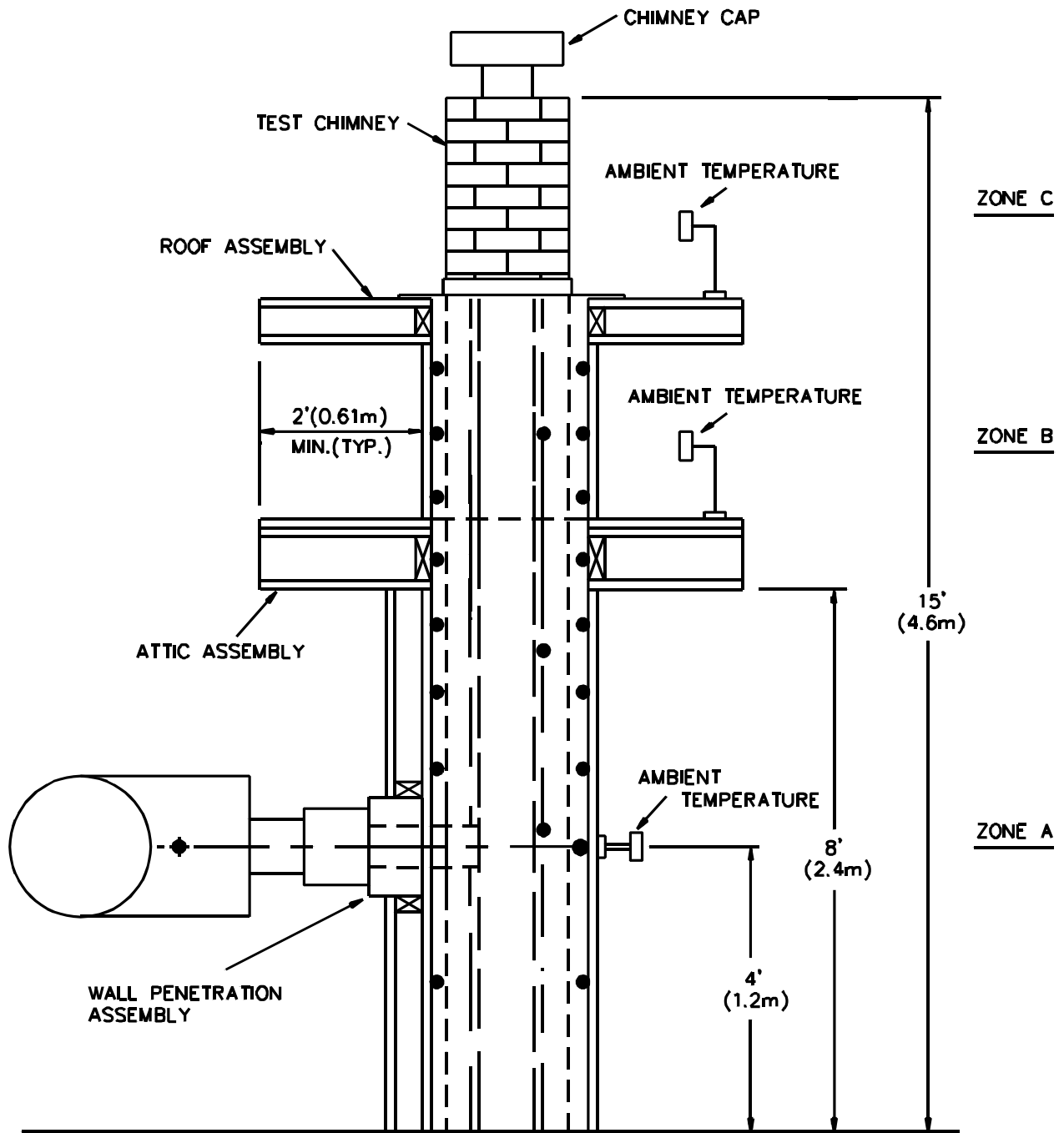
15.7 Ambient temperatures of a zone are to be determined by a shielded thermocouple located centrally within a vertically oriented 6-inch (152-mm) length of aluminum-painted 2-inch steel pipe open at both ends. Ambient temperatures are to be determined by shielded thermocouples located with reference to the various parts of the chimney, test structure, and flue-gas generator; and by placing the shield in a manner to avoid direct radiation to the thermocouple.

15.8 The ambient temperature in Zone A illustrated in Figure 15.4 is to be determined by a thermocouple located 4 feet (1.2 m) above the floor and 6 inches (152 mm) away from the plywood enclosure that is opposite the flue-gas generator.

15.9 The ambient temperature in Zone B illustrated in Figure 15.4 is to be determined by a thermocouple located 2 feet (610 mm) away from the back centerline of the test enclosure and 1 foot (305 mm) above the attic floor.

15.10 The ambient temperature in Zone C illustrated in Figure 15.4 is to be determined by a thermocouple located 2 feet (610 mm) away from the back centerline of the chimney and 1 foot (305 mm) above the roof.

Figure 15.4
Typical thermocouple locations – test chimney



S3232A

15.11 For purposes of determining temperature rises on chimney liner parts, on an enclosure, and on the test structure, the temperatures are to be referenced to ambient temperatures as determined in 15.1 – 15.10. Temperatures of joists and rafters are to be referenced to the average of the ambient temperatures above and below the joist or rafter area. Temperatures of floor or roof materials are to be referenced to the ambient temperatures above the floor or roof. Temperatures of ceiling material are to be referenced to the ambient temperature below the ceiling.

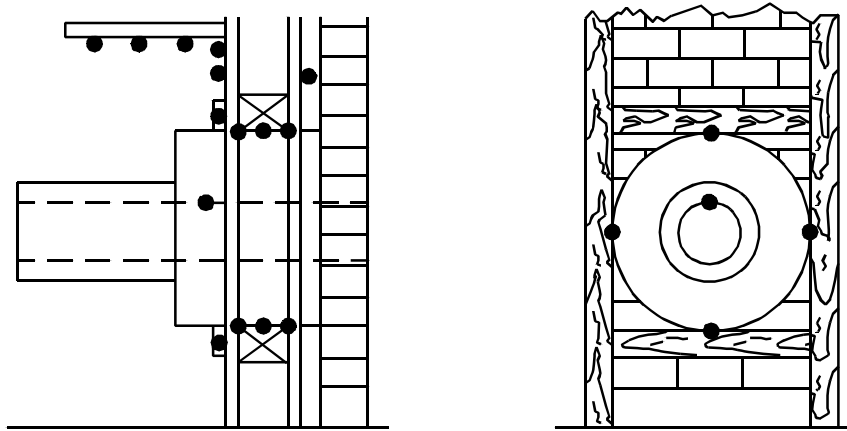
15.12 During the Temperature Tests, Sections 16 – 18C, the temperature rises are to be based on the ambient or room temperature recorded at the end of the firing period prescribed for the test.

Revised 15.12 effective August 20, 1999

15.13 For a chimney liner designed to take air from the outside of a building to cool the chimney liner, the ambient temperature of the space into which the chimney exhausts is to be measured by a thermocouple located on the same horizontal plane as the opening provided for the admission of outside air, 3 feet (0.9 m) from the opening. The temperature is to be maintained between 70 and 90 °F (21 and 32 °C) during all tests for temperature.

15.14 A minimum number of typical thermocouple locations on wood surfaces and chimney liner materials is shown in Figures 15.4 and 15.5. Additional thermocouples are to be used when required because of the construction and method of installation.

Figure 15.5
Typical thermocouple locations – wall penetration assembly



S3233A

Figure 15.5 revised August 20, 1998

15.15 During all temperature tests, maximum temperatures are attained when three successive readings taken at 30-minute intervals show no change or show a decrease.

16 Temperature Test for Solid-Fuel-Fired Appliances – 1000°F (538°C) Flue Gases

16.1 The maximum temperatures on surfaces of the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of chimney liner parts, including wall penetration parts, at points of zero clearance to the test structure, shall not be more than 90 °F (50°C) above ambient temperature during the period ending 4-1/2 hours after the start of the test and not more than 117 °F (65°C) above room temperature for any subsequent period when the flue-gas temperature is maintained as described in 16.3. The temperature on any part shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 16.1.

**Table 16.1
Maximum temperature rises**

Material	Maximum rise above room temperature			
	Column 1		Column 2	
	°F	°C	°F	°C
1. Aluminum alloys –				
1100 (2S)	330	183	430	239
3003 (3S)	430	239	530	294
2014, 2017, 2024, 5052	530	294	630	350
2. Aluminum-coated steel, heat-resistant type ^a	1030	572	1275	708
3. Carbon steel-coated with Type A19 ceramic	1030	572	1130	628
4. Galvanized steel ^b	480	267	630	350
5. Low-carbon steel, cast iron ^c	830	461	930	517
6. Stainless steel –				
Types 302, 303, 304, 321, 347	1235	686	1380	767
Type 316	1200	667	1345	748
Type 309S	1560	867	1705	950
Types 310, 310B	1610	894	1755	975
Type 430	1310	728	1455	808
Type 446	1730	961	1875	1042
^a If the reflectivity of aluminum-coated steel is utilized to reduce the risk of fire, the maximum temperature rise shall not be more than 830 °F (461 °C). ^b The specified maximum temperature rise shall apply if the galvanizing is required as a protective coating or if the reflectivity of the surface is utilized to reduce the risk of fire. ^c The specified maximum temperature rises apply to parts whose malfunction may cause the product to be unacceptable for use.				

16.2 The temperature of the flue gases entering the test chimney is to be regulated by varying the quantity of primary and secondary air induced into the generator when the flue-gas generator is fired at the specified input. Combustion is to be complete within the combustion chamber of the flue-gas generator.

16.3 The test is to be started with the test chimney liner (including the wall penetration assembly), chimney, and the test structure at room temperature. The flue-gas generator then is to be fired at the input specified in Column 1 of Table 14.1, and regulated to produce flue gases at a temperature of 1000 °F (555°C) at the thermocouple location designated in Figure 14.3. Temperatures at all points of measurement are to be recorded at intervals not exceeding 30 minutes until it is apparent that maximum temperatures have been attained, or for 8 hours, whichever occurs first.

Revised 16.3 effective August 20, 1999

17 Temperature Test for Solid-Fuel-Fired Appliances – 1400°F (760°C) Flue Gases

17.1 The maximum temperature attained on surfaces of the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of the chimney liner assembly (including the wall penetration assembly) at points of zero clearance to the test structure, shall be not more than 140 °F (78°C) above ambient temperature when the flue-gas temperature is maintained for 1 hour as described in 17.2. The temperature on any part of the chimney liner (including the wall penetration assembly) shall not exceed the maximum temperature specified for the materials used. See Column 2 of Table 16.1.

17.2 After maximum temperatures are attained under the test conditions described in 16.3, the flue-gas generator is to be fired at the input specified in Column 2 of Table 14.1, and regulated to produce flue gases at a temperature of 1400°F (760°C) at the thermocouple location designated in Figure 14.3. The test duration is to be 60 minutes. Temperatures at all points of measurement are to be recorded at intervals not exceeding 10 minutes until it is apparent that maximum temperatures have been attained.

Revised 17.2 effective August 20, 1999

18 Temperature Test for Solid-Fuel-Fired Appliances – 2100°F (1149°C) Flue Gases

18.1 The maximum temperature attained on the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of the chimney liner assembly (including the wall penetration assembly) at points of zero clearance to the test structure, shall not be more than 175 °F (97°C) above ambient temperature when tested as described in 18.3 – 18.5 or after the flue-gas generator is shut off.

18.2 A chimney liner assembly shall comply with the requirements specified in 13.2 and 13.3 after being tested in accordance with 18.3 – 18.5.

18.3 The test is to be started with the test chimney liner assembly, chimney, and the test structure at room temperature.

18.4 The test conditions then are to be established at the inputs shown in Column 1 of Table 14.1, and maintained to produce flue gas at a temperature of 1000 °F (538°C) as measured by means of a flue-gas thermocouple as shown in Figure 15.1 and located centrally in the generator. The operation is to be continued until maximum temperatures are attained on surfaces of chimney parts and the test structure, or for 8 hours, whichever occurs first.

Revised 18.4 effective August 20, 1999

18.5 After maximum temperatures are attained under the test conditions described in 18.4, the input to the flue-gas generator is to be increased to that specified in Column 3 of Table 14.1 and regulated to produce a temperature of 2100°F (1149°C) at the thermocouple location designated in Figures 14.1 and 14.2. The test is to be continued for 10 minutes, exclusive of the time taken to reach the 2100 °F (1149°C) temperature (which is not to exceed 15 minutes). At the end of the test period the flue-gas generator is to be shut off. Temperatures are to be recorded at intervals not exceeding 2 minutes until maximum temperatures have been attained.

18.6 The test specified in 18.5 is to be conducted three times on chimney liners and once on wall penetration assemblies. The first test is to be conducted with the entire connector pipe uninsulated. The two remaining tests are to be conducted with the full length of the connector pipe insulated with a 3-inch (75-mm) thick layer of ceramic blanket insulation or equivalent insulation having a K factor of 1.7 at 2000 °F (1093 °C). The insulation is to be applied to the chimney connector prior to increasing the input to the flue-gas generator to produce the flue gas temperature rise of 2030 °F (1128 °C) above room temperature. The second and third flue gas temperature test exposures are to be conducted after a 60 minute cooling period following the end of the previous exposure.

18A Temperature Test for Oil-Fired Appliances – 570°F (299°C) Flue Gases

18A.1 The maximum temperatures on surfaces of the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of chimney liner parts, including wall penetration parts, at points of zero clearance to the test structure, shall not be more than 90 °F (50 °C) above ambient temperature during the period ending 4-1/2 hours after the start of the test and not more than 117 °F (65 °C) above room temperature for any subsequent period when the flue-gas temperature is maintained as described in 18A.3. The temperature on any part shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 16.1.

Added 18A.1 effective August 20, 1999

18A.2 The temperature of the flue gases entering the test chimney is to be regulated by varying the quantity of primary and secondary air induced into the generator when the flue-gas generator is fired at the specified input. Combustion is to be complete within the combustion chamber of the flue-gas generator.

Added 18A.2 effective August 20, 1999

18A.3 The test is to be started with the test chimney liner (including the wall penetration assembly), chimney, and the test structure at room temperature. The flue-gas generator then is to be fired at the input specified in Column 1 of Table 14.2, and regulated to produce flue gases at a temperature of 500 °F (278 °C) above room temperature at the thermocouple location designated in Figure 14.3. Temperatures at all points of measurement are to be recorded at intervals not exceeding 30 minutes until it is apparent that maximum temperatures have been attained, or for 8 hours, whichever occurs first.

Added 18A.3 effective August 20, 1999

18A.4 The flue-gas generator inputs specified in Table 14.2 are based on values derived from the nominal rated capacity of heating equipment likely to be connected to a venting system of a given size. The flue-gas generator inputs are consistent with the heat loss to the venting system by such heating appliances.

Added 18A.4 effective August 20, 1999

18B Temperature Test for Oil-Fired Appliances – 1700°F (927°C) Flue Gases

18B.1 The maximum temperature attained on the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of the chimney liner system at points of zero clearance to the test structure, shall be not more than 175 °F (97 °C) above ambient temperature when tested as described in 18B.2 or after the flue-gas generator is shut off.

Added 18B.1 effective August 20, 1999

18B.2 After equilibrium temperatures are attained under the test conditions described in the Temperature Test for Oil-Fired Appliances – 570 °F (299 °C) Flue Gases, Section 18A, the input to the flue-gas generator is to be increased to that specified in Column 2 of Table 14.2 and regulated to produce a temperature of 1630 °F (906 °C) above room temperature at the location designated in Figure 14.3 and the test continued for 10 minutes, at which time the burner is to be shut off.

Added 18B.2 effective August 20, 1999

18C Temperature Test for Category I Gas-Fired Appliances – 470°F (243°C) Flue Gases

18C.1 The maximum temperatures on surfaces of the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of chimney liner parts, including wall penetration parts, at points of zero clearance to the test structure, shall not be more than 90 °F (50 °C) above ambient temperature during the period ending 1-1/2 hours after the start of the test and not more than 117 °F (65 °C) above room temperature for any subsequent period when the flue-gas temperature is maintained as described in 18C.3. The temperature on any part shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 16.1.

Added 18C.1 effective August 20, 1999

18C.2 The temperature of the flue gases entering the test chimney liner is to be regulated by varying the quantity of primary and secondary air induced into the generator when the flue-gas generator is fired at the specified input. Combustion is to be complete within the combustion chamber of the flue-gas generator.

Added 18C.2 effective August 20, 1999

18C.3 The test is to be started with the test chimney liner (including the wall penetration assembly), chimney, and the test structure at room temperature. The flue-gas generator then is to be fired at the input specified in Table 14.3, and regulated to produce flue gases at a temperature of 470 °F (243 °C) above room ambient at the thermocouple location designated in Figure 14.3. Temperatures at all points of measurement are to be recorded at intervals not exceeding 30 minutes until it is apparent that maximum temperatures have been attained, or for 8 hours, whichever occurs first.

Added 18C.3 effective August 20, 1999

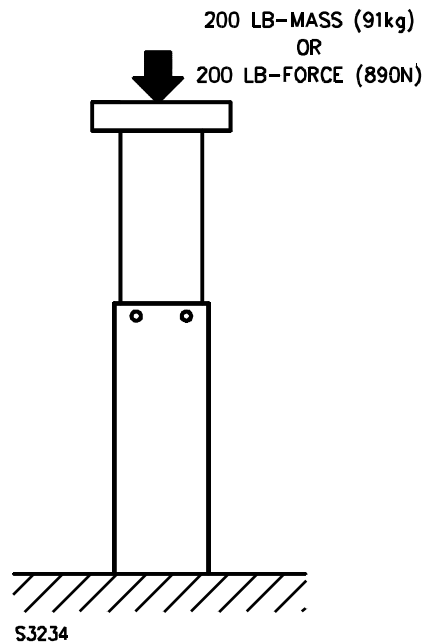
19 Loading Test for Metallic Chimney Liners

19.1 A metallic chimney liner section shall not be damaged when tested as described in 19.2 and 19.3. See 20.1 for additional loading requirements for metallic chimney liners.

19.2 Two sections of the chimney liner are to be assembled as described in the manufacturer's instructions except that fasteners, if used in the construction, are to be left out of the assembly.

19.3 The assembly is to be subjected to a load of 200 pounds-mass (91 kg) by means of a weight. See Figure 19.1. The load is to be applied for a minimum of 5 minutes.

Figure 19.1
Loading test

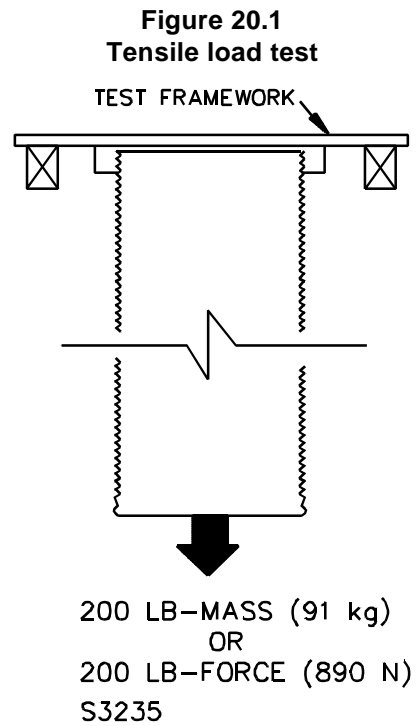


20 Vertical Support Test for Metallic Chimney Liners

20.1 A support assembly for a metallic chimney liner shall not be damaged, nor shall the security of its attachment to the chimney structure be impaired, when tested as described in 20.2 – 20.4. Additionally, a metallic chimney liner section shall not telescope into an adjoining section or be damaged when tested as described in 20.2 – 20.4.

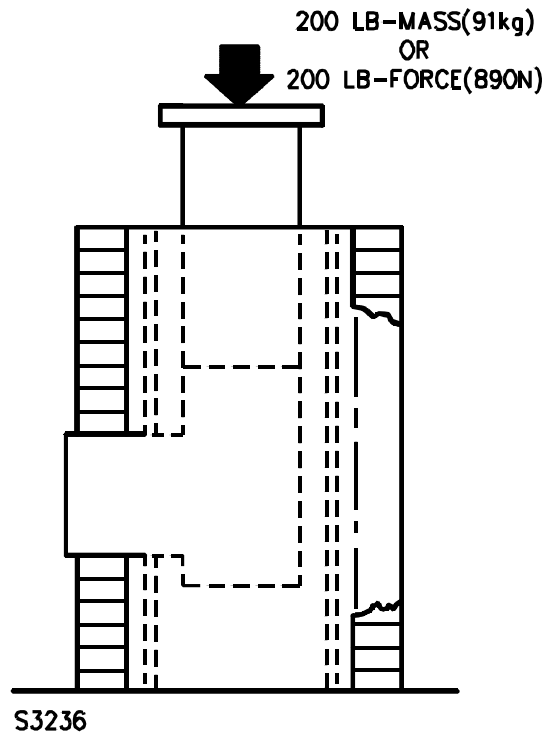
20.2 The support assembly is to be installed as described in the manufacturer's instructions in a test structure in a manner that simulates the installation that produces the greatest loading on the support assembly.

20.3 A support assembly that is subjected to tensile loading while in use, such as a cap mounted support, is to be loaded by means of a weight or tensile machine, whichever is convenient. The support assembly along with a section of the supported chimney liner is to be subjected to a load of 200 pounds-mass (91 kg) or 200 pounds-force (890 N) as illustrated in Figure 20.1. The load is to be applied for a minimum of 5 minutes.



20.4 A support assembly that is subjected to compressive loading while in use, such as a tee section, is to be loaded by means of a weight or tensile-compression machine, whichever is convenient. The assembly along with a section of the supported chimney liner is to be subjected to a load of 200 pounds-mass (91 kg) or 200 pounds-force (890 N) as illustrated in Figure 20.2. The load is to be applied for a minimum of 5 minutes.

Figure 20.2
Compressive load test

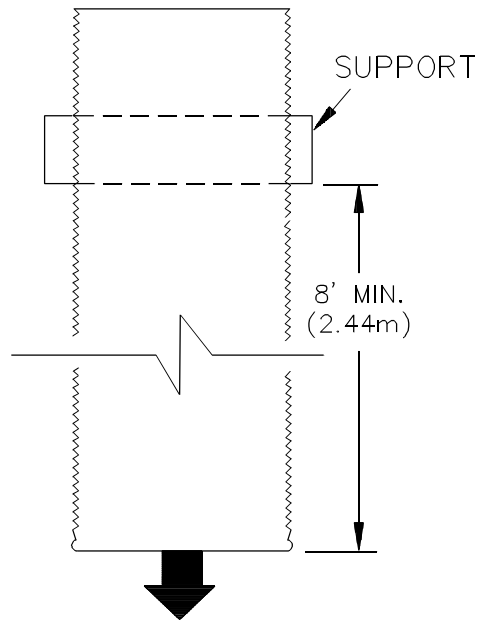


21 Strength Test for Metallic Chimney Liners

21.1 A chimney liner or its parts shall not break, split at a seam, disassemble, unlock, change shape, or become damaged to the extent that they are not capable of further use when subjected to a load of 200 pounds-mass (91 kg) applied as described in 21.2 and 21.3.

21.2 An 8-foot (2.44-m) long section of the chimney liner is to be secured in place in a test assembly such as illustrated in Figure 21.1. A weight of 200 pounds-mass (91 kg) is to be suspended from the bottom of the chimney liner section. The load is to be applied for a minimum of 5 minutes. When chimney liner sections are not produced in 8-foot lengths, then the standard length of chimney liner produced is to be used.

Figure 21.1
Strength test – single chimney liner section

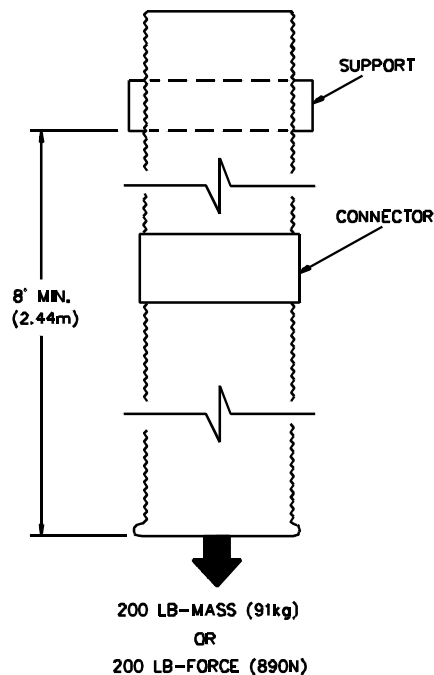


200 LB-MASS (91 kg)
OR
200 LB-FORCE (890 N)

S3237

21.3 Two sections of chimney liner sections are to be joined as specified in the installation instructions or training manual, with at least 8 feet (2.44 m) of liner suspended from the support. A weight of 200 pounds-mass (91 kg) is to be suspended from the bottom of the liner, as illustrated in Figure 21.2. The load is to be applied for a minimum of 5 minutes.

Figure 21.2
Strength test – joined chimney liner sections



S3238

22 Strength Test for Nonmetallic Chimney Liners

22.1 The compressive strength of a nonmetallic chimney liner, when tested in accordance with the Test Method for Compressive Strength of Lightweight Insulating Concrete, ASTM C495-86, shall:

- a) Be at least 500 psig (3.45 mPa); and
- b) Not crack or break at 500 psig.

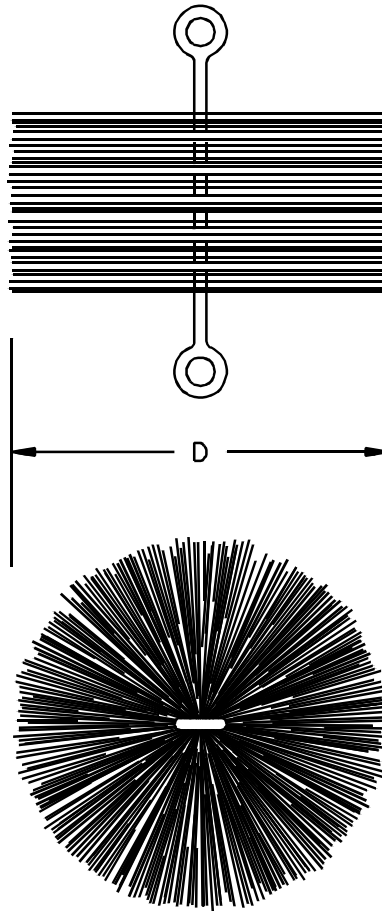
Four specimens are to be used to make the determinations required in (a) and (b).

23 Sweep Test

23.1 A metallic chimney liner shall not bend, break, split at a seam or joint, puncture, or experience a loss in mass of more than 0.1 per cent, and a nonmetallic chimney liner shall not crack, dislodge, or experience a loss in mass of more than 1.0 percent, when tested as described in 23.2.

23.2 Following the temperature tests described in Sections 16 – 18, a chimney liner is to be swept by means of a metal chimney cleaning brush as illustrated in Figure 23.1, having not less than 100 steel spines with each spine 0.024 to 0.051 inch (0.61 to 1.30 mm) thick, and a diameter equal to the diameter of the chimney liner. The brush is to be pulled through the liner from the cleanout door to the outlet and back down to the cleanout door 100 times. Other cleaning brushes that meet the intent of the requirement are to be used with chimney liners having shapes other than round.

Figure 23.1
Chimney cleaning brush



D = CHIMNEY LINING DIAMETER,
+ 1/4 TO 1/2" (6.4 TO 12.7mm), -0

S3239

Figure 23.1 revised August 20, 1998

24 Abrasion Test

24.1 A chimney liner incorporating insulation fully or partially exposed to the interior of the chimney, or incorporating a protective covering of a material less than the minimum thicknesses specified in Table 5.1, shall comply with the requirements specified in 24.2 and 24.3 when tested as described in 24.4.

24.2 The insulation and protective covering, when employed, shall not split, break open, or otherwise become damaged to the extent that they do not continue to function as intended when tested as described in 24.4.

24.3 The effectiveness of the insulation of the chimney liner shall not be reduced when tested as described in 24.4.

24.4 The entire length of the chimney liner assembly is to be inserted into a test chimney using the methods described in the manufacturer's installation instructions, and subsequently removed. The process of inserting and removing the liner assembly is to be conducted ten times.

25 Flexibility Test for Flexible Metal Liners

25.1 A flexible chimney liner shall not break open, split, change shape, crease, or otherwise be deformed after being bent and then straightened. The bending is to be performed by bending the chimney liner around a form of radius equal to four times the diameter of the chimney liner diameter or to the maximum bend that is achieved without kinking the assembly. See Figure 25.1. The chimney liner is to be rotated 120 degrees after each bending/straightening operation. The chimney liner used for this test is to be at least 6 feet (1.8 m) long and is to contain no joints.

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Figure 25.1
Flexibility test

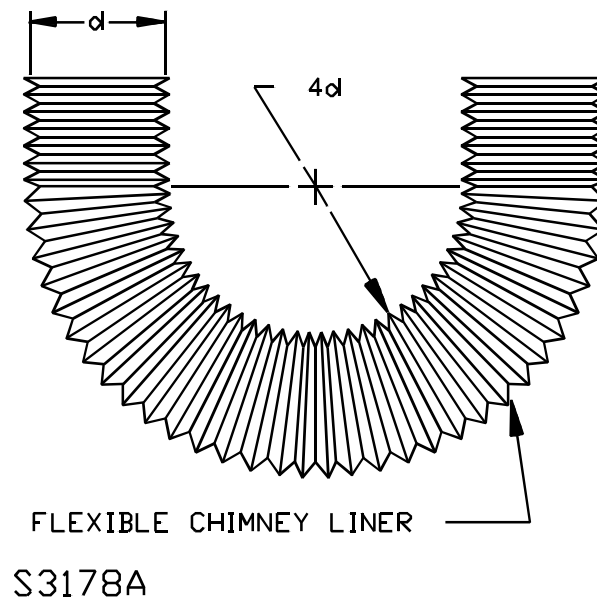


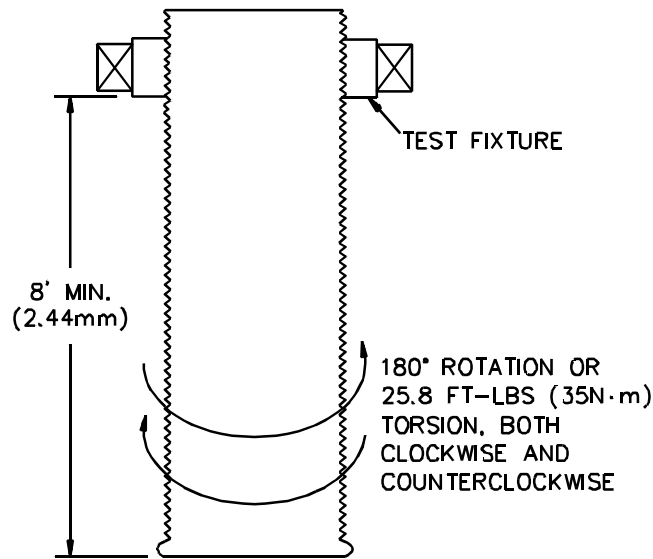
Figure 25.1 revised August 20, 1998

26 Torsion Test for Flexible Metal Liners

26.1 A flexible metal chimney liner shall not break open, split, change shape, crease or otherwise be deformed when tested as described in 26.2.

26.2 An 8-foot (2.44-m) long section of the liner is to be suspended from a test structure. One end of the chimney liner is to be attached to the test structure in a manner that prevents rotation at the point of attachment. The other end is to be rotated 180 degrees clockwise, or be subjected to a clockwise torque of 25.8 foot-pounds (35 N•m), whichever occurs first, and then returned to its original position. The liner is then to be rotated counterclockwise 180 degrees, or be subjected to a counterclockwise torque of 25.8 foot-pounds and returned to its original position. This procedure is to be conducted five times. See Figure 26.1.

Figure 26.1
Torsion test



S3240

27 Corrosion Resistance Test

27.1 When tested as described in 27.2 – 27.4, a metallic chimney liner, other than one constructed of Type 304, 316, 430, or 446 stainless steel, shall:

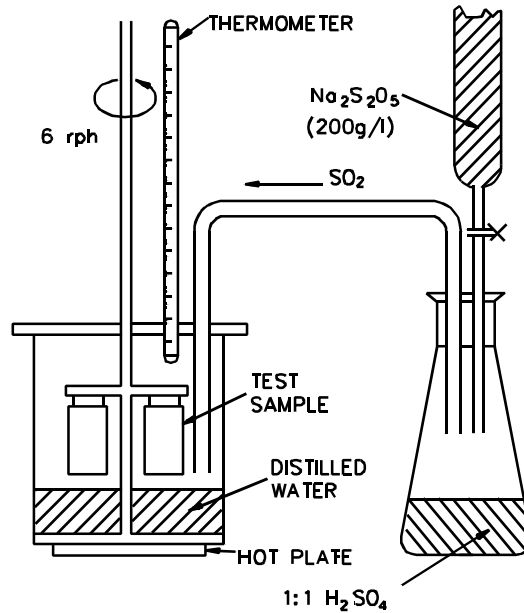
- a) Not experience a loss in weight of more than 10 percent; and
- b) Not experience a loss in integrity, such loss being indicated by the appearance of holes, or loosening of joints.

27.2 Two specimens, each 4 by 2-1/2 inches (100 by 65 mm) in size and free from dirt and surface defects such as scratches or dents, are to be exposed to the corrosive effects of sulfur dioxide at 100 °F (38 °C) and 100 percent relative humidity for a length of time required for the control specimen of Type G90 galvanized steel to become covered with red rust over 100 percent of its surface.

27.3 The exposure specified in 27.2 is to be accomplished by suspending the test specimens from a flat nonmetallic disc, 10 inches (250 mm) in diameter, that is fastened to a shaft and rotated at a speed of 6 revolutions per hour and enclosed in a container. The cover of the container is to be secured to the container so as to provide a gas-tight seal between the cover and the container. Distilled water is to be added to the container to maintain the required 100 percent relative humidity condition for the duration of the test. A continuous stream of sulfur-dioxide gas (SO₂) is to be fed into the container that contains the test sample (see 27.4).

27.4 The generator used to produce the gas is to consist of a 50 milliliter burette containing 200 grams of sodium metabisulfite ($\text{Na}_2\text{S}_2\text{O}_5$) per liter of distilled water connected to a 2 liter flask containing 300 milliliters of 1:1 H_2SO_4 solution. The solution of $\text{Na}_2\text{S}_2\text{O}_5$ /distilled water is to be drip fed to the H_2SO_4 solution at a rate of 1.5 milliliters per hour. The container is to be connected to the container that contains the test sample. See Figure 27.1.

Figure 27.1
Condensing SO_2 apparatus



S3241

Figure 27.1 revised August 20, 1998

27A Comparative Corrosion Exposure Test for Aluminum Liners

27A.1 When tested as described in 27A.2 – 27A.4, an aluminum metal liner with a minimum thickness less than 0.012 inch (0.3 mm) shall:

- a) Not exceed the calculated corrosion rate of the control material, aluminum Type 3003 with a thickness of 0.012 inch, by more than 20 percent; and
- b) Not experience a loss of integrity, such loss being indicated by the appearance of holes, or loosening of joints.

Added 27A.1 effective August 20, 1999

27A.2 Fifteen specimens, each 4 by 2-1/2 inches (100 by 65 mm) in size and free from dirt and surface defects such as scratches or dents, are to be exposed to the corrosive effects as specified in 27A.4.

Added 27A.2 effective August 20, 1999

27A.3 Before exposure, each specimen is to be weighed. Periodically during the exposure each specimen is to be visually examined and, at selected intervals, representative specimens are to be removed from the exposure, cleaned of corrosion products and reweighed. This procedure is to be continued until 10,000 cycles are completed.

Added 27A.3 effective August 20, 1999

27A.4 The specimens are to be placed in an exposure cabinet, with a spray dispersion tower as described in the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117, and exposed to a finely dispersed fog for 10,000 cycles of operation. A cycle consists of 5 minutes of solution spray and 15 minutes of air dry in an air stream maintained at 250 °F (121 °C). The solution that produces the fog is to have a pH of 2.5 and is to be composed of deionized water with 25 ppm Cl^{-1} , 1.1 ppm SO_4^{-2} , 0.9 ppm NO_3^{-1} , and 1.5 ppm NO_2^{-1} . The exposure cabinet is to be maintained at 120 °F (49 °C) for the duration of the exposure.

Added 27A.4 effective August 20, 1999

27B Comparative Corrosion Exposure Test for Stainless Steel Liners

27B.1 When tested as described in 27B.2 – 27B.4, a stainless steel liner with a minimum thickness less than 0.012 inch (0.3 mm) shall:

- a) Not exceed the calculated corrosion rate of the control material, stainless steel Type 304 with a thickness of 0.012 inch, by more than 20 percent; and
- b) Not experience a loss of integrity, such loss being indicated by the appearance of holes, or loosening of joints.

Added 27B.1 effective August 20, 1999

27B.2 The following specimens, free from dirt and surface defects such as scratches or dents, are to be exposed to the corrosive effects as specified in 27B.4:

- a) 15 flat coupons 3 by 0.005 inches (76 by 0.13 mm); and
- b) 15 formed coupons 3 by 5 by 0.005 inches (76 by 127 by 0.13 mm). The forming shall be representative of that required to produce the end product.

Added 27B.2 effective August 20, 1999

27B.3 Before exposure, each specimen is to be weighed. Periodically during the exposure each specimen is to be visually examined and, at selected intervals, representative specimens are to be removed from the exposure, cleaned of corrosion products and reweighed. This procedure is to be continued until 10,000 cycles are completed.

Added 27B.3 effective August 20, 1998

27B.4 The specimens are to be placed in an exposure cabinet, with a spray dispersion tower as described in the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117, and exposed to a finely dispersed fog for 10,000 cycles of operation. A cycle consists of 5 minutes of solution spray and 15 minutes of air dry in an air stream maintained at 150 °F (66 °C). The solution that produces the fog is to have a pH of 2.5 and is to be composed of deionized water with 25 ppm Cl^{-1} , 10 ppm SO_4^{-2} , 0.9 ppm NO_3^{-1} , and 70 ppm NO_2^{-1} . The exposure cabinet is to be maintained at 95 °F (35 °C) for the duration of the exposure.

Added 27B.4 effective August 20, 1999

28 Resistance to Action of Acids Test for Nonmetallic Flue-Gas Conduit

28.1 The percentage of acid-soluble matter in each sample of nonmetallic flue-gas conduit material shall not exceed 3.0 percent by weight when tested as described in 28.2 and 28.3.

28.2 A sample of each nonmetallic flue-gas conduit material is to be subjected to this test. Each sample is to have a square face area and is to be the maximum thickness used in the conduit. The total surface area is to be measured. The samples are to be washed with hot water and dried to constant weight in a ventilated oven at a temperature between 221 and 230 °F (105 and 110 °C).

28.3 Upon attaining constant weight, the samples are to be suspended and completely immersed in a 1/50 normal sulfuric acid solution [40 cubic centimeters of solution for each square inch (6.5 cm^2) of sample surface area] at a temperature between 70 and 90 °F (21 and 32 °C) for a period of 24 to 48 hours. The samples then are to be removed from the solution, washed with hot water, and dried to constant weight in a ventilated oven at a temperature between 221 and 230 °F (105 and 110 °C). This weight then is to be compared with the weight obtained as described in 28.2.

29 Freezing and Thawing Test for Water-Absorptive Nonmetallic Materials

29.1 Parts of nonmetallic materials that absorb water shall not show disintegration, cracking, or spilling, or loss of weight of more than 5 percent of the initial dry weight after being subjected to the freezing and thawing treatment described in 29.2 – 29.5.

29.2 The samples of each material to be tested are to be free from observable cracks. The samples are not free from containing laminations and fissures, only to the extent that they are representative of the material from which the samples are taken.

29.3 The samples are to be dried to constant weight in a ventilated oven at a temperature of 212 – 221 °F (100 – 105 °C). The samples then are to be submerged for 24 hours in water at a temperature of 64 – 75 °F (18 – 24 °C). The water then is to be heated to boiling temperature, maintained at this temperature for 5 hours, and then allowed to cool to a temperature of 64 – 75 °F (18 – 24 °C). Each sample then is to be removed from the water, wiped dry with a cloth, and weighed immediately. The average water absorption by weight is to be calculated and recorded.

29.4 Representative samples of complete parts, free of observable cracks or shattered edges, are to be identified. The samples are not free from containing laminations and fissures, only to the extent that they are representative of the material from which the samples are taken.

29.5 The samples are to be dried to constant weight in a ventilated oven at a temperature between 212 and 221 °F (100 and 105°C) and the weights recorded. The samples then are to be immersed for 72 hours in water at a temperature of 64 – 75 °F (18 – 24 °C), and then removed from the water and allowed to drain for not more than 1 minute. The superficial moisture is to be removed with a towel or blotting paper and the samples immediately subjected to three conditioning cycles. Each conditioning cycle is to consist of exposure to a temperature of 32 °F (0°C) for 16 hours, followed by exposure to a temperature of 212 °F (100°C) for 7 hours, and then followed by immersion in water for 1 hour. At the end of the test period, the samples are to be dried to constant weight, and the weight recorded.

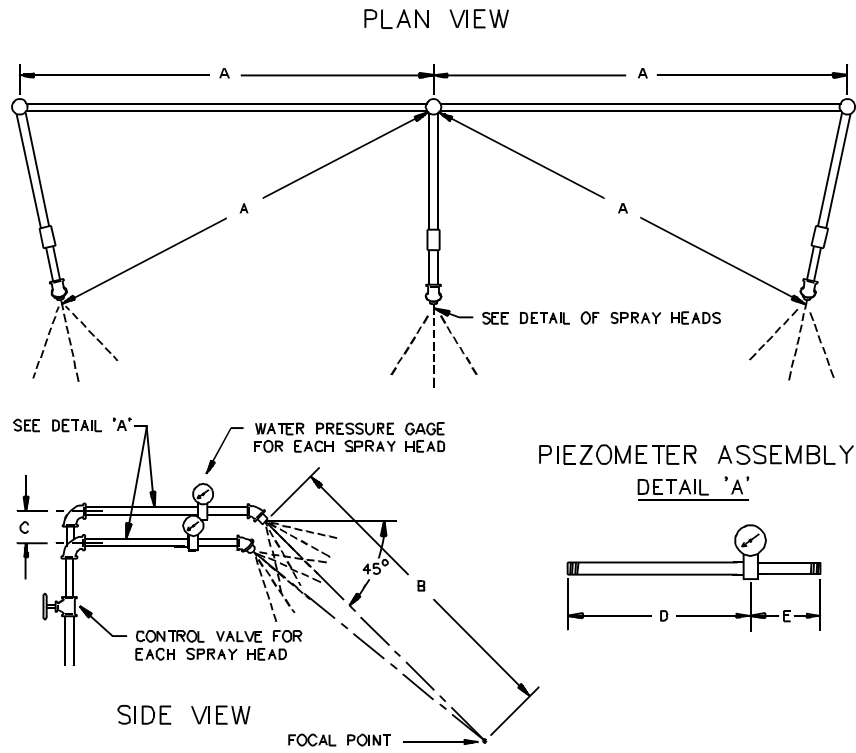
30 Rain Test

30.1 The quantity of water entering the flue-gas conduit or any other individual passageway shall not exceed 2 percent of that which enters the conduit or passageway if unprotected by a cap or other means when tested as described in 30.2 – 30.6.

30.2 Representative sizes and styles of caps are to be subjected to the tests described in 30.3 – 30.6. Each cap is to be installed on a chimney section in a manner that sheds the water spray away from the underside of the cap. The arrangement is to permit any water entering the test assembly from above to be observed at the underside of the chimney assembly and collected.

30.3 The rain test apparatus is to consist of three spray heads mounted in a water-supply pipe rack illustrated in Figure 30.1. Spray heads are to be constructed in accordance with the details illustrated in Figure 30.2. The water pressure for all tests is to be maintained at 5 psig (34.5 kPa) at each spray head. The spray is to be directed toward the top and side of the cap. The cap is to be centrally located within the spray pattern and the top of the cap under test is to be at least 3 feet (0.9 m) below the plane of the lower spray head outlet.

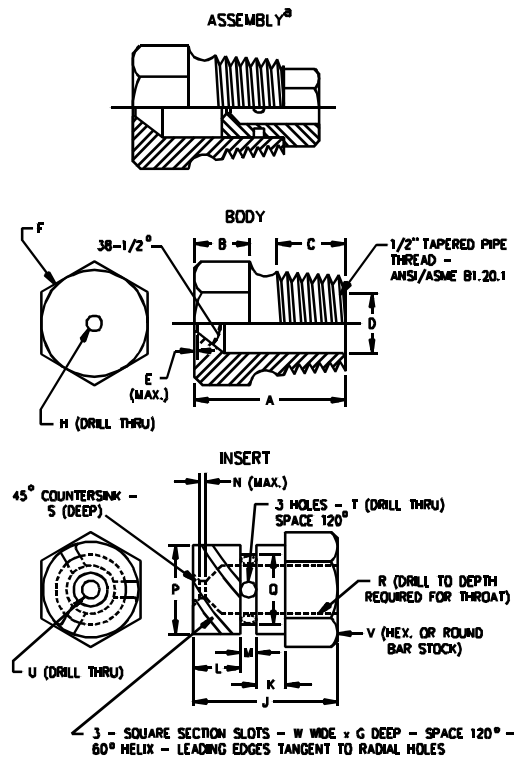
Figure 30.1
Rain test spray-head piping



Item	inch	mm
A	28	710
B	55	1400
C	2-1/4	55
D	9	230
E	3	75

RT101E

Figure 30.2
Rain test spray-head



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0	Q	.576	14.63
D	.578	14.68	R	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35) ^b	2.80
H	(No.9) ^b	5.0	U	(No. 40) ^b	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

^a Nylon Rain-Test Spray Heads are available from Underwriters Laboratories

^b ANSI B94.11M Drill Size

^c Optional - To serve as a wrench grip.

RT100E

30.4 The average rate of simulated rainfall in inches per hour over an area 12 inches (305 mm) in diameter with the water pressure at 5 psig (34.5 kPa) is to be determined as follows. A 12-inch diameter cylindrical container, open at one end and 20 inches (508 mm) deep, is to be used to collect the water spray for 30 minutes. The center of the open end of the container is to be located at the same position as the center of the upper surface or plane of the cap or assembly to be tested. The inches of water collected in 30 minutes is to be multiplied by two to determine the amount in inches per hour.

30.5 For the rain test of an assembly, arrangements are to be made for collecting, in separate containers, any water entering:

- a) The flue-gas conduit; and
- b) Any ventilation air passageway of a given configuration.

The rain test is to cover a period of 1 hour.

30.6 The maximum amount of water collected in either the flue-gas conduit or in any portion of the interior of the chimney shall not exceed the value obtained by application of the formula:

$$Q \leq 0.02 \times R \times A$$

in which:

Q is the volume of water actually collected, cubic inches per hour;

R is the rainfall, inches per hour; and

A is the area of the chimney interior, square inches.

30A Draft Loss and Wind Effects Test

30A.1 The requirements of this section only apply to vent caps which are intended to be used with gas fired appliances.

Added 30A.1 effective August 20, 1999

30A.2 A vent cap for direct attachment to a chimney liner and a vent cap of a roof assembly shall not impede the flow of flue gases in still air when tested as described in 30A.3 and 30A.4.

Added 30A.2 effective August 20, 1999

30A.3 The vent cap is to be mounted on a continuous length of chimney liner or on its roof assembly mounted, in turn, on a continuous length of chimney liner. The chimney is to be sealed so that there is no air flow. Static pressure within the chimney is to be determined by a pitot tube, pressure tap, or piezometer ring located 12 inches (300 mm) below the point of the vent cap's attachment. Pressure readings are to be taken with an instrument capable of being read to the nearest 0.001 inch (0.025 mm) of water column (w.c.). The chimney liner is to be the same nominal diameter as the vent cap under test. The vent cap manufacturer shall furnish a section of chimney liner not over 12 inches long, having a typical joint connecting to the vent cap. This pipe section is to be left in place on the end of the liner for the test for wind effects where applicable. All joints in the test chimney between the inlet end and the vent cap under test are to be sealed or taped against leakage for all tests.

Added 30A.3 effective August 20, 1999

30A.4 An upward air velocity of 10 feet (3.05 m) per second [velocity pressure 0.023 inch (0.60 mm) w.c.] is to be established in the uncapped test chimney and the static pressure measured. The vent cap is to be placed on the test chimney and an upward velocity of 10 feet (3.05 m) per second is to be established in the test chimney, and the static pressure measured. The difference between the static pressures shall not exceed 0.034 inch (0.86 mm) w.c.

Added 30A.4 effective August 20, 1999

30A.5 A vent cap for direct attachment to a chimney liner having an internal diameter of 12 inches (300 mm) or less shall not impede the flow of flue gases due to wind action at angles from 45 degrees below horizontal to 45 degrees above horizontal when tested as described in 30A.6 and 30A.7.

Added 30A.5 effective August 20, 1999

30A.6 The vent cap, mounted on a continuous length of chimney liner as described in 30A.3, is to be fixed in position at a wind generator outlet to obtain various elevation angles of wind approach. The wind generator is to be able to produce a uniform wind front of 20 miles per hour (32 km/h) velocity [29.3 feet per second (8.93 m/s); velocity pressure 0.192 inch (4.88 mm) w.c.] over an area described by a diameter not less than 12 inches (300 mm) greater than the maximum width of the vent cap under test. The velocity is determined to be uniform when the variation at any point does not exceed 5 percent of the specified velocity. The configuration of the chimney and vent cap is to be such that the vent cap remains centered in the wind front during rotation about any axis.

Added 30A.6 effective August 20, 1999

30A.7 With the vent cap in place on the chimney liner and an upward air velocity of 10 feet per second (3.05 m/s) in the chimney, a simulated wind front of 20 miles per hour (32 km/h) is to be directed at the vent cap at a series of elevation angles ranging from 45 degrees below horizontal to 45 degrees above the horizontal, in 15 degree intervals. The average of the static pressures in the chimney shall be not more than 0.068 inch (1.73 mm) w.c. greater than the pressure measured in the uncapped test chimney as described in 30A.4 when:

- a) At a horizontal wind front and at the three angles below horizontal; and
- b) At a horizontal wind front and at the three angles above the horizontal.

Added 30A.7 effective August 20, 1999

30A.8 Vent caps that are nonsymmetrical and intended for mounting in any orientation about their vertical axis are to be rotated and tested in any position in azimuth, including one(s) that imposes the highest draft loss.

Added 30A.8 effective August 20, 1999

30A.9 A vent cap for direct attachment to a chimney liner having an internal diameter of 12 inches (300 mm) or less shall induce the intended updraft effect when subjected to wind flow past the vent cap, as determined by the test methods described in 30A.10 and 30A.11.

Added 30A.9 effective August 20, 1999

30A.10 The test arrangement described in 30A.3 and 30A.6 is to be employed. The vent cap is to be placed on the chimney liner and centered in the wind front. The inlet to the chimney is to be sealed so that there is no air flow through the chimney. A 20 mile per hour (32 km/h) wind front is to be directed at the vent cap at a series of elevation angles ranging from 45 degrees below horizontal to 45 degrees above horizontal in 15 degree intervals. Vent caps that are nonsymmetrical and intended for mounting in any orientation about the vertical axis are to be rotated and tested at the position in azimuth that creates the minimum updraft capability.

Added 30A.10 effective August 20, 1999

30A.11 At the angles of wind front elevation and azimuth described in 30A.10, the average static pressure within the sealed test chimney shall be equal to or less than 0.034 inch (0.86 mm) w.c. below atmospheric pressure. For winds approaching from below horizontal, the static pressure is to be the average of the pressures at horizontal and the three angles below horizontal. For winds approaching from above the horizontal, the static pressure is to be the average of the pressures at horizontal and the three angles above the horizontal. No individual pressure reading at any angle above or below horizontal shall indicate a pressure greater than atmospheric pressure.

Added 30A.11 effective August 20, 1999

30B Puncture Test for Flexible Aluminum Metal Liners

30B.1 A flexible aluminum metal liner shall not be punctured when tested as described in 30B.2 – 30B.6.

Added 30B.1 effective August 20, 1999

30B.2 A test apparatus providing for a free fall of a plunger onto the surface of the specimen is to be used for this test. See Figure 30B.1.

Added 30B.2 effective August 20, 1999

30B.3 The plunger is to consist of a 3/8-inch (9.52 mm) diameter steel rod having a steel head, 9/16-inch (14.2-mm) diameter, attached to the impact end. The length of the plunger assembly is to provide a 2 pound (0.90 kg) weight. The surfaces of the rod and head are to be smooth. The impact end of the rod is to be formed as shown in Figure 30B.1.

Added 30B.3 effective August 20, 1999

30B.4 Guides arranged to allow for an essentially frictionless fall of the plunger and means for measuring the height of fall are to be provided.

Added 30B.4 effective August 20, 1999

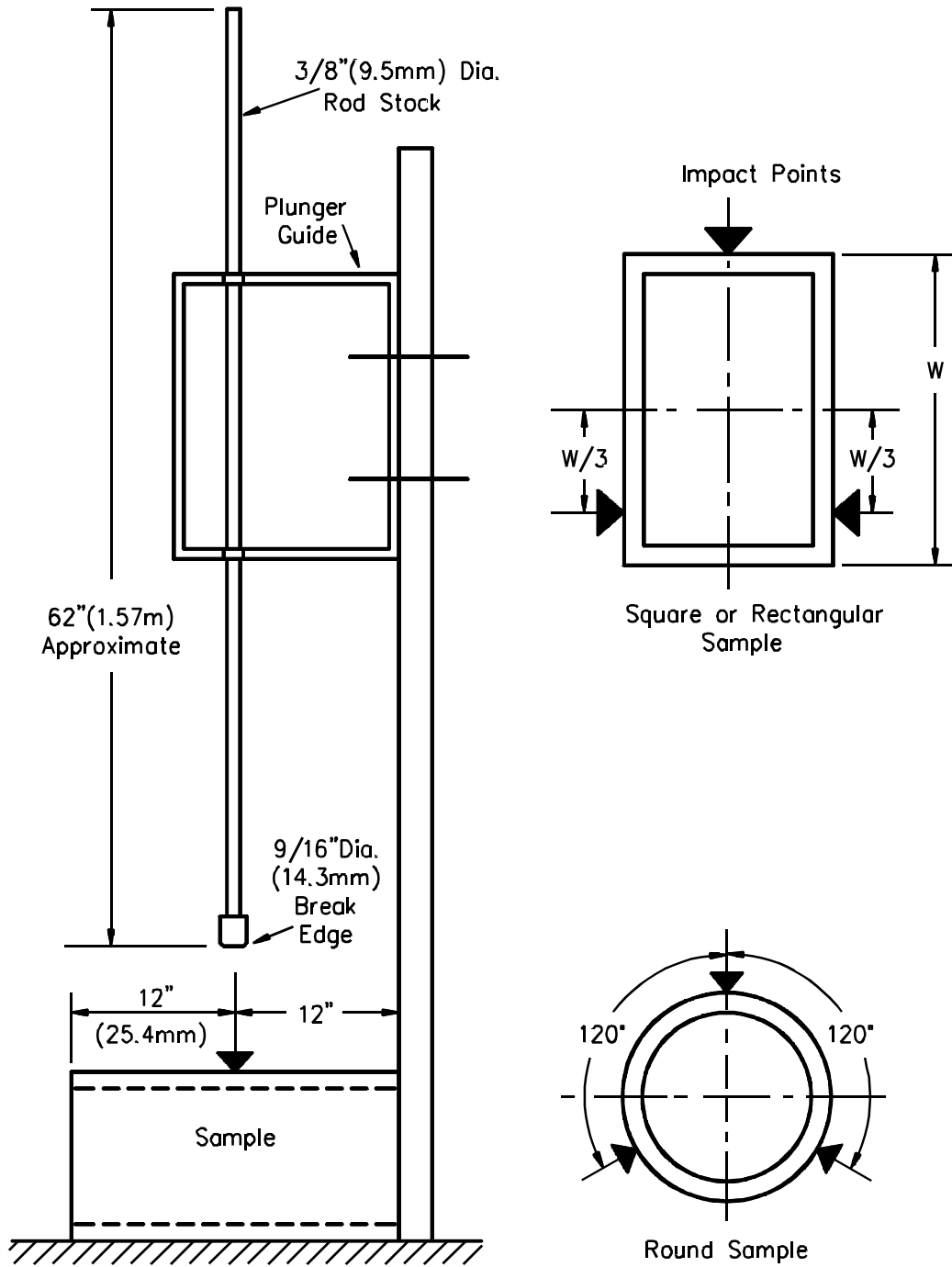
30B.5 Pieces 2 feet (0.6 m) long taken from liner sections are to be subjected to this test. The specimens are to be provided with a firm support below and throughout their length and width. At least three areas of each specimen are to receive the impact of the plunger at the impact points shown in Figure 30B.1.

Added 30B.5 effective August 20, 1999

30B.6 The specimens shall prevent the complete penetration of the plunger head when the plunger falls through a distance of 20 inches (508 mm) as measured to the top surface of the specimen.

Added 30B.6 effective August 20, 1999

Figure 30B.1
Puncture test



S2456

Added Figure 30B.1 effective August 20, 1999

MARKING

31 General

31.1 Each individual chimney liner assembly part, such as a liner section, tee, cap, wall penetration assembly, and bag or container of mix for nonmetallic lining materials shall be marked with the following:

- a) Manufacturer's or private labeler's name or identifying symbol;
- b) Distinctive part or model designation; and
- c) "Install and Use Only in Accordance With * Installation and Maintenance Instructions," or equivalent.

* Manufacturer's or private labeler's name.

31.2 The markings specified in 31.1 shall be permanent when affixed to an exposed part of the assembly (such as a cap, flashing, or wall penetration assembly), so as to be identifiable from either the interior or exterior of the building after the chimney liner installation has been completed. The markings specified in 31.1 is not required to be permanent when affixed to a part that is not readily visible after chimney liner installation, such as chimney liner sections.

31.3 A marking required to be permanent shall be molded; die-stamped; paint-stenciled, stamped, or etched metal that is permanently secured to the chimney assembly; or indelibly stamped on a pressure-sensitive label. Usage, handling, and storage of the product are to be evaluated in determining the permanence of the marking. Adhesive attached marking and labeling systems shall comply with the applicable requirements in the Standard for Marking and Labeling Systems, UL 969.

31.4 Each chimney liner section shall be marked with an arrow, with the word "up" next to an arrow pointing upward, when the section is intended to be oriented in one direction.

31.5 When a manufacturer produces chimney liner parts at more than one factory, each individual part shall have a distinctive marking to identify it as the product of a particular factory.

31.6 The exterior surface of each chimney liner section for metal chimney liners, and each bag or container of mix for nonmetallic chimney lining material, shall be permanently marked with the statement "THIS LINER IS TO BE INSTALLED IN A MASONRY CHIMNEY WHERE THERE IS A MINIMUM CLEARANCE OF ^a INCH AIR SPACE BETWEEN COMBUSTIBLE MATERIALS AND THE CHIMNEY EXTERIOR," or equivalent. This and other required marking information shall appear:

- a) At least once on each metal liner section and shall be repeated at 5 foot (1.5 m) intervals on sections longer than 5 feet; and
- b) On each bag or container of mix for nonmetallic chimney lining materials. Each bag or container of nonmetallic chimney lining material shall also be marked with the minimum lining material thickness.

^a Manufacturer's specified minimum clearance of 0 or 1 inch (0 or 25 mm).

31.7 The exterior surface of each part of a chimney liner intended for connection to a Category I gas-fired appliance shall be permanently marked with the following, "For Use Only With Category I Appliances Which Burn Natural Gas or Propane". The exterior surface of each part of a chimney liner intended for connection to a oil-fired appliance shall be permanently marked with the following, "For Use Only With Appliances Which Burn Oil Fuel". The exterior surface of each part of a chimney liner intended for connection to a solid-fuel-fired appliance shall be permanently marked with the following, "For Use Only With Appliances Which Burn Solid Fuel". When a chimney liner is intended for connection to more than one type of appliance, the above markings are able to be combined.

Added 31.7 effective August 20, 1999

32 Installation and Maintenance Instructions

32.1 General

32.1.1 Installation and maintenance instructions shall be provided, either combined in a single manual or as separate manuals, and shall be packed in the package containing an essential part of the chimney liner. Reference shall be made on or inside each chimney liner part or material package specifying the location of the instructions.

Exception: Installation instructions are not required to be provided when:

- a) The chimney liner requires that installation be accomplished by a qualified person only;*
- b) The chimney liner requires specialized equipment for installation; and*
- c) A training manual is provided to the installer by the manufacturer.*

32.1.2 The installation and maintenance instructions shall be illustrated and include directions and information necessary to complete the intended installation and maintenance of the chimney liner.

32.2 Installation instructions

32.2.1 The installation instructions or training manual (see Exception to 32.1.1) shall include particular details concerning:

- a) The manufacturer's or private labeler's name, address, and catalog designation or equivalent trade designation of the chimney liner and all parts or materials necessary for its installation.
- b) The parts required and the step-by-step process for installing the chimney liner.
- c) Types of heating appliances that are intended to be connected to the chimney liner.
- d) Limitations with respect to installation; such as minimum air space clearances to be maintained between the inside of the masonry chimney (or flue tile lining) and the liner, maximum height, minimum thicknesses of nonmetallic liner material, joining of two or more parts to constitute the intended assembly, and the like.
- e) Specifications contained in the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, NFPA 211, concerning termination of a chimney above a roof, its maximum and minimum height above a roof, its proximity to adjacent walls or buildings, and clearances to combustible materials.
- f) Reference to the use of raincaps.
- g) A warning against the use of materials other than as specified in the manufacturer's instructions.
- h) A statement specifying that the chimney liner be sized not less than that specified in the appliance manufacturer's instructions.
- i) The following or an equivalent statement: "Contact Local Building or Fire Officials About Restrictions and Installation Inspection in Your Area."
- j) A statement specifying that, prior to installation of the liner into a masonry chimney, the chimney be thoroughly cleaned (with specific reference to the requirement of removing tar glaze creosote) and checked for cracked, loose, or missing bricks, mortar, or other materials that could inhibit correct installation of the chimney lining system. A statement shall also be included specifying that the air space clearances between the masonry chimney exterior and combustible materials should be checked to verify that the chimney is in accordance with clearance specifications contained in:
 - 1) NFPA 211;
 - 2) Other recognized major building codes; or
 - 3) The manufacturer's installation instructions.

The instructions shall additionally specify the minimum inside dimensions of the chimney, minimum thickness of the brick, and the minimum and maximum height of the chimney required for the intended installation.

k) Installation of the wall penetration assembly, clean out tee, and clean out door, if provided. Specific illustrations showing the assembly of these parts, proximity to framed stud openings, and other building components (walls, floors, ceilings) shall also be included.

l) Required clearances and installation requirements for chimney connectors used to connect a heating appliance to the chimney liner. Specific illustrations showing acceptable methods of passing a chimney connector through a combustible wall to a masonry chimney shall also be included.

m) For a chimney that requires field drilling, specification of the type and size drill bit to be used to drill through the inner section of the chimney liner section.

n) A statement specifying that wall penetration assemblies are not to be located directly behind a heating appliance.

32.2.2 The installation instructions are to be used as a guide during the examination and tests of a chimney lining system. Only those parts and installations that are included in the examination and tests shall be referenced in the instructions. The instructions need not be in final printed form for the investigation.

32.2.3 If installation instructions are not provided (see Exception to 32.1.1), the maintenance instructions shall specify, at the beginning of the instructions, that the product is intended for installation only by trained representatives of the manufacturer or private labeler.

32.3 Maintenance instructions

32.3.1 The maintenance instructions shall include particular details concerning:

a) The manufacturer's or private labeler's name, address, and catalog designation or equivalent trade designation of the chimney liner and all replaceable parts.

b) Instructions on proper inspection methods and frequency of inspections [see (h) for specific reference concerning creosote buildup].

c) Recommendations to have the chimney lining system checked by an authorized representative of the company, or by some other qualified person, such as a certified chimney sweep, at least once annually following initial installation of the lining system.

d) A list of the types of heating appliances that are intended to be connected to the chimney liner.

e) The recommended method of cleaning the chimney liner, including the method of access through the top of the chimney.

f) A warning against using any parts or materials with the chimney liner other than those specified.

g) A statement specifying that any heating appliance connected to the chimney liner must not have a flue outlet size larger than the chimney liner area at its smallest point.

h) For liners intended for connection to solid-fuel-fired appliances, reference to the formation and removal of creosote and soot buildup in the chimney lining system as follows (the inspection frequency "once every two months" stated below is a maximum time period subject to the manufacturer's or private labeler's option):

"Creosote and Soot-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 may condense on the inside of the chimney liner during slow-burning firing periods. As a result, creosote residue accumulates on the chimney liner. When ignited, this creosote makes an extremely hot fire.

The chimney liner system should be inspected at least once every two months during the heating season to determine if a creosote or soot buildup has occurred.

If creosote or soot has accumulated, it should be removed to reduce the risk of a chimney fire."

i) Precautions to be taken, when required, on initial firing of an appliance that is vented through the chimney liner.

j) The posting of notices near the point where the connection is made to the gas vent or roof jack, concerning limitations to use with either gas or gas and oil appliances only, when a liner is for use with either gas or gas and oil fuel only.

Revised 32.3.1 effective August 20, 1999

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Superseded requirements for

the Standard for

Chimney Liners

UL 1777, Second Edition

The requirements shown are the current requirements that have been superseded by requirements in revisions issued for this Standard. To retain the current requirements, do not discard the following requirements until the future effective dates are reached.

1.1 These requirements cover metallic and nonmetallic chimney liners intended for field-installation into new or existing masonry chimneys that are used for the natural draft venting of gas-, liquid-, and solid-fuel-fired residential-type appliances in which the maximum continuous flue-gas outlet temperatures do not exceed 1000 °F (538 °C).

5.2 The minimum thickness of materials, including any coatings, shall be as specified in Table 5.1.

Exception: The minimum thickness of materials employed as a protective covering over insulation, not subject to contact with flue gases, are not required to be as specified in Table 5.1. See Abrasion Test, Section 24.

**Table 5.1
Thickness of materials**

Description	Minimum thickness	
	Inch	(mm)
Aluminum alloys	0.016	(0.41)
Aluminum-coated steel, Type T1-40 (regular [0.40 ounces per square foot (0.12 kg/m ²)])	0.018	(0.46)
Cast iron	0.125	(3.17)
Galvanized steel (G90 Coating designation)	0.018	(0.46)
Porcelain-enameled steel	0.032	(0.81)
Stainless steel	0.012	(0.30)
Steel, uncoated or painted	0.053	(1.35)
Cast or fired refractory	0.40	(10.2)

5.3 A flue-gas conveying conduit of a chimney liner shall be Type 304, 316, 430, or 446 stainless steel or stainless steel having at least equivalent properties, porcelain-coated steel, or cast or fired refractory. Porcelain-coated steel and cast or fired refractory shall comply with the requirements in Sections 28, Resistance to Action of Acids Test for Nonmetallic Flue-Gas Conduits, and Section 29, Freezing and Thawing Test for Water Absorptive Nonmetallic Materials, as applicable.

5.5 Other parts of a chimney liner subject to contact by flue gases or flue-gas air mixtures at or beyond the terminus of the flue-gas conveying conduit (such as caps) shall be of material equivalent to the flue-gas conveying conduit as specified in 5.3.

5.6 An outer casing or other structural part exclusive of the flue-gas conveying conduit:

- a) The deterioration or corrosion of which would result in the collapse of the chimney liner or otherwise increase the risk of injury to persons; or
- b) That is subject to condensation,

shall be of stainless steel, galvanized steel, or aluminum-coated steel. Galvanized steel or aluminum-coated steel shall comply with the requirements in 5.7. Stainless steel shall be in accordance with Table 5.1.

Exception No. 1: This requirement does not apply to the flue-gas conveying conduit. See 5.3.

Exception No. 2: This requirement does not apply to parts subject to contact by flue-gas or flue-gas air mixtures at or beyond the terminus of the flue-gas conveying conduit. See 5.5.

13.2 After being subjected to the tests specified in Sections 16 – 30, as applicable, a product shall be capable of being further used. The chimney and chimney liner shall be free of cracks, distortion, or other damage. The chimney and chimney liner are to be visually inspected (including the use of a video camera, if necessary) to determine that damage has not occurred.

13.3 Test results indicating compliance with the requirements in 13.2 include the following:

- a) No part of the product has become damaged or permanently distorted to an extent that it or the masonry chimney will not continue to function as intended.
- b) Joints in liner sections, and between adjacent liner sections that are intended to be joined together, have not opened.
- c) The effectiveness of any required protective coating or finish on metal parts has not been reduced.
- d) A cementitious or ceramic material has not cracked in a manner allowing portions of the liner to become dislodged by poking the liner with a sharp instrument or by the process of cleaning the chimney to the extent that the serviceability of the chimney liner is impaired. (See Torsion Test for Flexible Metal Liners, Section 26, and Sweep Test, Section 23.)
- e) Cracks are not observable in porcelain enamel used as a required protective coating when the surface is examined under a microscope of 60 magnification.
- f) The reflectivity of a surface has not been impaired if the reflectivity is utilized to reduce the risk of fire.
- g) Burning or scaling of metal parts is not evident upon visual observation.

Exception: Scaling of the chimney liner flue material that does not impair the function of the chimney liner is acceptable after exposure to the test specified in Section 18, Temperature Test – 2100EF (1149EC) Flue Gases.

- h) The effectiveness of insulating material has not been reduced.
- i) Bricks used in the test assembly shall not have loosened due to expansion of the test assembly to a degree that diminishes the overall structural integrity of the chimney.

14.12 A gas-fired flue-gas generator as illustrated in Figure 14.3 is to be used to supply flue gases to the chimney liner being tested. The generator is to produce the flue gases at the specified test temperatures when fired at the test input specified in Table 14.1.

**Table 14.1
Flue-gas generator inputs**

Equivalent nominal diameter of chimney liner		Minimum input to flue-gas generator Btu per hour (kW)					
Inches	(mm)	Column 1		Column 2		Column 3	
		Temperature Test – 1000°F (538°C) Flue Gases, Section 16		Temperature Test – 1400°F (760°C) Flue Gases, Section 17		Temperature Test – 2100°F (1125°C) Flue Gases, Section 18	
6	(150)	48,500	(14.2)	59,200	(17.4)	175,000	(51.2)
7	(180)	65,800	(19.3)	80,500	(23.6)	237,000	(69.4)
8	(200)	86,200	(25.3)	106,000	(31.1)	310,000	(91.0)
9	(230)	109,000	(31.9)	133,000	(39.0)	392,000	(115.0)
10	(250)	135,000	(39.6)	165,000	(48.4)	486,000	(142.4)
12	(300)	195,000	(57.2)	238,000	(69.8)	699,000	(205.0)

15.3 The gas burner then is to be operated as for the Temperature Test – 1000 °F (538 °C) Flue Gases, Section 16, and the dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple is 930°F (517°C) above room temperature by using the flue-gas generator input specified in Column 2 of Table 14.1, for the size of chimney being tested.

15.4 The dilution air adjustments for tests described in Sections 16 – 18 are to be set as required to obtain the specified flue-gas temperatures for the individual test as measured by the thermocouple located as described in 15.2.

15.12 During the Temperature Test – 1400 °F (760 °C) Flue Gases, Section 17, and Temperature Test – 2100 °F (1149 °C) Flue Gases, Section 18, temperature rises are to be based on the ambient or room temperature recorded at the end of the firing period prescribed for the test.

16.3 The test is to be started with the test chimney liner (including the wall penetration assembly), chimney, and the test structure at room temperature. The flue-gas generator then is to be fired at the input specified in Column 2 of Table 14.1, and regulated to produce flue gases at a temperature of 1000 °F (555 °C) at the thermocouple location designated in Figure 14.3. Temperatures at all points of measurement are to be recorded at intervals not exceeding 30 minutes until it is apparent that maximum temperatures have been attained, or for 8 hours, whichever occurs first.

17.2 After maximum temperatures are attained under the test conditions described in 16.3, the flue-gas generator is to be fired at the input specified in Column 3 of Table 14.1, and regulated to produce flue gases at a temperature of 1400°F (760 °C) at the thermocouple location designated in Figure 14.3. The test duration is to be 60 minutes. Temperatures at all points of measurement are to be recorded at intervals not exceeding 10 minutes until it is apparent that maximum temperatures have been attained.

18.4 The test conditions then are to be established at the inputs shown in Column 2 of Table 14.1, and maintained to produce flue gas at a temperature of 1000 °F (538 °C) as measured by means of a flue-gas thermocouple as shown in Figure 15.1 and located centrally in the generator. The operation is to be continued until maximum temperatures are attained on surfaces of chimney parts and the test structure, or for 8 hours, whichever occurs first.

32.3.1 The maintenance instructions shall include particular details concerning:

- a) The manufacturer's or private labeler's name, address, and catalog designation or equivalent trade designation of the chimney liner and all parts or materials that may need to be replaced periodically.
- b) Instructions on proper inspection methods and frequency of inspections [see (h) for specific reference concerning creosote buildup].
- c) Recommendations to have the chimney lining system checked by an authorized representative of the company, or by some other qualified person, such as a certified chimney sweep, at least once annually following initial installation of the lining system.
- d) A list of the types of heating appliances that are intended to be connected to the chimney liner.
- e) The recommended method of cleaning the chimney liner, including the method of access through the top of the chimney.
- f) A warning against using any parts or materials with the chimney liner other than those specified.
- g) A statement specifying that any heating appliance connected to the chimney liner must not have a flue outlet size larger than the chimney liner area at its smallest point.
- h) Reference to the formation and removal of creosote and soot buildup in the chimney lining system as follows (the inspection frequency "once every two months" stated below may be a shorter time period at the manufacturer's or private labeler's option):

"Creosote and Soot-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 may condense on the inside of the chimney liner during slow-burning firing periods. As a result, creosote residue accumulates on the chimney liner. When ignited, this creosote makes an extremely hot fire.

The chimney liner system should be inspected at least once every two months during the heating season to determine if a creosote or soot buildup has occurred.

If creosote or soot has accumulated, it should be removed to reduce the risk of a chimney fire."

- i) Precautions to be taken, if any, on initial firing of an appliance that is vented through the chimney liner.