

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.

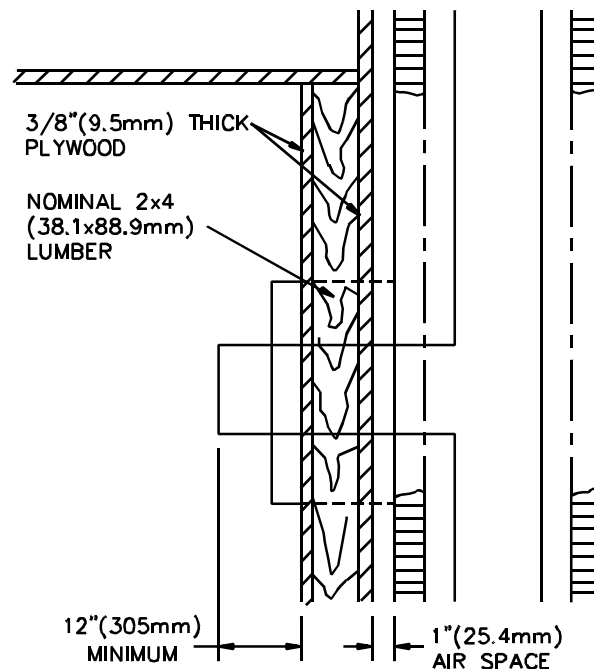
10 Wall Penetration Assemblies

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.

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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.