UL 1777

STANDARD FOR SAFETY

Chimney Liners

UL Standard for Safety for Chimney Liners, UL 1777

Fifth Edition, Dated October 2, 2015

Summary of Topics

This revision of ANSI/UL 1777 dated April 2, 2024 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated February 9, 2024.

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Standard for Chimney Liners

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The most recent designation of ANSI/UL 1777 as a Reaffirmed American National Standard (ANS) occurred on April 2, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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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).

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; National Fuel Gas Code, NFPA 54 and codes such as the International Building Code, International Gas Code, International Mechanical Code, International Residential 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 Chimney liners with cementitious or refractory flue gas conveying conduits shall be evaluated and marked in accordance with the solid-fuel-fired-appliance sections of these requirements.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 Glossary

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

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

3.3 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.

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

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

3.6 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.

3.7 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.

3.8 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.

3.9 DIRECT CONNECTION SYSTEM – A means to route combustion products from the outlet of an appliance through the damper area and to the chimney liner.

3.10 FIREPLACE, MASONRY – A field-constructed assembly constructed in accordance with the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances, NFPA 211; National Fuel Gas Code, NFPA 54 and codes such as the International Building Code, International Gas Code, International Mechanical Code, International Residential Code, and the Uniform Mechanical Code.

3.11 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.

3.12 NATURAL DRAFT – The draft created by an appliance that operates at neutral or negative pressure, as measured at the outlet of the appliance.

3.13 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.

3.14 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.

3.15 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 rating established for the intended conditions of use.

4.4 Specific components are 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.

5 Undated References

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

CONSTRUCTION

6 Materials

6.1 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.

6.2 The minimum thickness of materials, including any coatings, shall be as specified in Table 6.1.

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 6.1. See Abrasion Test, Section 28.

Exception No. 2: The minimum thickness of materials determined to comply with the Comparative Corrosion Exposure Test For Aluminum Liners, Section 32, or the Comparative Corrosion Exposure Test For Stainless Steel Liners, Section 33, is not required to be as specified in Table 6.1.

Table 6.1
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)

6.3 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 34, Resistance to Action of Acids Test for Nonmetallic Flue-Gas Conduits, and Section 35, Freezing and Thawing Test for Water Absorptive Nonmetallic Materials, as applicable.

6.4 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.

6.5 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 6.1.

6.6 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 6.3 and 6.4.

6.7 An outer casing or other structural part exclusive of the flue-gas conveying conduit shall be of stainless steel, galvanized steel, or aluminum-coated steel when:

a) Deterioration or corrosion of the casing or part would result in the collapse of the chimney liner or otherwise increase the risk of injury to persons; or

b) It is subject to condensation.

Galvanized steel or aluminum-coated steel shall comply with the requirements in 6.8. Stainless steel shall be in accordance with Table 6.1.

Exception No. 1: This requirement does not apply to the flue-gas conveying conduit. See 6.3 and 6.4.

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 6.6.

6.8 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) the Weight (Mass) of Coating Requirements table in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653, with not less than 40 percent of the zinc on any side, based on the minimum single spot test in ASTM A653. The weight of zinc coating shall be established in accordance with the Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90. Aluminum-coated steel shall be of Type T1-40 (regular) [0.40 ounce per square foot (0.12 kg/m^2)].

6.9 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 6.1, or the equivalent.

6.10 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 6.8. Paint coatings shall remain intact at the maximum temperatures obtained on the part during the tests specified in these requirements.

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

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

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

6.14 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).

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

6.16 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.

6.17 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.

7 Assembly

7.1 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.

7.2 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.

7.3 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.

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

7.5 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.

7.6 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.

7.7 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.

7.8 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.

7.9 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.

8 Chimney Caps

8.1 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 36.

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 36, and with the requirements for the material from which the cap is formed, see 7.5; and

b) The use of such cap is specified in the installation instructions or training manual.

8.2 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.

8.3 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.

9 Chimney Top Covers

9.1 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.

9.2 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 36.

10 Joints

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

10.2 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 14.2 and 14.3). 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).

10.3 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 7.1. 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.

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

10.5 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.

10.6 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.

10.7 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.

11 Wall Penetration Assemblies

11.1 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 11.1. Separate parts shall be supplied to accommodate thicker walls. The construction shall not void

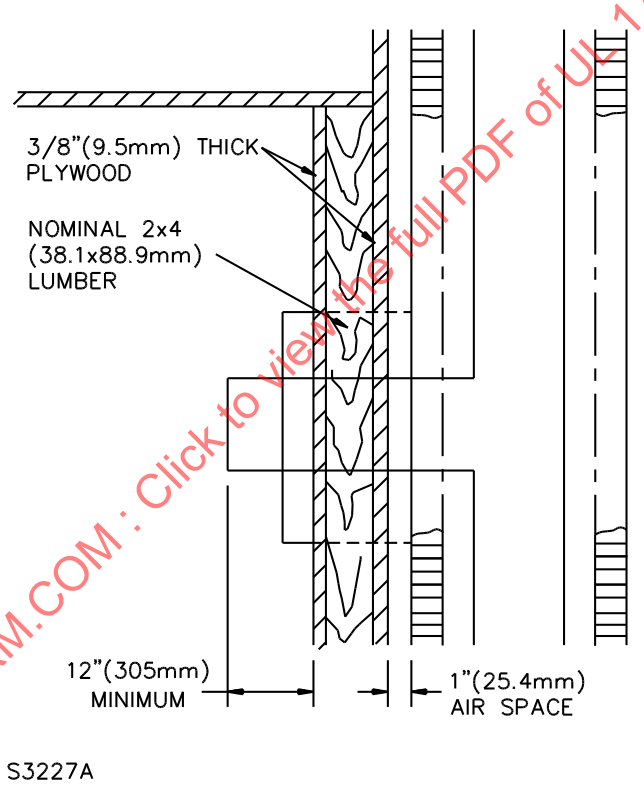
firestopping provided for a concealed space when installed in accordance with the manufacturer's installation instructions or training manual.

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.

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 11.1

Wall penetration assembly



12 Radiation Shields

12.1 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.

13 Tee Sections and Support Assemblies for Metallic Chimney Liners

13.1 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 24.

PERFORMANCE

14 General

14.1 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.

14.2 After being subjected to the tests specified in Sections 17 – 22, 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.

14.3 Test results indicating compliance with the requirements in 14.2 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 30, and Sweep Test, Section 27.)

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 19 – 22.

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.

14.4 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.

15 Test Installation

15.1 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.

15.2 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.

15.3 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.

15.4 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.

15.5 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 ±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 Figure 15.1 and Figure 15.2.

Figure 15.1

Test chimney without wall penetration assembly

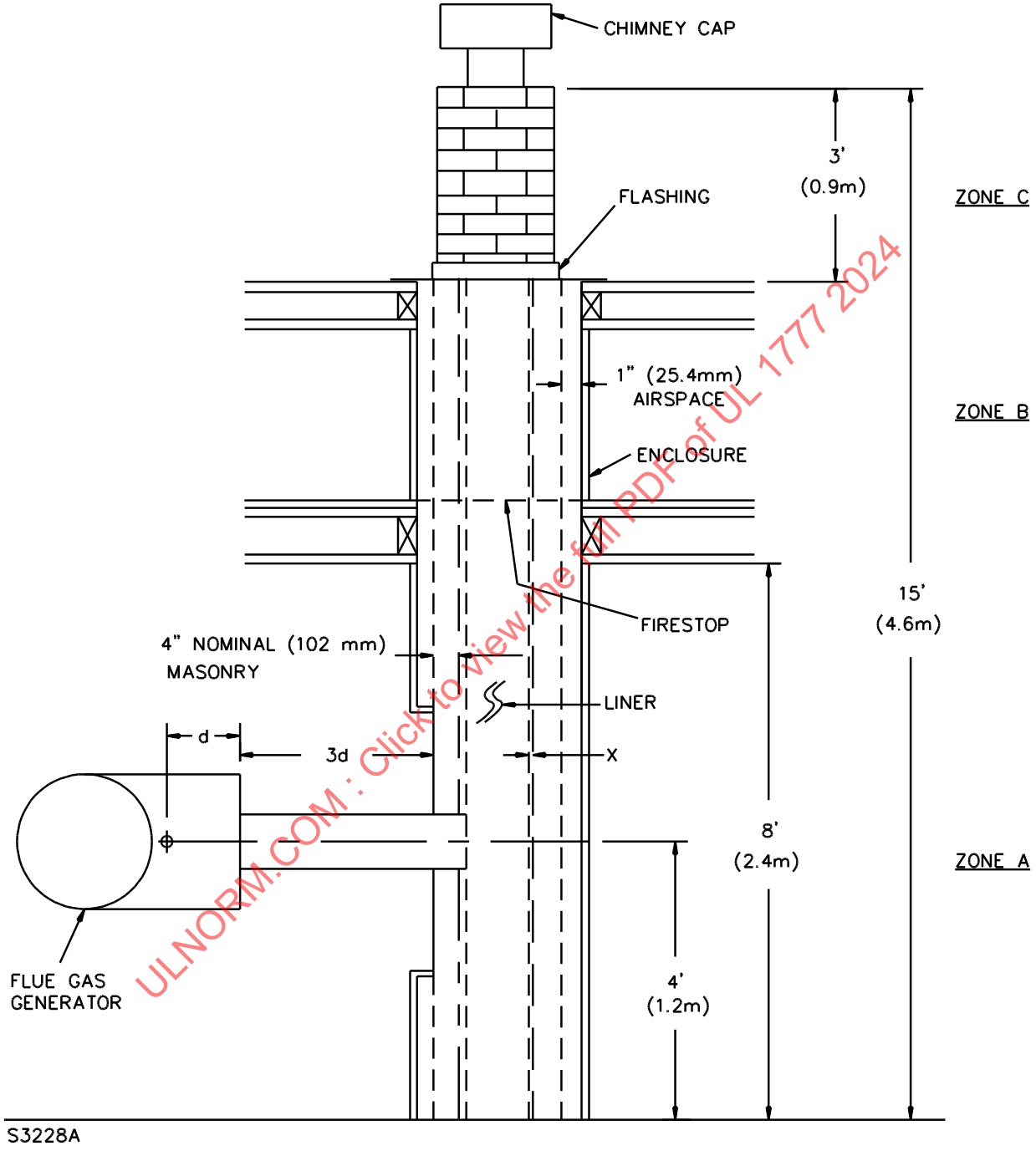
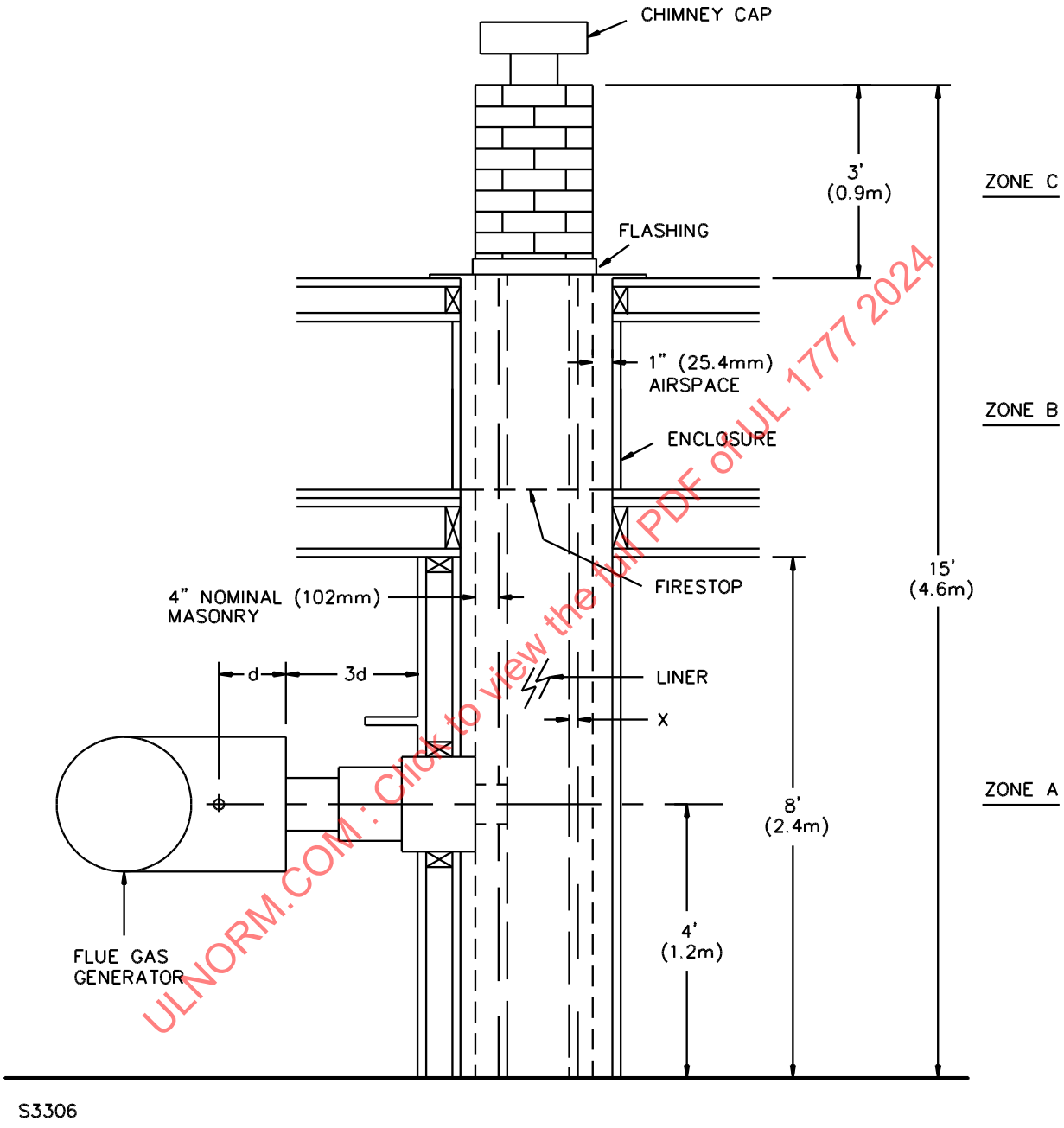


Figure 15.2

Test chimney with wall penetration assembly



15.6 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.

15.7 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.

15.8 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.

15.9 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.

15.10 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.

15.11 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.

15.12 A gas-fired flue-gas generator as illustrated in Figure 15.3 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 15.1 for solid-fuel-fired appliances, Table 15.2 for oil-fired appliances, and Table 15.3 for gas-fired appliances.

Figure 15.3

Flue-gas generator

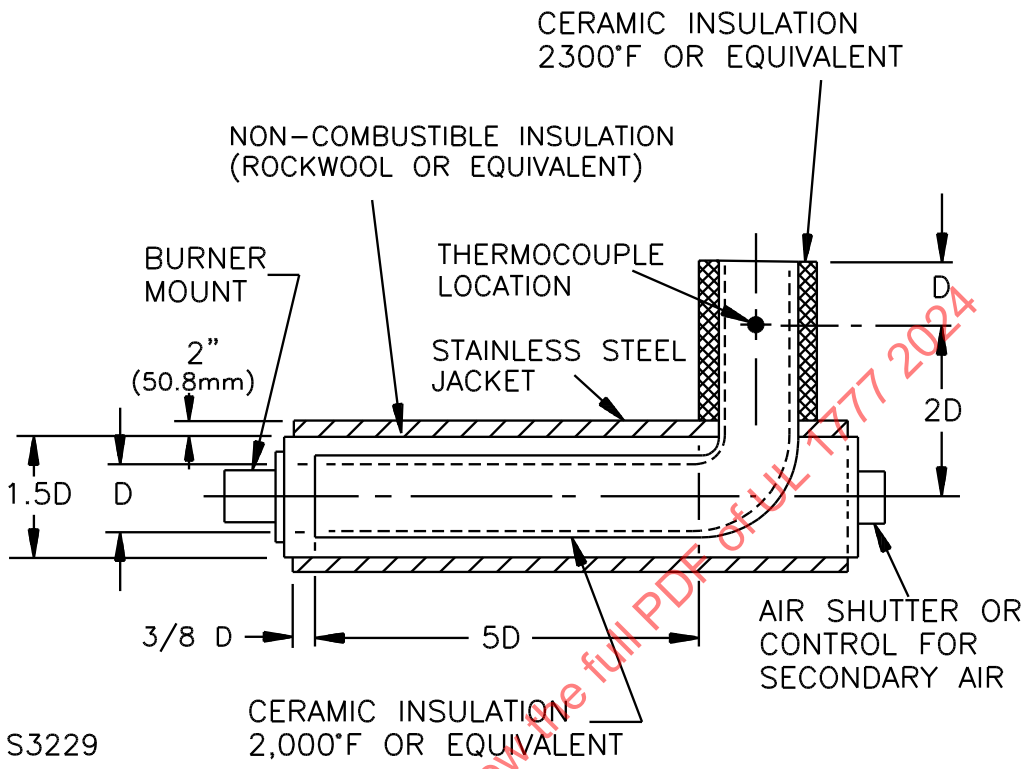


Table 15.1
Flue-gas generator inputs (for solid-fuel-fired appliances)

Equivalent nominal diameter of chimney liner		Minimum input to flue-gas generator, Btu per hour (kW)					
		Column 1		Column 2		Column 3	
		Temperature test for solid-fuel-fired appliances – 1000°F (538°C) flue gases, Section 17		Temperature test for solid-fuel-fired appliances – 1400°F (760°C) flue gases, Section 18		Temperature test for solid-fuel-fired appliances – 2100°F (1149°C) flue gases, Section 19	
Inches	(mm)						
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)

Table 15.2
Flue-gas generator inputs (for oil-fired appliances)

Equivalent nominal diameter of chimney liner		Minimum input to flue-gas generator			
		Column 1		Column 2	
Inches	(mm)	btu/hr	(kW)	btu/hr	(kW)
		Temperature test for oil-fired appliances – 570°F (299°C) flue gases, Section 20		Temperature test for oil-fired appliances – 1700°F (927°C) flue gases, Section 21	
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)

Table 15.3
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 22	
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)

15.13 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.

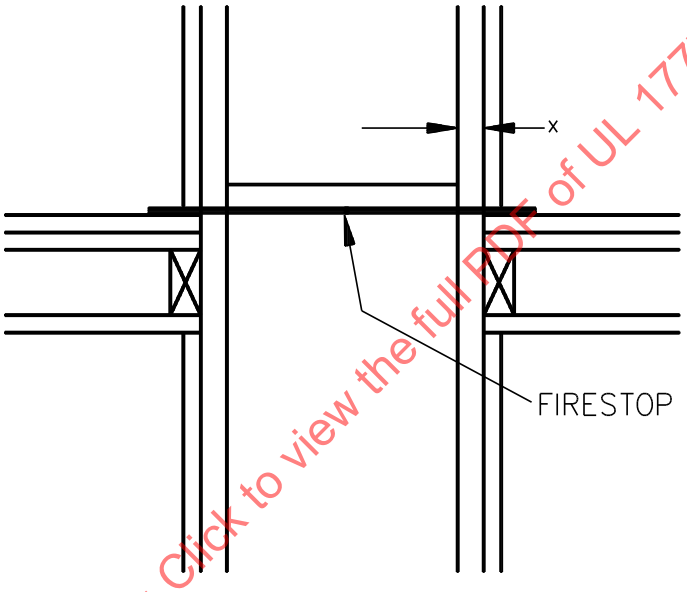
Exception: A burner assembly other than a premix type shall not be used unless the assembly is designed for and operated to supply the gas and air in a stoichiometric mixture to the flue gas generator.

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

15.14 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 Figure 15.4 and Figure 15.5. The dimension "X" is to be 1 inch (25 mm) on all four sides, or 0 inch on all four sides.

Figure 15.4

Test chimney ceiling firestop

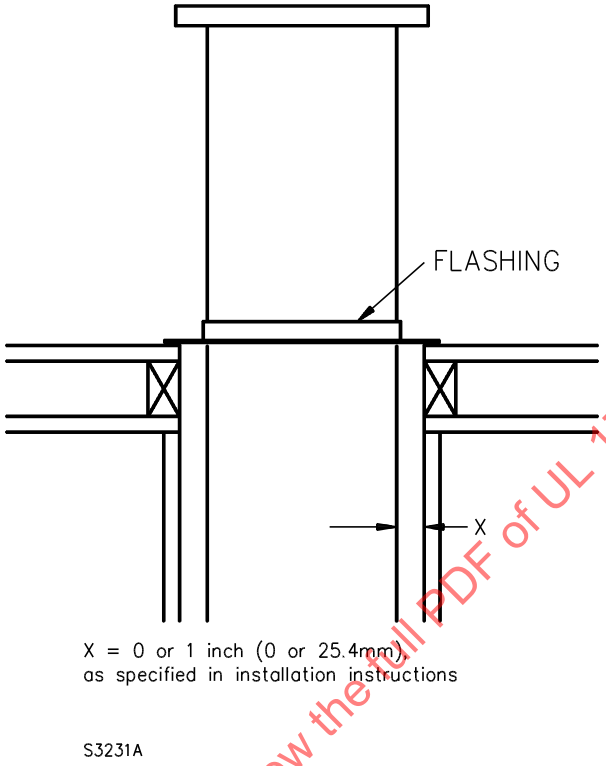


X = 0 or 1 inch (0 or 25.4 mm), as specified in installation instructions

S3230B

Figure 15.5

Test chimney roof flashing



15.15 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 Figure 15.4 and Figure 15.5. All ceiling, floor, and roof material is to be cut flush with the inside of all framed joist openings.

15.16 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 Figure 15.1 and Figure 15.2.

15.17 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.

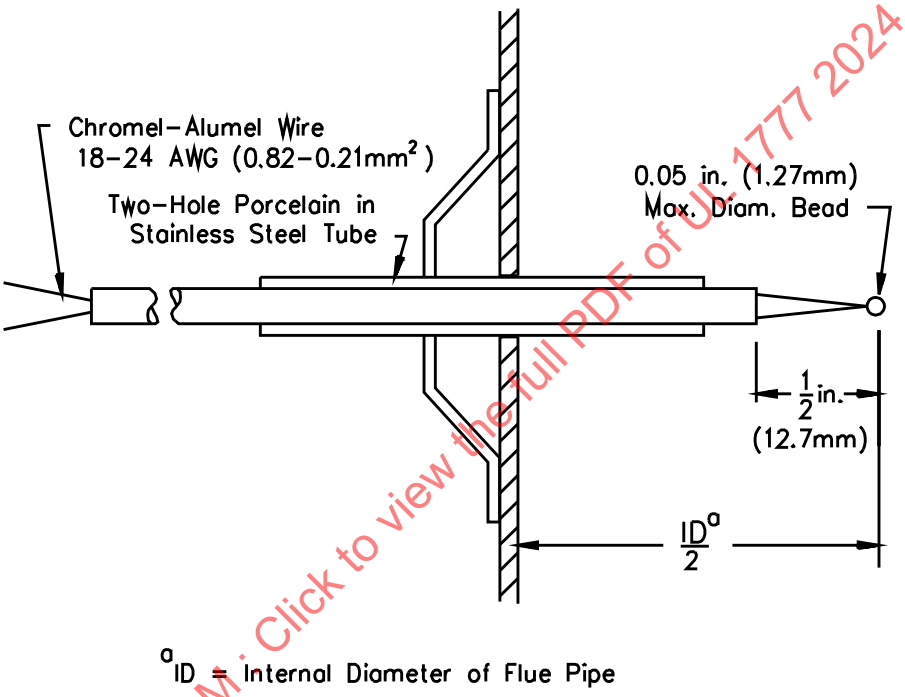
15.18 All joints and openings between spacers or supports and the test enclosure, all joints in a test enclosure, and all joints intended to be sealed for field installation are to be sealed with plastic-coated or film-faced pressure-sensitive tape lapping the joint by a minimum of 1 inch (25 mm) on 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, at elevated temperatures of 150°F (66°C).

16 Temperature Measurement

16.1 Flue-gas temperatures are to be determined for the tests in Sections 17 – 19 by a thermocouple, such as illustrated by Figure 16.1. The thermocouple is to be located within the insulated outlet of the flue-gas generator as illustrated in Figure 15.3. The thermocouple is to be Type K (chromel-alumel) of 18 – 24 AWG (0.82 – 0.21 mm^2) wire with an untwisted welded bare bead junction not more than 0.050 inch (1.27 mm) diameter.

Figure 16.1

Flue-gas thermocouple and support bracket



16.2 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.

16.3 The gas burner then is to be operated as specified in the Temperature Tests, Sections 17 – 22, and the dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple described in 16.2 is as specified for the individual tests by using the flue-gas generator input specified in Table 15.1, Table 15.2, or Table 15.3 for the size of the liner being tested.

16.4 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 24 AWG (0.21 mm^2). Thermocouples are to be:

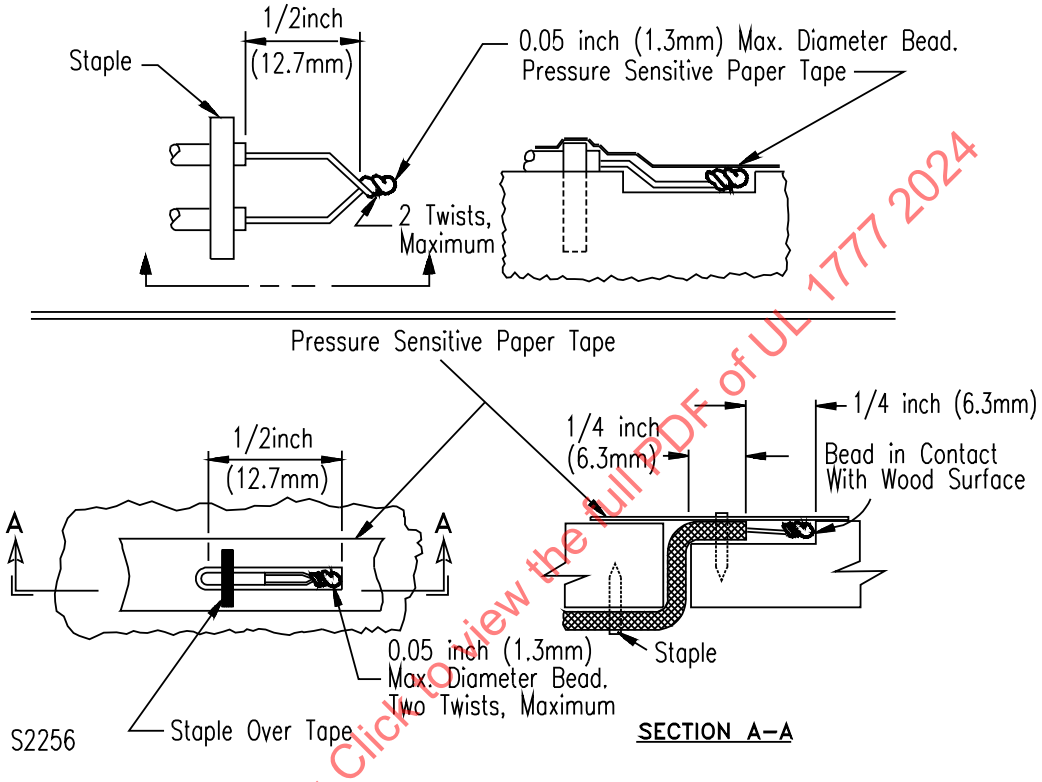
a) Attached to test enclosure elements having a surface adjacent to the chimney and onto roof areas adjacent to the chimney so as to have 1/2 inch (12.7 mm) of wire exposed; and

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 16.2.

Figure 16.2

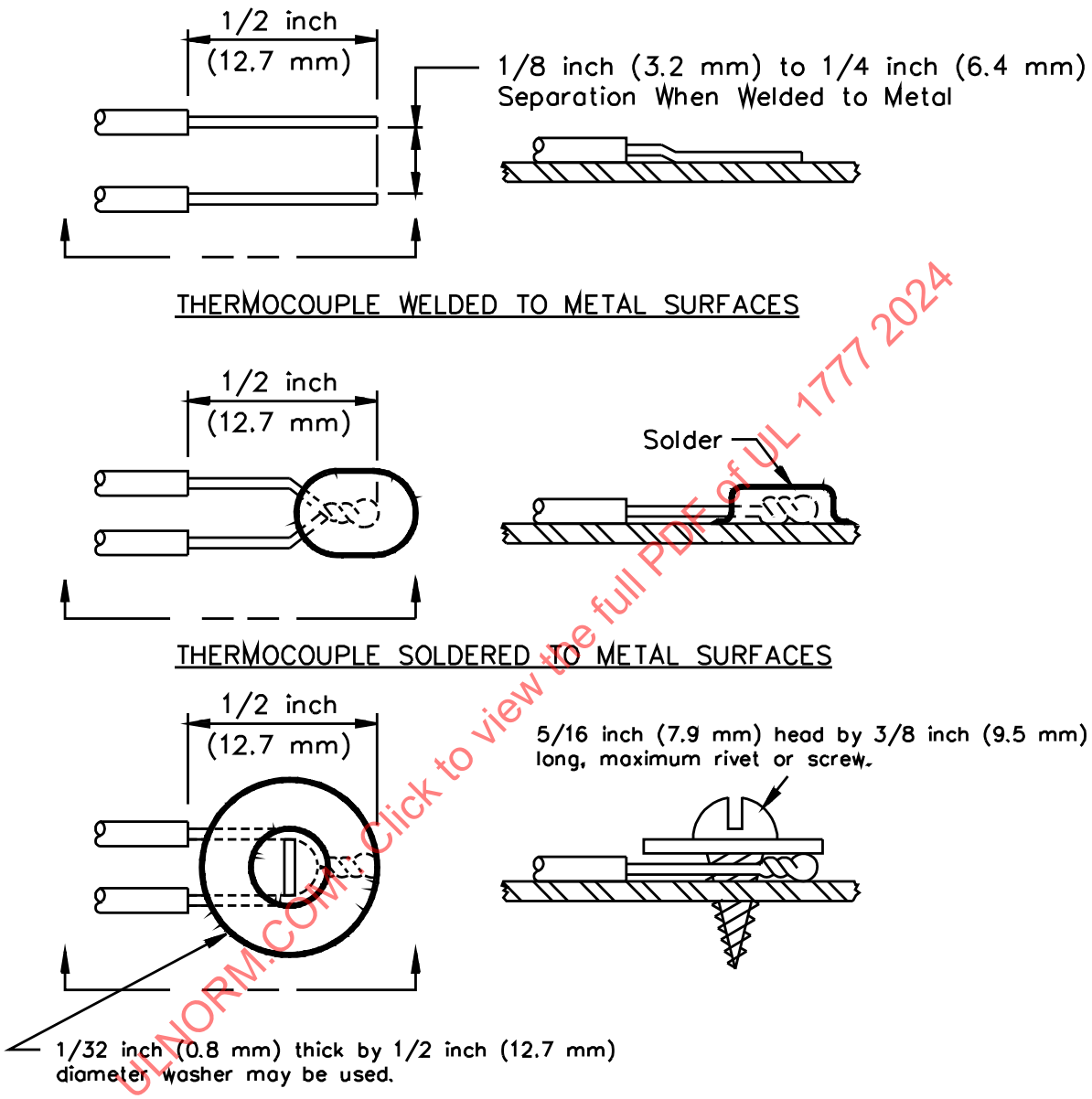
Thermocouple installation methods on wood surfaces



16.5 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 16.3. 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 16.3

Thermocouple installation methods on metal surfaces



S2257

16.6 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.

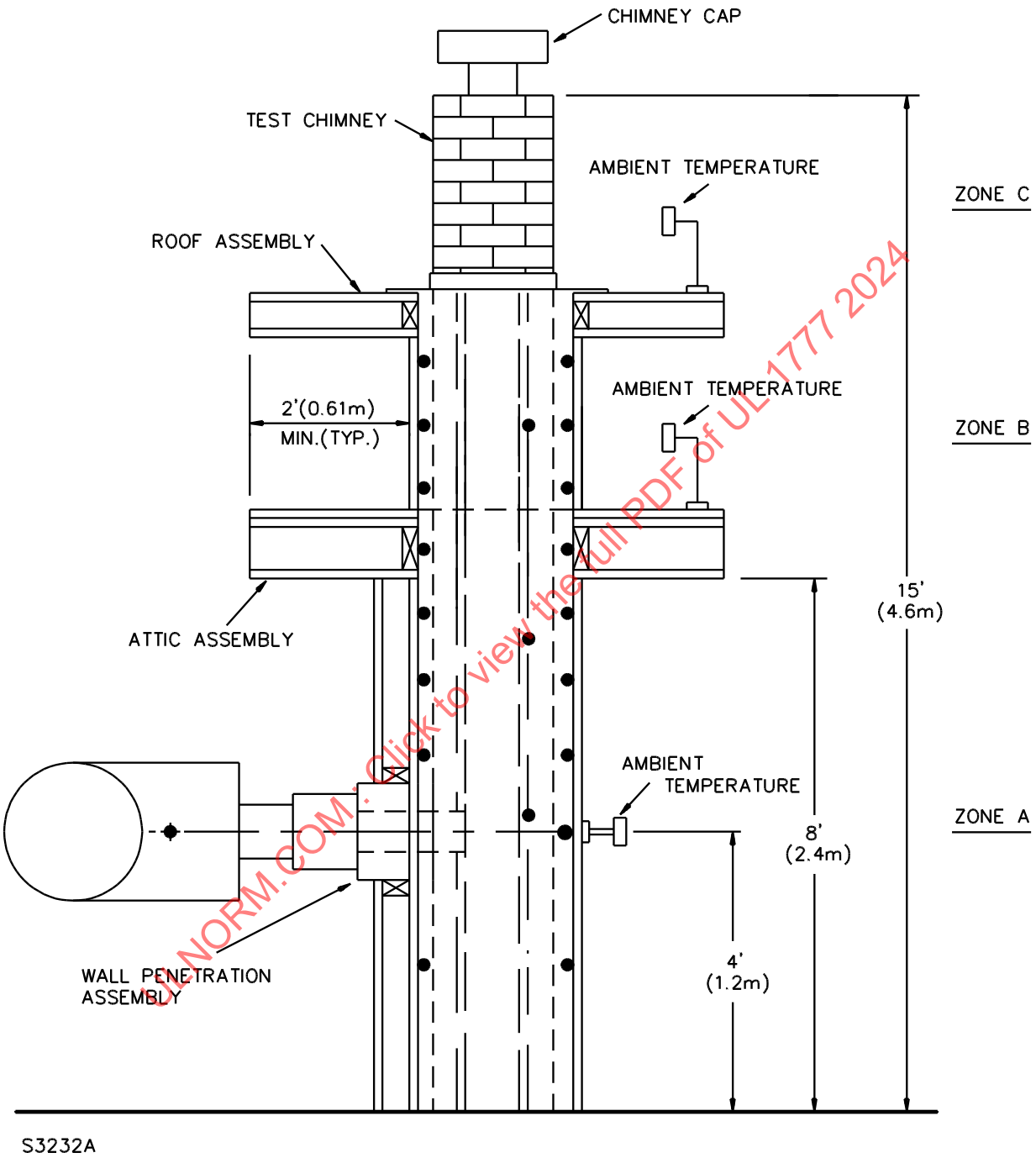
16.7 The ambient temperature in Zone A illustrated in Figure 16.4 is to be determined by a thermocouple located 4 feet (1.2 m) above the floor and 6 inches (152 mm) away from the plywood enclosure that is opposite the flue-gas generator.

16.8 The ambient temperature in Zone B illustrated in Figure 16.4 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.

16.9 The ambient temperature in Zone C illustrated in Figure 16.4 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 16.4

Typical thermocouple locations – test chimney



16.10 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 16.1 – 16.9. 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 material 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.

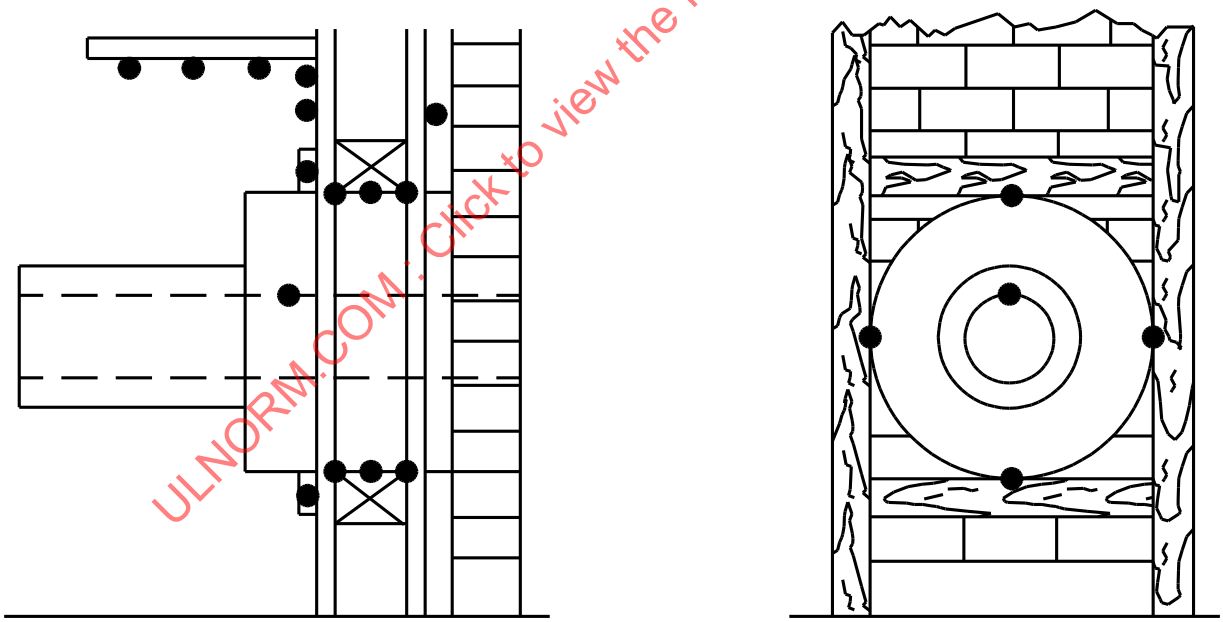
16.11 During the Temperature Tests, Sections 17 – 22, the temperature rises are to be based on the ambient or room temperature recorded at the end of the firing period prescribed for the test.

16.12 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.

16.13 A minimum number of typical thermocouple locations on wood surfaces and chimney liner materials is shown in Figure 16.4 and Figure 16.5. Additional thermocouples are to be used when required because of the construction and method of installation.

Figure 16.5

Typical thermocouple locations – wall penetration assembly



S3233A

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

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

17.1 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 17.3. The temperature on any part shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 17.1.

Table 17.1
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.

17.2 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.

17.3 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 15.1, and regulated to produce flue gases at a temperature of 1000°F (555°C) at the thermocouple location designated in Figure 15.3. 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.

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

18.1 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 18.2. 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 17.1.

18.2 After maximum temperatures are attained under the test conditions described in 17.3, the flue-gas generator is to be fired at the input specified in Column 2 of Table 15.1, and regulated to produce flue gases at a temperature of 1400°F (760°C) at the thermocouple location designated in Figure 15.3. 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.

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

19.1 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 19.3 – 19.5 or after the flue-gas generator is shut off.

19.2 A chimney liner assembly shall comply with the requirements specified in 14.2 and 14.3 after being tested in accordance with 19.3 – 19.5.

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

19.4 The test conditions then are to be established at the inputs shown in Column 1 of Table 15.1, 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 16.1 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.

19.5 After maximum temperatures are attained under the test conditions described in 19.4, the input to the flue-gas generator is to be increased to that specified in Column 3 of Table 15.1 and regulated to produce a temperature of 2100°F (1149°C) at the thermocouple location designated in Figure 15.1 and Figure 15.2. 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.

19.6 The test specified in 19.5 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.

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

20.1 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 20.3. The temperature on any part shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 17.1.

20.2 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.

20.3 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 15.2, and regulated to produce flue gases at a temperature of 500°F (278°C) above room temperature at the thermocouple location designated in Figure 15.3. 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.

20.4 The flue-gas generator inputs specified in Table 15.2 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.

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

21.1 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 21.2 or after the flue-gas generator is shut off.

21.2 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 20, the input to the flue-gas generator is to be increased to that specified in Column 2 of Table 15.2 and regulated to produce a temperature of 1630°F (906°C) above room temperature at the location designated in Figure 15.3 and the test continued for 10 minutes, at which time the burner is to be shut off.

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

22.1 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 22.3. The temperature on any part shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 17.1.

22.2 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.

22.3 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 15.3, and regulated to produce flue gases at a temperature of 470°F (243°C) above room ambient at the thermocouple location designated in Figure 15.3. 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.

23 Loading Test for Metallic Chimney Liners

23.1 A metallic chimney liner section shall not be damaged when tested as described in 23.2 and 23.3. See 24.1 for additional loading requirements for metallic chimney liners.

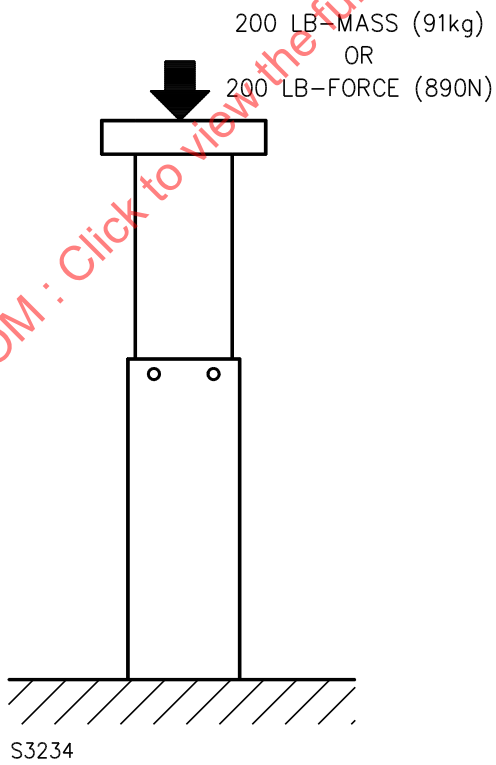
Exception: A non-rigid metallic chimney liner that is intended only for top mounted support (24.3) is not required to comply with 23.2 and 23.3.

23.2 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.

23.3 The assembly is to be subjected to a load of 200 pounds-mass (91 kg) by means of a weight. See Figure 23.1. The load is to be applied for a minimum of 5 minutes.

Figure 23.1

Loading test



24 Vertical Support Test for Metallic Chimney Liners

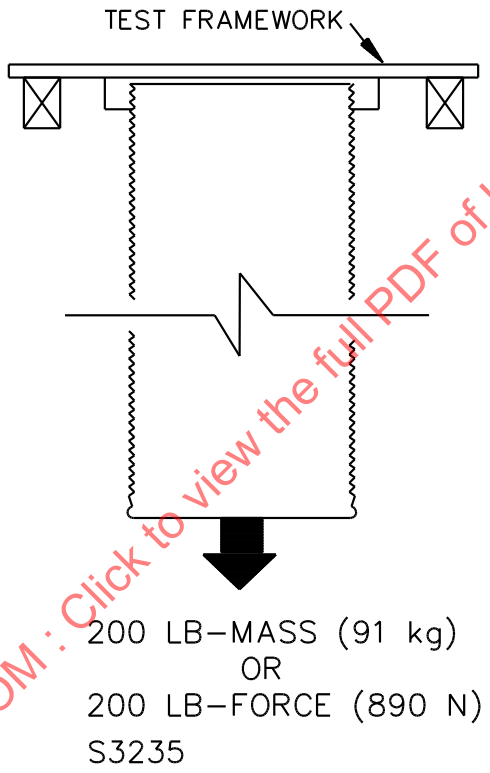
24.1 A support assembly for a metallic chimney liner shall not be damaged, nor shall the security of its attachment to the chimney structure be impaired, when tested as described in 24.2 – 24.4. Additionally, a metallic chimney liner section shall not telescope into an adjoining section or be damaged when tested as described in 24.2 – 24.4.

24.2 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.

24.3 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 the load specified in Table 25.1 as illustrated in Figure 24.1. The load is to be applied for a minimum of 5 minutes.

Figure 24.1

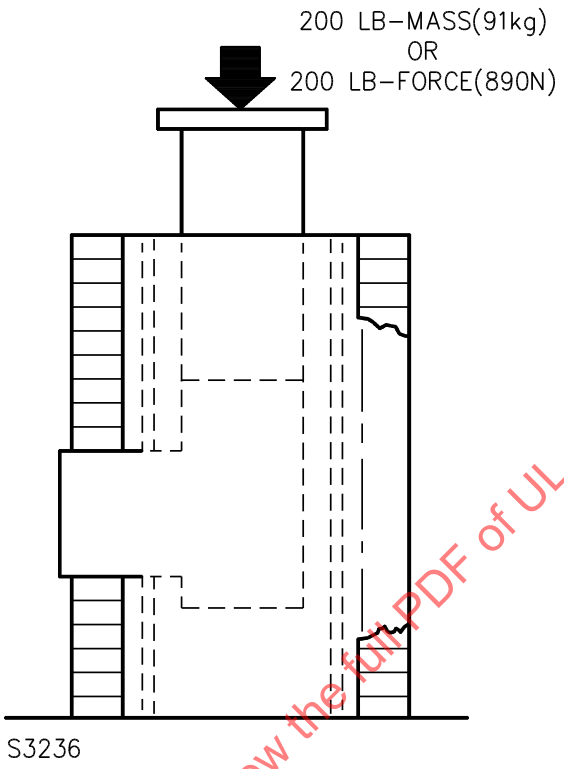
Tensile load test



24.4 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 24.2. The load is to be applied for a minimum of 5 minutes.

Figure 24.2

Compressive load test



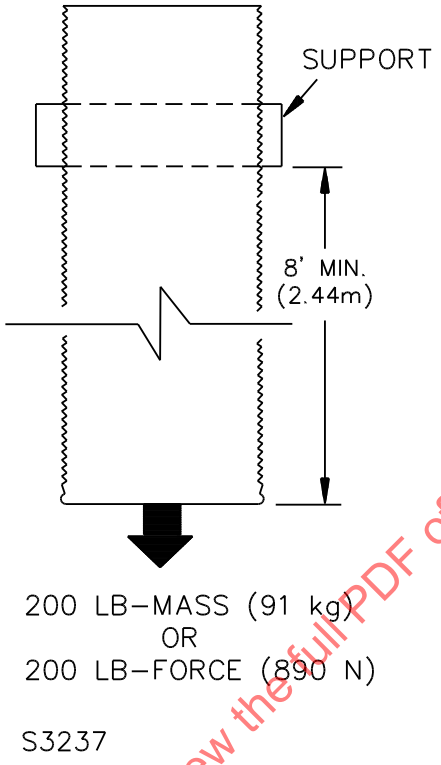
25 Strength Test for Metallic Chimney Liners

25.1 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 tested as described in 25.2 and 25.3.

25.2 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 25.1. A weight specified in Table 25.1 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 25.1

Strength test – single chimney liner section



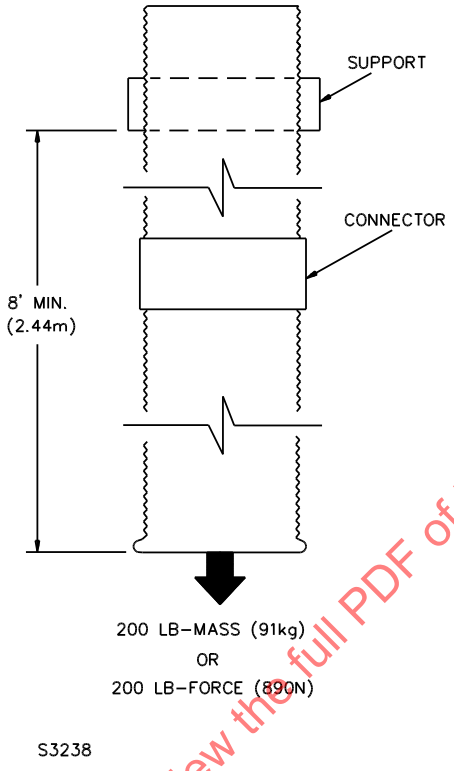
25.3 Two sections of chimney liner sections are to be joined as specified in the installation instructions or training manual, with at least 8 feet (2.44 m) of liner suspended from the support. A weight specified in Table 25.1 is to be suspended from the bottom of the liner, as illustrated in Figure 25.2. The load is to be applied for a minimum of 5 minutes.

Table 25.1
Strength test load

Liner type	Marking (See 39.7)	Mass (pounds)	Mass (Kg)
Gas fired appliance only	When marked with 39.7(a) only	100	(46)
All liners except those for gas fired appliances	When marking includes 39.7 (b) or (c) or any combination of (a), (b) and (c)	200	(91)

Figure 25.2

Strength test – joined chimney liner sections



26 Strength Test for Nonmetallic Chimney Liners

26.1 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, 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).

27 Sweep Test

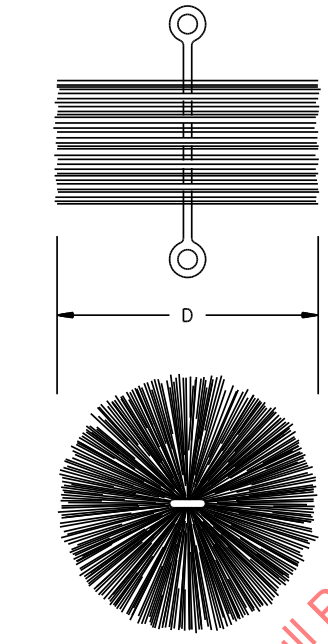
27.1 A metallic chimney liner shall not bend, break, split at a seam or joint, puncture, or experience a loss in mass of more than 0.1 percent, and a nonmetallic chimney liner shall not crack, dislodge, or experience a loss in mass of more than 1.0 percent, when tested as described in 27.2.

Exception: A metallic chimney liner that does not include the markings specified in 39.7 (b) or (c) is not required to comply with the Sweep Test, Section 27.

27.2 Following the temperature tests described in Sections 17 – 19, a chimney liner is to be swept by means of a metal chimney cleaning brush as illustrated in Figure 27.1, 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 27.1

Chimney cleaning brush



28 Abrasion Test

28.1 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 6.1, shall comply with the requirements specified in 28.2 and 28.3 when tested described in 28.4.

28.2 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 28.4.

28.3 The effectiveness of the insulation of the chimney liner shall not be reduced when tested as described in 28.4.

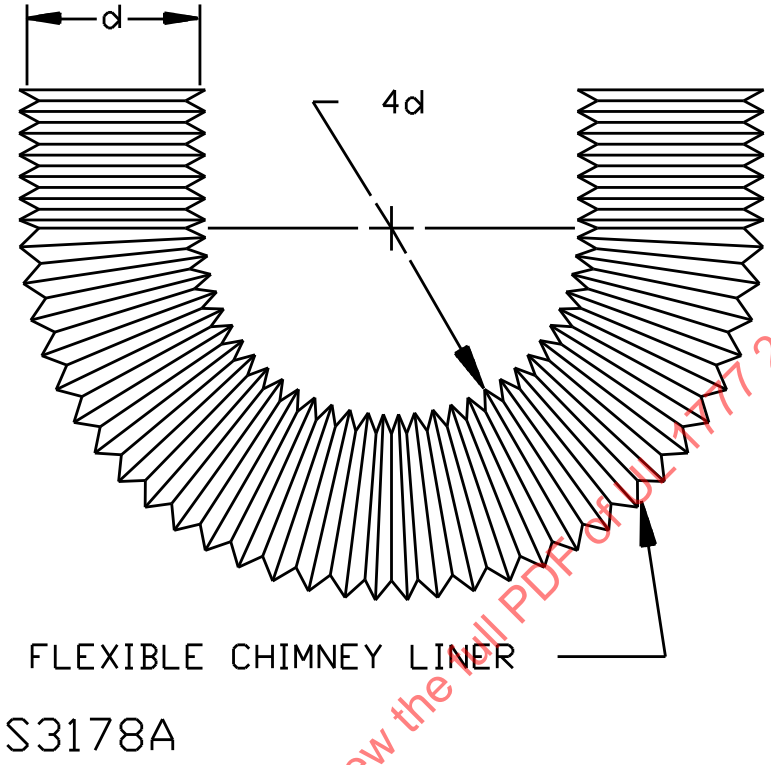
28.4 The entire length of the chimney liner assembly is to be inserted into a test chimney using the methods described in the manufacturer's installation instructions, and subsequently removed. The process of inserting and removing the liner assembly is to be conducted ten times.

29 Flexibility Test for Flexible Metal Liners

29.1 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 29.1. 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.

Figure 29.1

Flexibility test



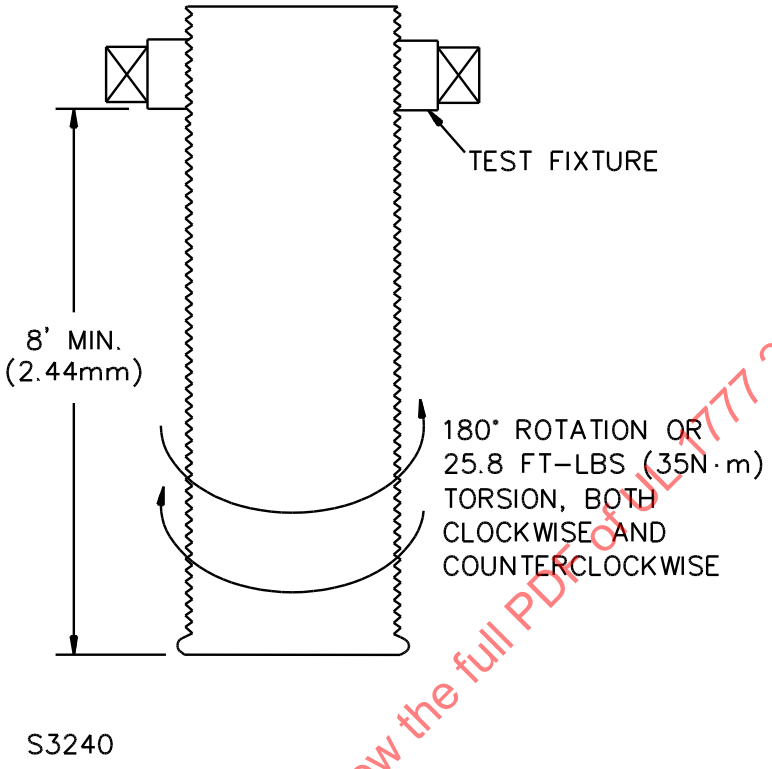
30 Torsion Test for Flexible Metal Liners

30.1 A flexible metal chimney liner shall not break open, split, change shape, crease or otherwise be deformed when tested as described in 30.2.

30.2 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 30.1.

Figure 30.1

Torsion test



31 Corrosion Resistance Test

31.1 When tested as described in 31.2 – 31.4, 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.

31.2 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.

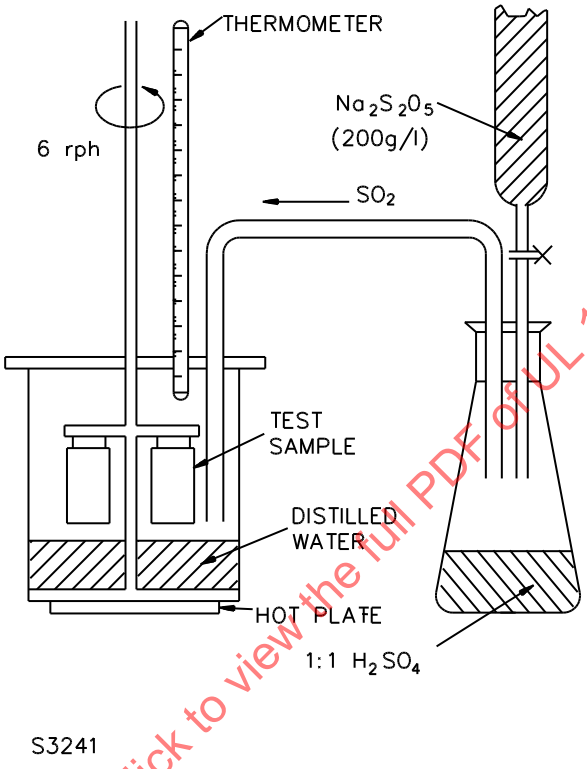
31.3 The exposure specified in 31.2 is to be accomplished by suspending the test specimens from a flat nonmetallic disc, 10 inches (250 mm) in diameter, that is fastened to a shaft and rotated at a speed of 6 revolutions per hour and enclosed in a container. The cover of the container is to be secured 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 (SO_2) is to be fed into the container that contains the test sample (see 31.4).

31.4 The generator used to produce the gas is to consist of a 50 milliliter burette containing 200 grams of sodium metabisulfite ($Na_2S_2O_5$) per liter of distilled water connected to a 2 liter flask containing 300 milliliters of 1:1 H_2SO_4 solution. The solution of $Na_2S_2O_5$/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 31.1.

Figure 31.1

Condensing SO_2 apparatus



32 Comparative Corrosion Exposure Test for Aluminum Liners

32.1 When tested as described in 32.2 – 32.4, 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.

32.2 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 32.4.

32.3 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.

32.4 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.

33 Comparative Corrosion Exposure Test for Stainless Steel Liners

33.1 When tested as described in 33.2 – 33.4, 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.

33.2 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 33.4:

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.

33.3 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.

33.4 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.

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

34.1 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 34.2 and 34.3.

34.2 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).

34.3 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 34.2.