UL 103

STANDARD FOR SAFETY

Factory-Built Chimneys for Residential Type and Building Heating Appliances

UL Standard for Safety for Factory-Built Chimneys for Residential Type and Building Heating Appliances, UL 103

Eleventh Edition, Dated October 15, 2010

Summary of Topics

This revision of ANSI/UL 103 dated September 24, 2021 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 UL'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 July 9, 2021.

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OCTOBER 15, 2010
(Title Page Reprinted: September 24, 2021)

UL 103

Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances

The First and Second editions were titled Chimneys, Factory-Built.

Fifth Edition – February, 1978
Sixth Edition – February, 1983
Seventh Edition – February, 1989
Eighth Edition – August, 1994
Ninth Edition – December, 1995
Tenth Edition – August, 2001

Eleventh Edition

October 15, 2010

This ANSI/UL Standard for Safety consists of the Eleventh Edition including revisions through September 24, 2021.

The most recent designation of ANSI/UL 103 as a Reaffirmed American National Standard (ANS) occurred on September 24, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 103 on September 16, 1991. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover factory-built chimneys intended for venting gas, liquid, and solid-fuel fired residential-type appliances and building heating appliances in which the maximum continuous flue-gas outlet temperatures do not exceed 1000°F (538°C). Factory-built chimneys are intended for installation in accordance with the Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances, NFPA 211, and in accordance with codes such as the International Mechanical Code, the International Residential Code, and the Uniform Mechanical Code. They are intended for installation inside or outside of buildings or both, in a manner that provides a vertical (30 degree maximum offset) conduit or passageway to transport flue gases to the outside.

1.2 The chimneys covered by these requirements comply with either a limited duration 1700°F (927°C) flue-gas temperature test or a limited duration 2100°F (1149°C) flue-gas temperature test, at the manufacturer's option.

1.3 These requirements cover dual purpose residential type and building heating appliance type chimneys, and single purpose building heating appliance type chimneys. Dual purpose residential type and building heating appliance type chimneys are tested enclosed and intended to be installed unenclosed or enclosed with combustible construction. Single purpose building heating appliance type chimneys are tested unenclosed and intended to be installed unenclosed or enclosed in a noncombustible chase.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2 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.

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

2.4 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.

3 Units of Measurement

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

4 Undated References

4.1 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.

5 Glossary

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

5.2 COMBUSTIBLE MATERIAL, NONCOMBUSTIBLE MATERIAL – As used in these requirements, these terms are defined in the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, NFPA 211.

CONSTRUCTION

6 Materials

6.1 A chimney part shall be made of noncombustible corrosion-resistant materials. Metals shall not be used in combinations at any location within the assembly that causes galvanic action.

6.2 The minimum thickness of sheet metal including any coatings and of other materials shall comply with Table 6.1.

6.3 A flue-gas conveying conduit of a chimney shall be of stainless steel, porcelain-coated steel or cast or fired refractory of the minimum thickness specified in Table 6.1. Porcelain-coated steel and cast or fired refractory shall comply with the requirements of the applicable tests described in Sections 31 – 35.

6.4 An unreinforced outer casing of a chimney shall be of galvanized steel, aluminum-coated steel, Series 300 or 400 stainless steel, or equivalent material. Minimum thickness of these materials shall be as specified in Table 6.1.

6.5 An outer casing reinforced by solid refractory not less than 2 inches (50.8 mm) thick shall be of galvanized steel, aluminum-coated steel, stainless steel or equivalent material. Minimum thickness of these materials shall be as specified in Table 6.1.

6.6 Parts of a chimney subject to contact by flue gases or flue-gas air mixtures at or beyond the terminus of the flue-gas conveying conduit shall be of a material equivalent to the flue-gas conveying conduit. See 6.3.

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

a) Is such that deterioration or corrosion of the part causes the chimney system to collapse or otherwise increase the risk of injury to persons;

b) Adjoins firestopping material; or

c) Is subject to condensation.

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

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

Exception No. 2: This requirement does not apply to parts subject to contact by flue-gas or flue-gas air mixtures at or beyond the terminus of the flue-gas conveying conduit. See 6.6.

Table 6.1
Minimum thickness of chimney material

Type of material	Use of material	Paragraph reference	Equivalent nominal inside diameter of chimney					
			12 or less inches (305 or less mm)		Over 12 to 24 inches (over 305 to 610 mm)		Over 24 to 36 inches (over 610 to 914 mm)	
			Minimum material thickness					
			Inch	(mm)	Inch	(mm)	Inch	(mm)
Stainless steel – Series 300 or 400 or equivalent	Flue-gas conduit of chimneys evaluated to 1700°F; other parts exposed to flue gases or subject to condensation	6.3, 6.6	0.012[a]	(0.30)	0.016	(0.41)	0.020	(0.51)
Stainless steel – Series 300 or 400 or equivalent	Flue-gas conduit of chimneys evaluated to 2100°F	6.3	0.015	(0.33)	0.016	(0.41)	0.020	(0.51)
Stainless steel – Series 300 or 400 or equivalent	Outer casing, unreinforced	6.4	0.012	(0.30)	0.016	(0.41)	0.026	(0.66)
	Outer casing, reinforced	6.5	0.012	(0.30)	0.012	(0.30)	0.012	(0.30)
	Component or subassembly	6.9	0.012	(0.30)	0.012	(0.30)	0.012	(0.30)
Galvanized steel, G-90 coating designation or aluminum-coated steel – Type T1-40	Outer casing, unreinforced	6.4, 6.7	0.018	(0.46)	0.023	(0.58)	0.034	(0.86)
	Outer casing, reinforced	6.5	0.018	(0.46)	0.018	(0.46)	0.018	(0.46)
	Component or subassembly	6.9	0.018	(0.46)	0.023	(0.58)	0.034	(0.86)
Aluminum alloys or painted steel	Component or subassembly	6.9	0.016	(0.41)	0.016	(0.41)	0.016	(0.41)
Steel, painted	Outer casings or structural part	6.10	0.053	(1.35)	0.053	(1.35)	0.053	(1.35)
Porcelain-coated steel-base metal	Flue-gas conduit of chimneys evaluated to 1700°F	6.3	0.026	(0.66)	0.032	(0.81)	0.032	(0.81)
Cast iron	Outer casing or structural part	6.10	0.125	(3.18)	0.125	(3.18)	0.125	(3.18)
Cast or fired refractory, clay tile	Flue-gas conduit	6.3	0.40	(10.2)	0.65	(16.5)	1.00	(25.4)

[a] Flue-gas conduit employed for tee sections shall be of 0.015 inch (0.38 mm) minimum thickness.

6.8 Galvanized steel used for outer casings, structural parts, firestopping or other components or subassemblies shall have a zinc-coating complying with the coating designation G90 (former coating class 1.25 commercial) in the Weight (Mass) of Coating Requirements table of 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 the ASTM designation. 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, or subassemblies, which are not required to conform to 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 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 determined as having corrosion resistance 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 that is not self-supporting shall be applied to solid surfaces so that the insulation does not sag. An adhesive or cement used to attach such material shall retain its adhesive qualities at any temperature the adhesive attains when tested in accordance with these requirements and at 0°F (minus 18°C).

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

6.15 Asbestos material shall not be used.

7 Assembly

7.1 A chimney shall consist of all the essential parts required for the intended installation of a complete chimney assembly. 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: An assembly or component part intended to be cut to length or to be fitted by the installer is provided when 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. Drilling shall not occur unless:

a) The drilling operation does not weaken the assembly or penetrate into the flue liner; and

b) The size of the required drill bit is specified and the instructions clearly describe the locations 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 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-pipe section or length, cap, firestop-spacer, support element, roof assembly, or jack shall be completely assembled by the manufacturer at the factory.

7.4 To comply with the requirements of 7.3, a chimney-pipe section comprised of a flue-gas conveying conduit, formed insulation or other intermediate assembly, and an outer jacket, which are separable, shall be preassembled and packaged as one unit. A firestop-spacer assembly constructed in two halves shall

be packaged as one unit. In such cases, each separable part shall be completely formed, including the joining of all seams.

7.5 After being installed in accordance with the manufacturer's instructions, a chimney shall be positioned securely and resistant to wind damage. See Vertical Support Test, Section 26; Strength Test, Section 27; and Wind Load Test, Section 28.

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

7.7 The construction of a chimney shall not void the firestopping required between spaces of a building when the chimney is installed in accordance with the manufacturer's instructions.

7.8 When a chimney assembly incorporates elbows, no part of the chimney shall be at an angle of more than 30 degrees from the vertical at any point in the assembly, and the chimney shall not include more than two offsets (four elbows).

8 Chimney Caps

8.1 A cap shall be provided.

Exception: A chimney designated as a building heating appliance type only and that does not incorporate unprotected ventilation openings terminating exterior to the building is not required to be provided with a cap.

8.2 A cap shall resist the entrance of debris and rain into the flue gas conveying conduit and into any unprotected ventilation openings terminating exterior to the building. Protection devices intended to protect only ventilation air openings terminating exterior to the building shall resist the entrance of debris and rain into such ventilation openings. See Rain Test, Section 28.

8.3 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 will obstruct the flue-gas or cooling-air passages.

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

9 Firestop-Spacers

9.1 A chimney intended to pass through a floor or ceiling of a building shall be provided with an assembly constructed to provide firestopping at the framed joist opening and to establish and maintain required minimum clearances between chimney sections and combustible construction in this area. Spacers shall have the strength and bearing surface to maintain the required clearance from chimney sections to joists and ceiling and floor material.

9.2 A firestop shall provide complete firestopping when the assembly is installed in a framed joist opening that is 1/2 inch (13 mm) greater on each side than the opening for which the assembly is intended. A spacer shall provide for continuous interference around the perimeter of the construction for a height of not less than 1 inch (25 mm). The inside diameter of the firestop opening shall not be more than 1/8 inch (3.2 mm) greater than the outside diameter of the chimney pipe, including chimney joints and raised projections.

9.3 An attic insulation shield shall be provided to restrict loose fill or other insulation from contacting the chimney section. The attic insulation shield assembly shall maintain an air space clearance not less than the air space clearance marked on the chimney sections. The vertical height of the shield above attic construction material shall be not less than 10 inches (254 mm). The spacer shall extend to the chimney above the 10 inches at an angle of not greater than 45 degrees from a vertical coinciding with the perimeter of the shield.

9.4 The attic insulation shield required by 9.3 shall be separate from the firestop-spacer when the shield is intended to be removed. Also, the removal of the shield, or any part of the shield, shall not affect the firestop-spacer assembly. When the shield is not intended to be removed, the attic insulation shield is integral with the firestop-spacer. The spacer assembly includes the attic insulation shield above the attic floor and the firestop-spacer below the attic joist.

9.5 An attic insulation shield shall be provided with a permanent marking, visible after installation, as specified in 36.3, when the shield is:

a) Intended for installation in an unoccupied attic space;

b) Specified in the installation instructions in accordance with 37.5 (t); and

c) Tested in accordance with the Exception to 17.2.9.

9.6 When openings for ventilation in an attic insulation shield intended for installation in an unoccupied attic space are provided, the openings shall not be located less than 10 inches (254 mm) above the attic construction material and shall be constructed to restrict:

a) Entrance of insulation into the area between the chimney and the shield; and

b) Accumulation of the insulation in or near the openings, as determined by the attic insulation ventilation opening test described in Section 29, Attic Insulation Shield Ventilation Opening Test.

10 Joints

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

10.2 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.

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

10.4 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.

10.5 A joint shall not reduce the capacity of the chimney to the extent that it interferes with venting.

10.6 A chimney joint shall be constructed to resist the entrance of rain such that condensation does not flow from the exterior of a chimney section to the interior of a lower section.

10.7 A chimney intended for use in positive internal pressure applications shall be of a design such that the seal (resistance to leakage) is created at or between joints of the flue gas passageway. Supplemental

sealing methods at the outer wall shall not be relied upon to comply with the Positive Pressure Applications Test, Section 24.

11 Radiation Shields

11.1 A radiation shield provided to comply with the maximum temperature limits of these requirements for floor or ceiling structures shall:

a) Be an integral part of a firestop-spacer or support assembly; and

b) Provide a continuous barrier for a vertical distance, referenced to the ceiling or floor level, of not less than 10 inches (254 mm).

11.2 The assembly described in 11.1 shall fit into a framed joist area not larger than the sum of:

a) 1/2 inch (12.7 mm) greater on each side than the outside diameter of the chimney; and

b) Twice the dimension specified in the installation instructions for clearance between chimney sections and combustible enclosures.

11.3 Parts of a firestop-spacer or support assembly that are not intended to provide shielding from radiation to combustible construction are not radiation shields.

11.4 A radiation shield provided to obtain compliance with the maximum temperature limits of these requirements for roof structures shall not be employed in a roof or other terminating assembly intended to be altered in the field when such alteration requires the shifting or relocation of the shield.

12 Roof Assemblies

12.1 The height of a roof assembly shall be such that the flue-gas exit is not less than 3 feet (0.9 m) above the highest point where the chimney passes through the roof.

12.2 A roof assembly installed in accordance with the installation instructions shall resist the entrance of excess water and debris into the building. See Rain Test, Section 30.

12.3 A roof assembly shall resist the accumulation of soot and debris therein when such accumulation obstructs flue-gas or cooling-air passages. See Sections 20 – 23.

12.4 A section of a roof assembly that gives access to the chimney flue shall be removable and replaceable by the use of simple hand tools (screwdriver, wrench, pliers, or similar tools) to allow for chimney cleaning in accordance with the maintenance instructions without bending or deforming of the chimney or roof assembly section.

12.5 A roof flashing assembly that provides for ventilation shall be constructed so that soot or debris does not accumulate on the assembly to the extent that ventilation openings intended to remain open are obstructed. (See also the requirements of 9.2 and 17.2.13, which apply to openings between the chimney and the flashing, and between the flashing and the test enclosure.) See Figure 12.1, which illustrates a typical roof flashing housing assembly. The ventilation shall be provided by one or more fixed openings surrounding the chimney and the assembly shall comply with all of the following:

a) The openings shall not permit entrance of a 1/4 inch (6.4 mm) diameter rod.

b) The lowest portion of the opening in the flashing shall not be less than 6 inches (152 mm) above the roof, measured perpendicular to the roof.

c) The assembly shall incorporate a storm collar.

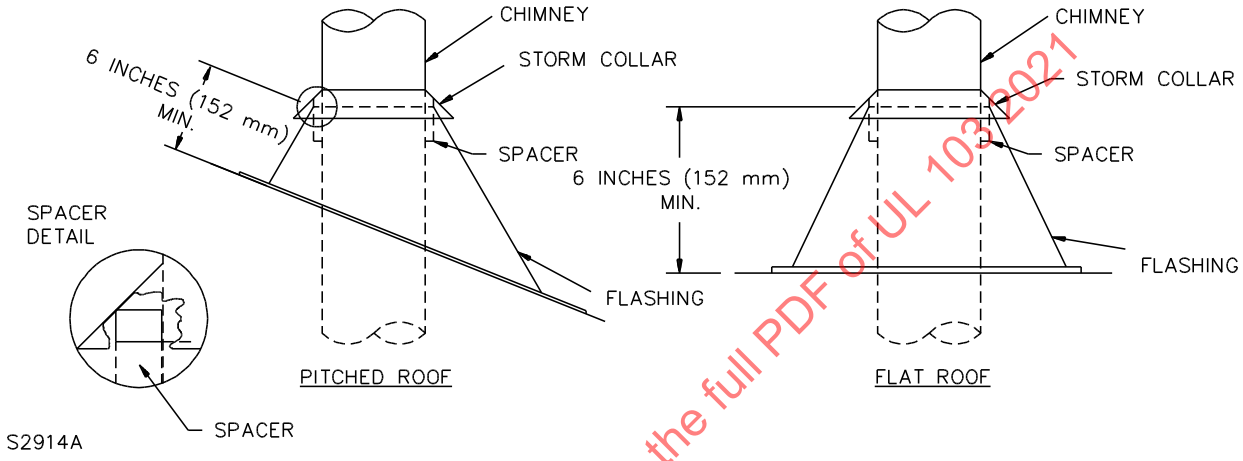
d) The intended openings shall be maintained by means of:

1) Spacers factory attached to the flashing; or

2) Designed openings in the assembly.

Figure 12.1

Typical roof flashing housing assembly



13 Roof Jacks

13.1 A roof jack constructed for placement in contact with combustible roof, rafter, insulation, and ceiling material shall provide a continuous surface or barrier for a vertical distance, measured from the roof line, of at least 6 inches (150 mm).

13.2 When installed in accordance with the manufacturer's instructions, a roof jack shall protect against the entrance of water and debris into the building where the chimney passes through the roof. See Rain Test, Section 30.

13.3 A roof jack shall be constructed so that soot or debris does not accumulate therein when such accumulation obstructs flue-gas or cooling-air passages.

13.4 A section of a roof jack that gives access to the chimney flue shall be removable and replaceable by the use of simple hand tools (screwdriver, wrench, pliers, or similar tools) to allow for chimney cleaning in accordance with the installation instructions without bending or deforming of the chimney or roof jack section.

14 Support Assembly

14.1 A support assembly (such as a ceiling or floor support) shall establish and maintain the minimum required clearance between a chimney section and combustible construction. A support for installation in a joist area shall constitute a complete firestop when tested in accordance with these requirements.

14.2 A support assembly shall sustain a load equivalent to four times the weight imposed upon it by all chimney parts it is intended to support. See Vertical Support Test, Section 26.

14.3 A support assembly intended to be secured by nails or screws shall be arranged so that the load on such holding means is a shear load.

14.4 A chimney assembly intended for exterior installation shall be provided with support assemblies. See Sections 26, Vertical Support Test, and 28, Wind Load Test.

14.5 An offset chimney section shall be supported at or immediately above the vertical return elbow at the first floor or roof above the offset section.

14.6 An exterior support assembly shall be constructed to maintain specified clearances to adjacent combustible construction.

15 Openings in Chimney Walls

15.1 Openings for air flow provided in the chimney's walls shall not be located in the flue gas conduit wall. Such openings shall not impair the structural integrity of the chimney.

15.2 The openings for air flow specified in 15.1 shall be located within the chimney support assembly. Those openings made at chimney joints that are intended for fastening adjoining chimney sections together only are not air flow openings and are not required to be located within the chimney support assembly.

PERFORMANCE

16 General

16.1 When a chimney is tested in accordance with these requirements, specified temperatures on combustible construction shall be maintained.

16.2 After being subjected to the tests specified in Sections 19 – 23, as applicable, a chimney shall be capable of being used further.

16.3 Test results indicating compliance with the requirement of 16.2 include the following:

a) No part of the chimney has become damaged or permanently distorted to an extent that it or the chimney assembly does not continue to function as intended.

b) The effectiveness of any required protective coating or finish on metal parts has not been reduced.

c) A ceramic material shows no evidence of cracking, disintegration, or spalling to the extent that serviceability of any part of an assembly has been impaired.

d) Cracks are not observable in porcelain enamel used as a required protective coating when the surface is examined under a microscope of 60 magnification.

e) The reflectivity of a surface has not been impaired when the reflectivity is utilized to reduce the risk of fire.

f) Burning or scaling of metal parts is not evident upon visual observation.

Exception: Scaling of chimney flue liner material that does not impair the function of the chimney is permitted after exposure to the temperature test specified in Section 23.

g) The effectiveness of insulating material has not been reduced.

16.4 Thermal insulation shall comply with the following requirements during and following tests on the chimney:

a) The products resulting from the combustion or volatilization of any combustible binder shall be discharged to the chimney terminus outside of the building.

b) The insulating material shall remain in its intended position.

c) The thermal conductivity of the insulating material shall not be increased.

d) The thermal insulation shall not show evidence of softening, melting, or other evidence of malfunction or deterioration.

17 Test Installations

17.1 General

17.1.1 The following factors are to form the basis of the performance tests of a factory-built chimney:

a) For a chimney intended to be enclosed by combustible construction:

1) Size and type of chimney.

2) Height in feet (m) of chimney.

3) Minimum clearance to combustible construction.

b) For an unenclosed chimney installation:

1) Size and type of chimney.

2) Height in feet (m) of chimney.

3) Installation with or without a roof jack.

17.1.2 An insulated chimney is to be preconditioned by subjecting chimney sections filled with the minimum weight insulation specified by the manufacturer to vibration for two 1-hour periods. The vibration is to consist of a vertical displacement of 1/64 inch (0.4 mm) at a frequency of 60 hertz. The chimney sections are to be mounted vertically on a vibration table, first inverted for 1 hour and then mounted in the intended installation position for 1 hour.

17.1.3 During the temperature tests, thermocouples are to be located on each chimney section and test enclosure adjacent to any voids in the chimney that result from settling of insulation during the vibration specified in 17.1.2.

17.2 Enclosed chimney installations (residential type and building heating appliance chimney)

17.2.1 The general form of a test structure for a chimney is illustrated in Figure 17.1. The height and arrangement of the structure for various designs is illustrated in Figure 17.2. Test structure details for various arrangements of support, firestop-spacers, and roof assemblies are illustrated in Figure 17.3 – Figure 17.9.

17.2.2 Chimneys are to be tested using the chimney arrangement illustrated in sketch No. 3 of Figure 17.2. When the design indicates that in one or more tests higher temperatures are developed with a chimney of another height (chimney arrangement), tests are to be conducted with the height producing the highest temperature condition; a height greater than that specified by the manufacturer shall not be employed. See sketch Nos. 2 and 4 of Figure 17.2. When the chimney arrangement is limited to that illustrated in sketch No. 1 of Figure 17.2, or when the maximum height of the chimney is limited to be consistent with the arrangement illustrated in sketch No. 2 of Figure 17.2, the chimney shall be so tested.

Figure 17.1

Typical test structure for chimneys tested enclosed within test room

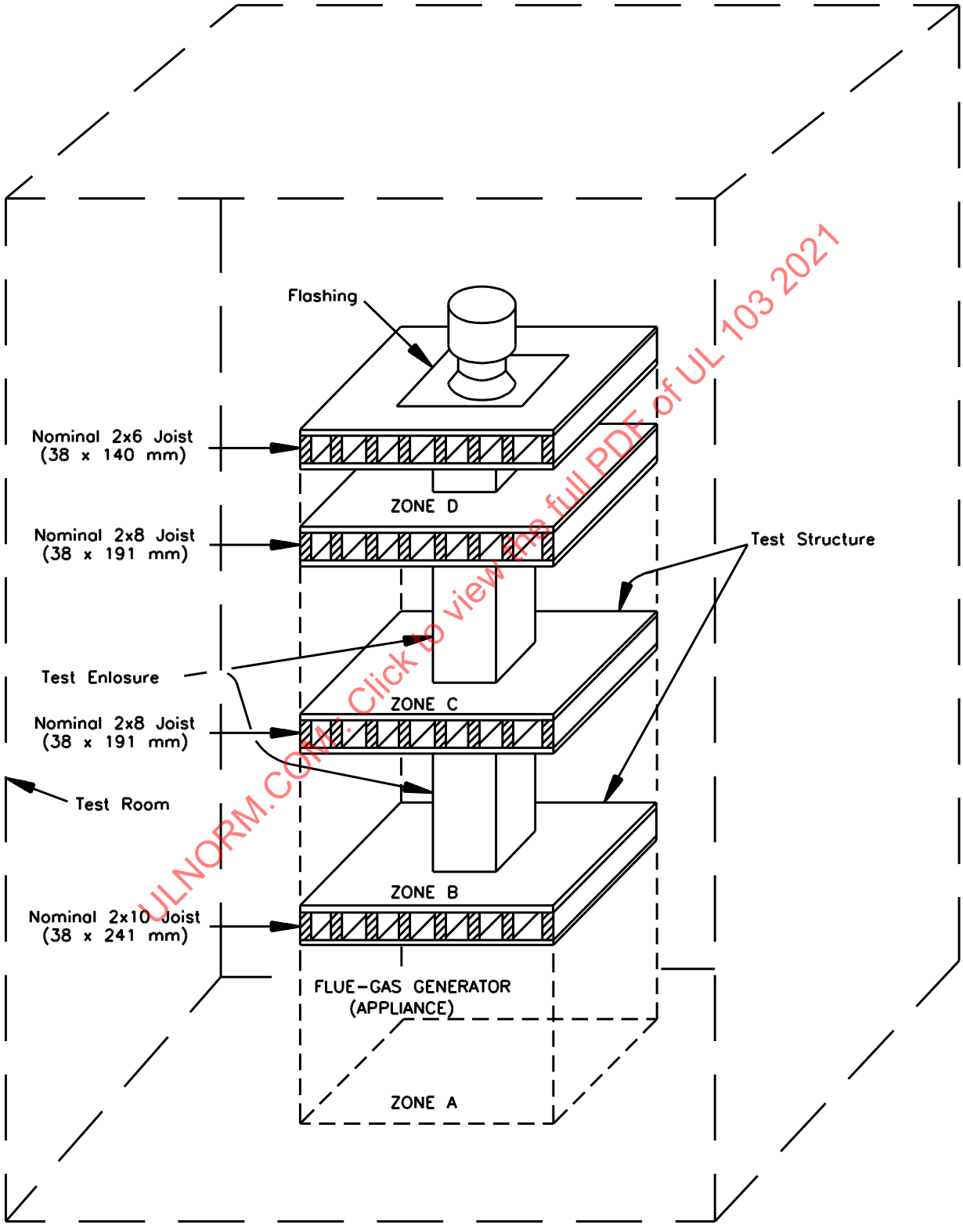
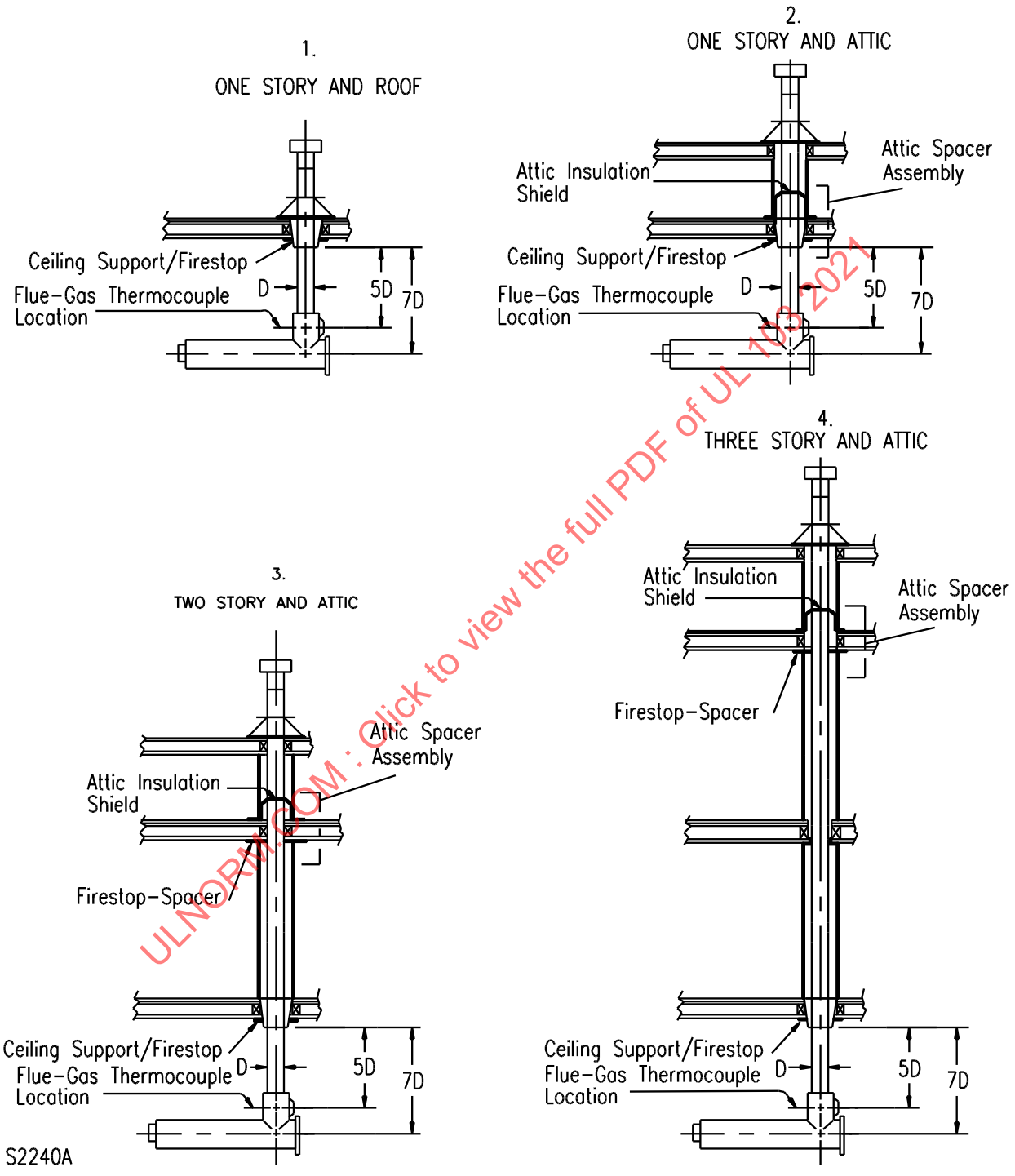


Figure 17.2

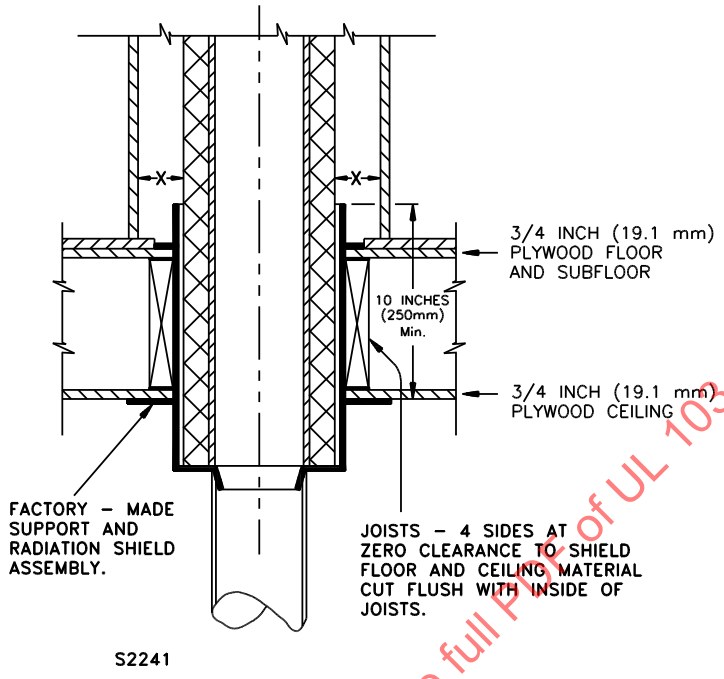
Test structure for various enclosed chimney arrangements



Chimney Shown Totally Enclosed at Specified Clearance

Figure 17.3

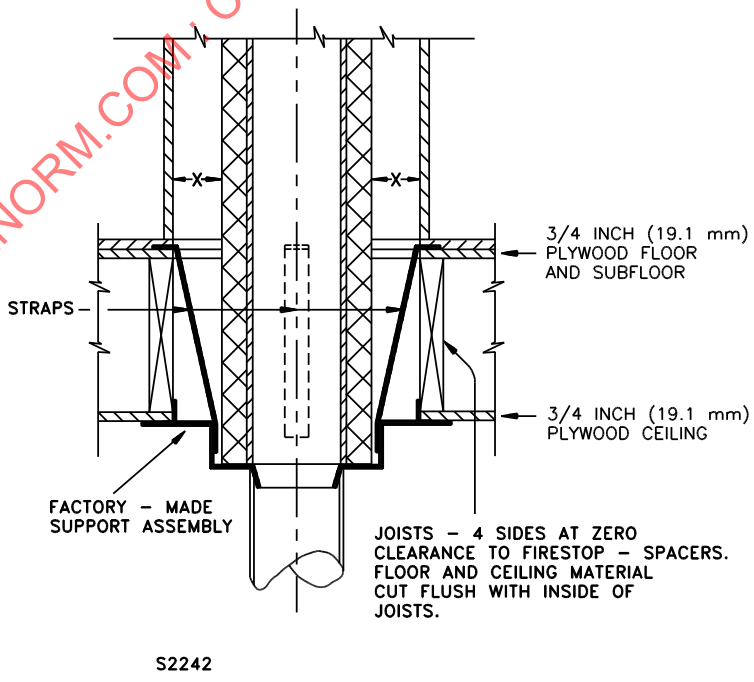
Test structure details for support assembly with radiation shield



Enclosure Shown at Specified Clearance Denoted by "X"

Figure 17.4

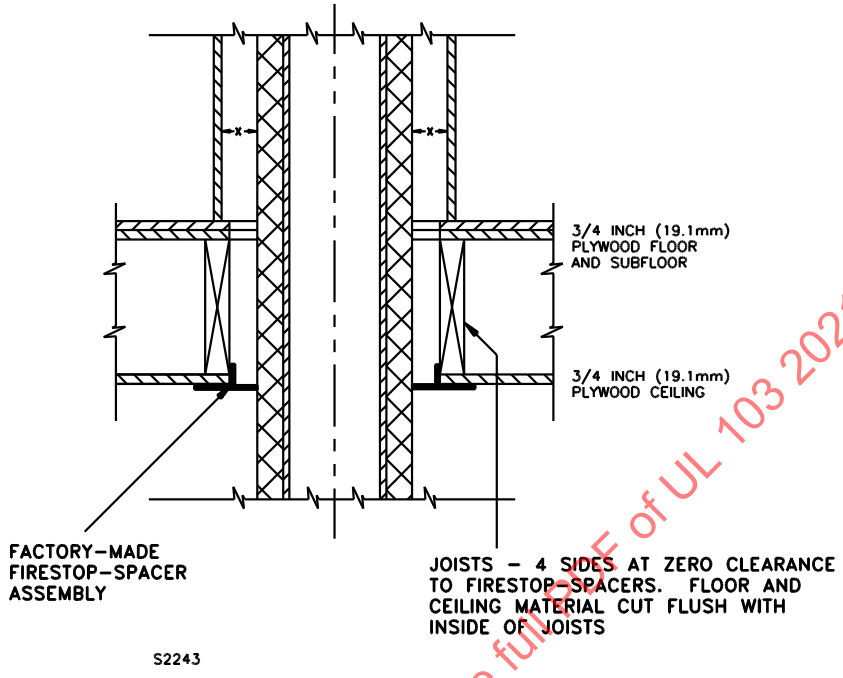
Test structure details for support assembly



Enclosure Shown at Specified Clearance Denoted by "X"

Figure 17.5

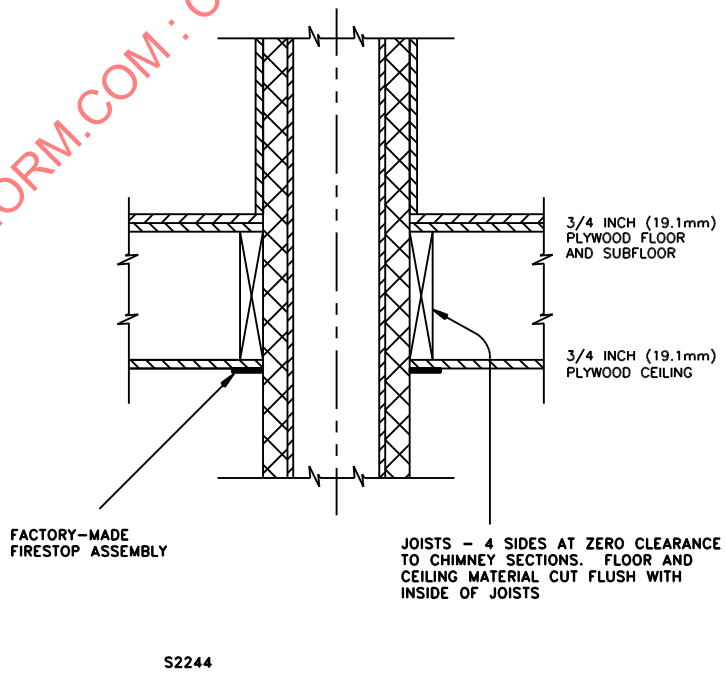
Test structure for firestop-spacer assembly



Enclosure Shown at Specified Clearance Denoted by "X"

Figure 17.6

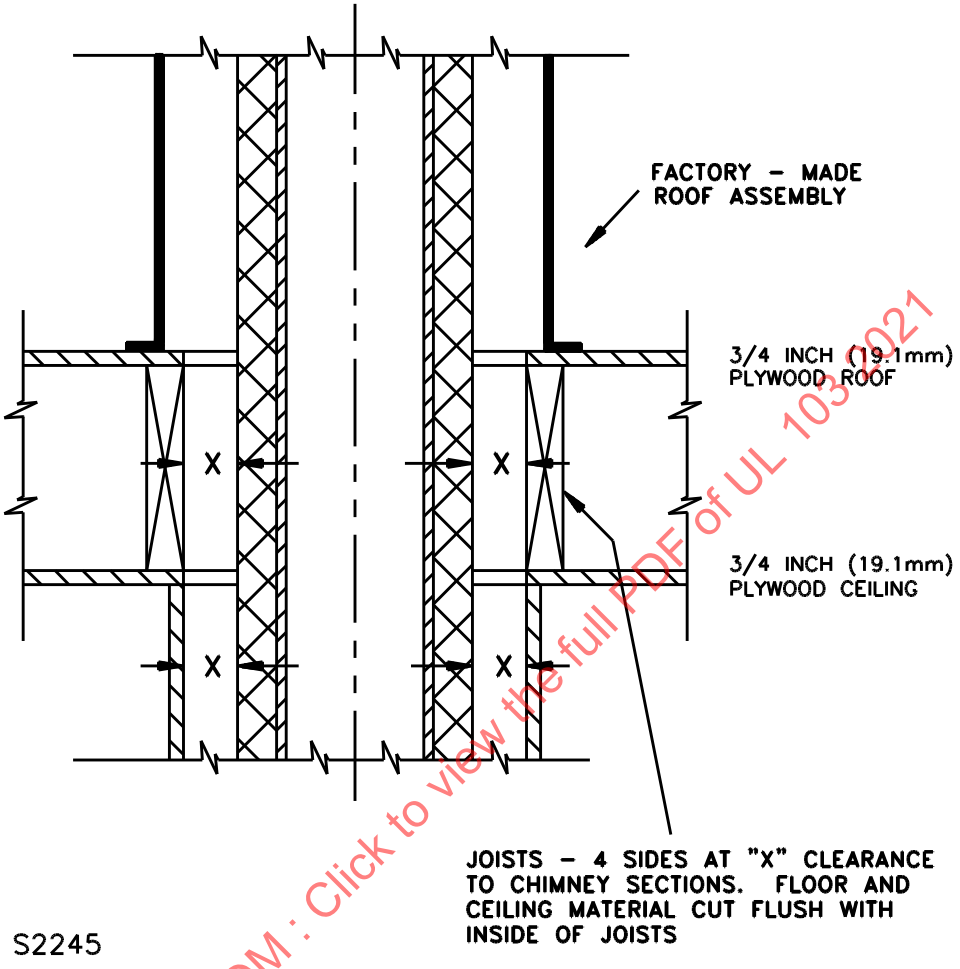
Test structure details for firestop assembly



Enclosure Shown at Zero Clearance

Figure 17.7

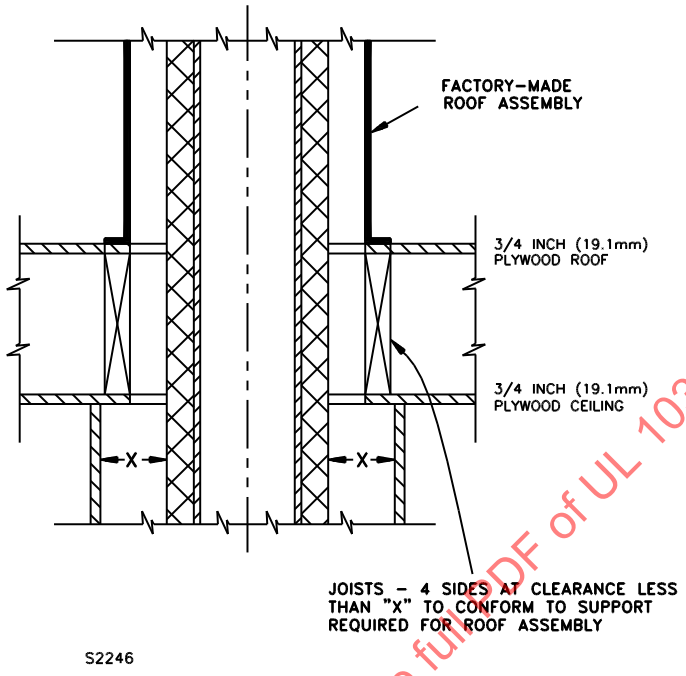
Test structure details for roof assembly



Roof Assembly Larger Than Enclosure Area

Figure 17.8

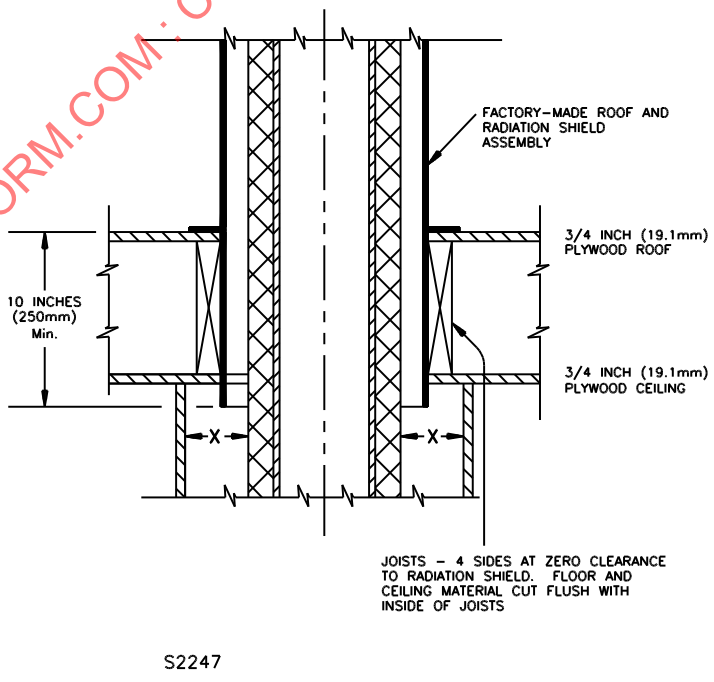
Test structure details for roof assembly



Roof Assembly Smaller Than Enclosure Area

Figure 17.9

Test structure details for roof assembly



Roof Assembly of Type Not Requiring Field Alteration to Conform to Roof Line

17.2.3 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 (ppm) throughout the period of any tests. The room is to be free of extraneous drafts and the chimney is 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.

17.2.4 The openings intended to provide such air flow within an occupied space of the building are to be sealed closed during the tests when a chimney provides for taking air:

a) From an occupied space and exhausting such air to the outside of a building; or

b) From the enclosure to cool the chimney.

An occupied space is that space enclosed by the outermost envelope of a building.

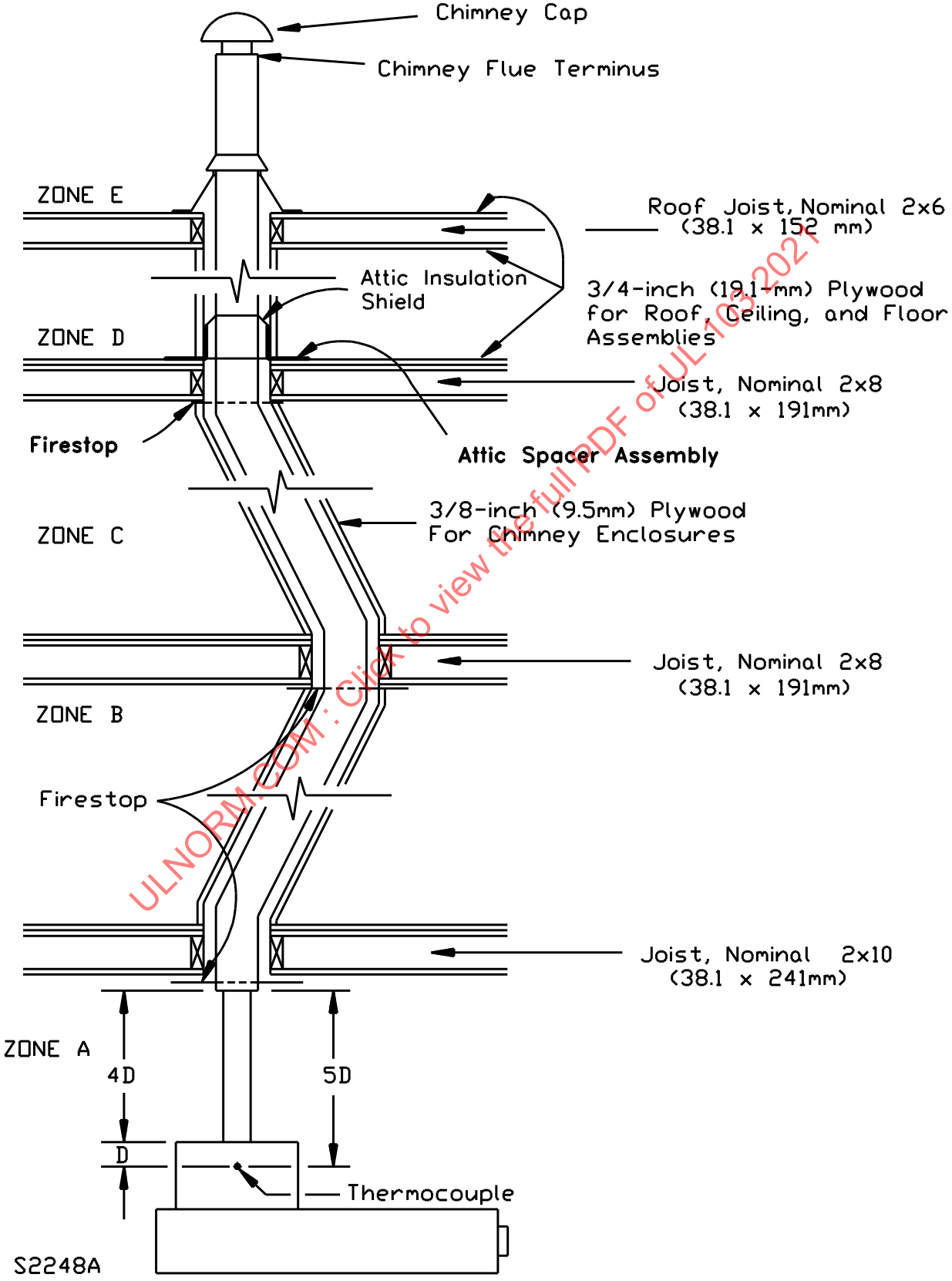
Exception: Openings for air flow in the chimney support assembly that are inaccessible and will not be blocked by the user to overcome nuisance drafts are not required to be sealed.

17.2.5 When a chimney provides for taking air from the outside of a building to cool the chimney, the openings are to be sealed unless the air is drawn into the chimney cooling passageway at the cap and discharged into a separate discharge passageway of the chimney, other than the flue gas conduit. The test arrangement is to provide means for maintaining the temperature of such air between 70 and 90°F (21 and 32°C).

17.2.6 A test chimney is to consist of an assembly composed of standard chimney sections and other furnished parts erected according to the manufacturer's illustrated installation instructions. The top of a test chimney is identified as terminating at the roof assembly and cap. Other functional parts of the chimney, such as a support or firestop-spacer, are to be used during a test. A chimney incorporating an elbow is to be installed and tested as described in Figure 17.10. When the use of four elbows (two sets) is specified by the manufacturer, the installation is to be completed using the minimum height and distances between elbows permitted by the instructions.

Figure 17.10

Test structure incorporating chimney elbows



17.2.7 A gas-fired flue-gas generator as illustrated in Figure 17.11 is to be used to supply flue gases to the chimney being tested. The generator is to produce flue gases at the specified test temperatures when fired at the test input specified in Table 17.1.

Figure 17.11

Flue-gas generator

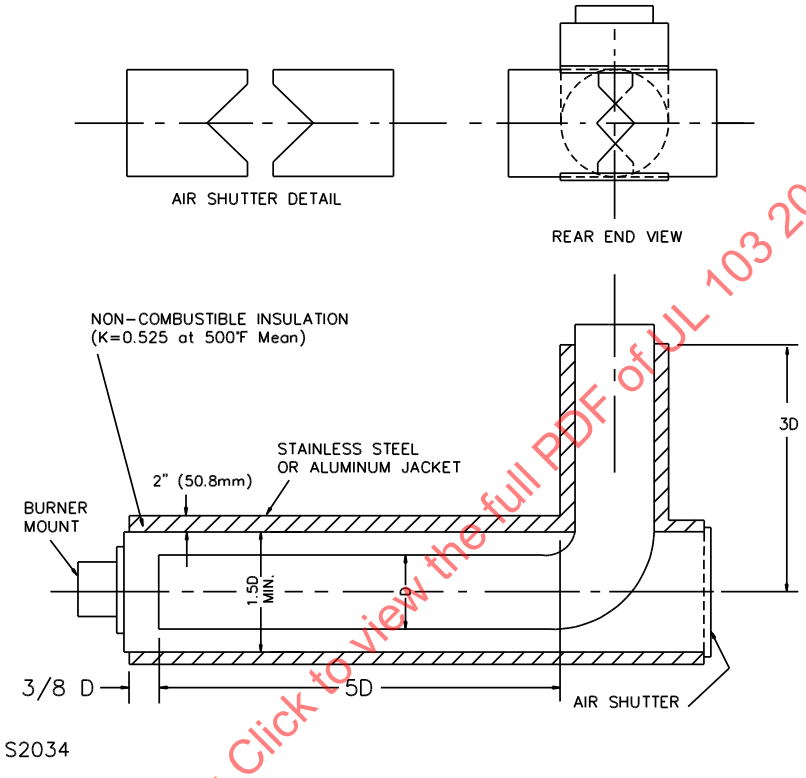


Table 17.1
Flue-gas generator inputs

Equivalent nominal diameter of chimney		Minimum input to flue-gas generator, btu per hour (kW)							
Inches	(mm)	Column 1		Column 2		Column 3		Column 4	
		Temperature test – 1700°F (927°C) flue gases		Temperature test – 1000°F (538°C) flue gases		Temperature test – 1400°F (760°C) flue gases		Temperature test – 2100°F (1125°C) flue gases	
6	150	97,000	(28.4)	48,500	(14.2)	59,200	(17.4)	175,000	(51.2)
7	180	131,600	(38.6)	65,800	(19.3)	80,500	(23.6)	237,000	(69.4)
8	200	172,400	(50.5)	86,200	(25.3)	106,000	(31.1)	310,000	(91.0)
9	230	218,000	(63.9)	109,000	(31.9)	33,000	(39.0)	392,000	(115.0)
10	250	270,000	(79.1)	135,000	(39.6)	165,000	(48.4)	486,000	(142.4)
12	300	390,000	(114)	195,000	(57.2)	238,000	(69.8)	699,000	(205.0)
14	360	528,000	(155)	264,000	(77.4)	323,000	(94.7)	952,000	(279.0)
16	410	690,000	(202)	345,000	(101)	421,000	(123)	1,240,000	(363.6)

Table 17.1 Continued on Next Page

Table 17.1 Continued

Equivalent nominal diameter of chimney		Minimum input to flue-gas generator, btu per hour (kW)							
Inches	(mm)	Column 1		Column 2		Column 3		Column 4	
		Temperature test – 1700°F (927°C) flue gases		Temperature test – 1000°F (538°C) flue gases		Temperature test – 1400°F (760°C) flue gases		Temperature test – 2100°F (1125°C) flue gases	
18	460	873,000	(256)	436,000	(128)	533,000	(156)	–	
20	510	1,080,000	(317)	539,000	(158)	658,000	(193)	–	
22	560	1,304,000	(382)	652,000	(191)	796,000	(233)	–	
24	610	1,552,000	(455)	776,000	(227)	947,000	(278)	–	
26	660	1,821,000	(534)	911,000	(267)	1,111,000	(326)	–	
28	710	2,112,000	(619)	1,056,000	(310)	1,289,000	(378)	–	
30	760	2,425,000	(711)	1,212,000	(355)	1,480,000	(434)	–	
36	900	3,491,000	(1023)	1,746,000	(512)	2,131,000	(625)	–	

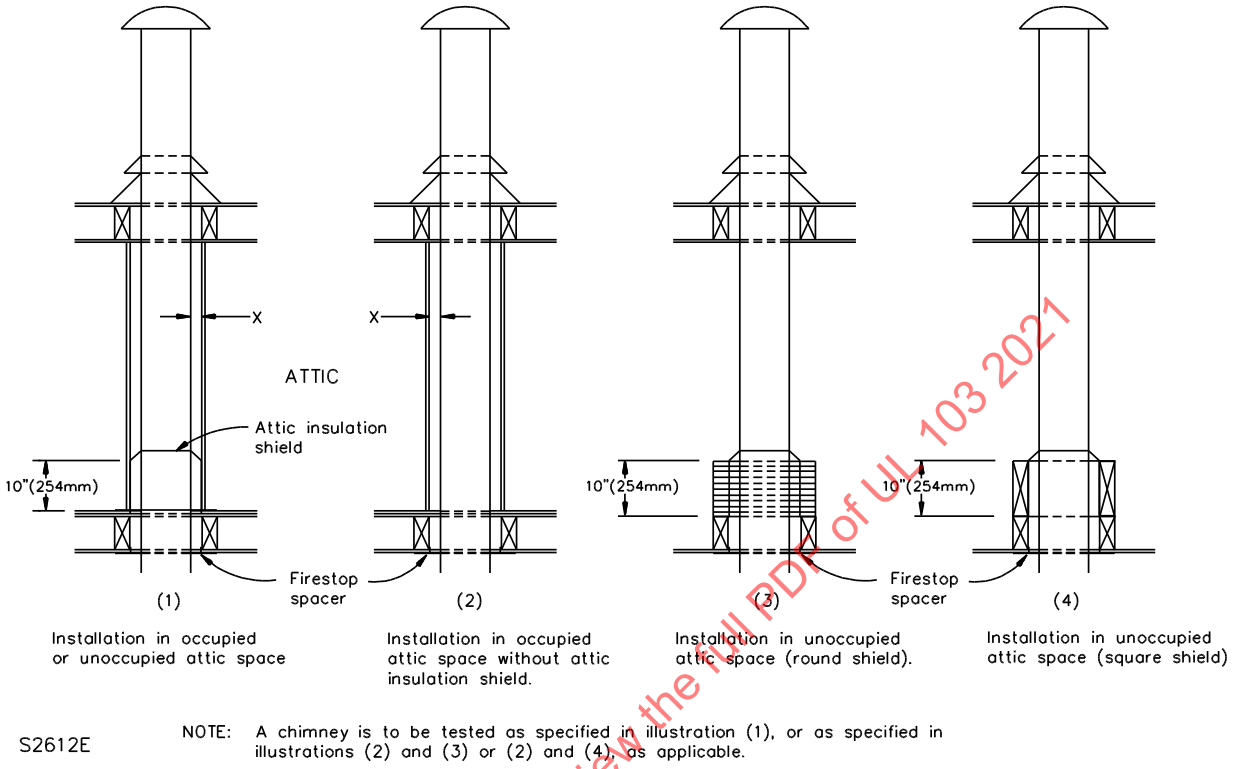
17.2.8 A premix type burner assembly, such as an Eclipse brand, or the equivalent, capable of supplying an air-gas mixture, with not less than 70 percent primary combustion air (70 percent of premixed theoretical air), to a flame retention burner nozzle tip is to be used. Combustion is to be complete within the horizontal straight length of the flue-gas generator combustion chamber. The insulated 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 four chimney diameters along the pipe centerline from the generator outlet to the point of entry into the chimney when located vertically, or three chimney diameters along the pipe centerline from the generator outlet to the point of entry into the chimney when located horizontally for through-the-wall arrangements.

17.2.9 The chimney is to be totally enclosed for its full height within all stories and attic space. Chimneys are to be tested on the basis of clearance from the enclosure of 0, 1, or 2 inches (0, 25, or 51 mm) as specified by the manufacturer's installation instructions, as measured between the outer surface of the chimney-pipe sections and the interior surfaces of the enclosing material. These clearances are designated by the dimensions "X" in Figure 17.3 – Figure 17.9 and in illustrations (1) and (2) in Figure 17.12. The chimney enclosure material is to be 3/8-inch (9.5-mm) thick plywood and is to be closed at each floor-joist level by the installation of a manufacturer's firestop-spacer assembly. Such assemblies are to be placed at the ceiling line of each floor-joist level except that at the joist level serving the attic space the assembly is placed on top of the attic-space floor material. The attic insulation shield is to be placed above the floor-joist level on top of the attic space floor material.

Exception: A chimney intended for installation in an unoccupied attic space as described in 9.5 is to be tested as shown in illustrations (2) and (3) or (2) and (4), as applicable, in Figure 17.12. The attic insulation shield is to be placed above the floor-joist level on top of the attic space joist.

Figure 17.12

Typical test structure details for attic installations



17.2.10 For test purposes, the inside diameter of the firestop opening shall not be more than 1/8 inch (3.2 mm) greater than the minimum outside diameter of the chimney pipe.

17.2.11 The test enclosure material at each floor 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 by 235 or 184 mm)] lumber, forming a box placed at zero clearance to the chimney sections or to a manufacturer's support or firestop-spacer assembly. The test enclosure material used to enclose an attic insulation shield for use in an unoccupied attic space when the shield is tested as specified in illustration (3) or (4) of Figure 17.12 is to be:

a) 1/2 inch (12.7 mm) or 3/4 inch (19 mm) thick plywood filler panels stacked to a vertical height of 10 inches (254 mm) above the attic joists, with a circular cutout in each panel to provide zero clearance around the attic insulation shield and extending a minimum of 1-1/2 inches (38.1 mm) from the shield for circular attic insulation shields; or

b) Trade size 2 by 12 inches [nominal 1-1/2 by 11-1/4 inches (37 by 286 mm)] lumber, with the 11-1/4-inch dimension reduced to 10 inches, forming a box enclosure to provide zero clearance around the entire perimeter of the attic insulation shield for rectangular attic insulation shields. The test enclosure material at the roof-joist level is to be trade size 2 by 6 inches [nominal 1-1/2 by 5-1/2 inches (38 by 140 mm)] lumber, forming a box placed at the clearance specified by the manufacturer for enclosures or at the lesser clearance required to provide support means for a roof assembly. See Figure 17.7 – Figure 17.9 and Figure 17.11. All ceiling, floor, and roof material is to be cut flush with the inside of all framed joist openings.

17.2.12 Plywood used for the test enclosure is to be 3/8 inch (9.5 mm) thick. All wall and ceiling surfaces at the inlet to the chimney, and all plywood surfaces, are to be painted flat black on the side facing the test assembly.

17.2.13 The following are to be sealed with plastic-coated or film-faced pressure-sensitive tape lapping the joint by a minimum of 1 inch (25.4 mm) on each side:

a) Openings between spacers or supports (including firestops) and the test enclosure;

b) Openings between the flashing and the roof;

c) Ventilated flashing openings;

Exception: The flashing openings are not required to be taped when the opening between the attic firestop and the chimney is sealed.

d) All joints and openings in the test enclosure; and

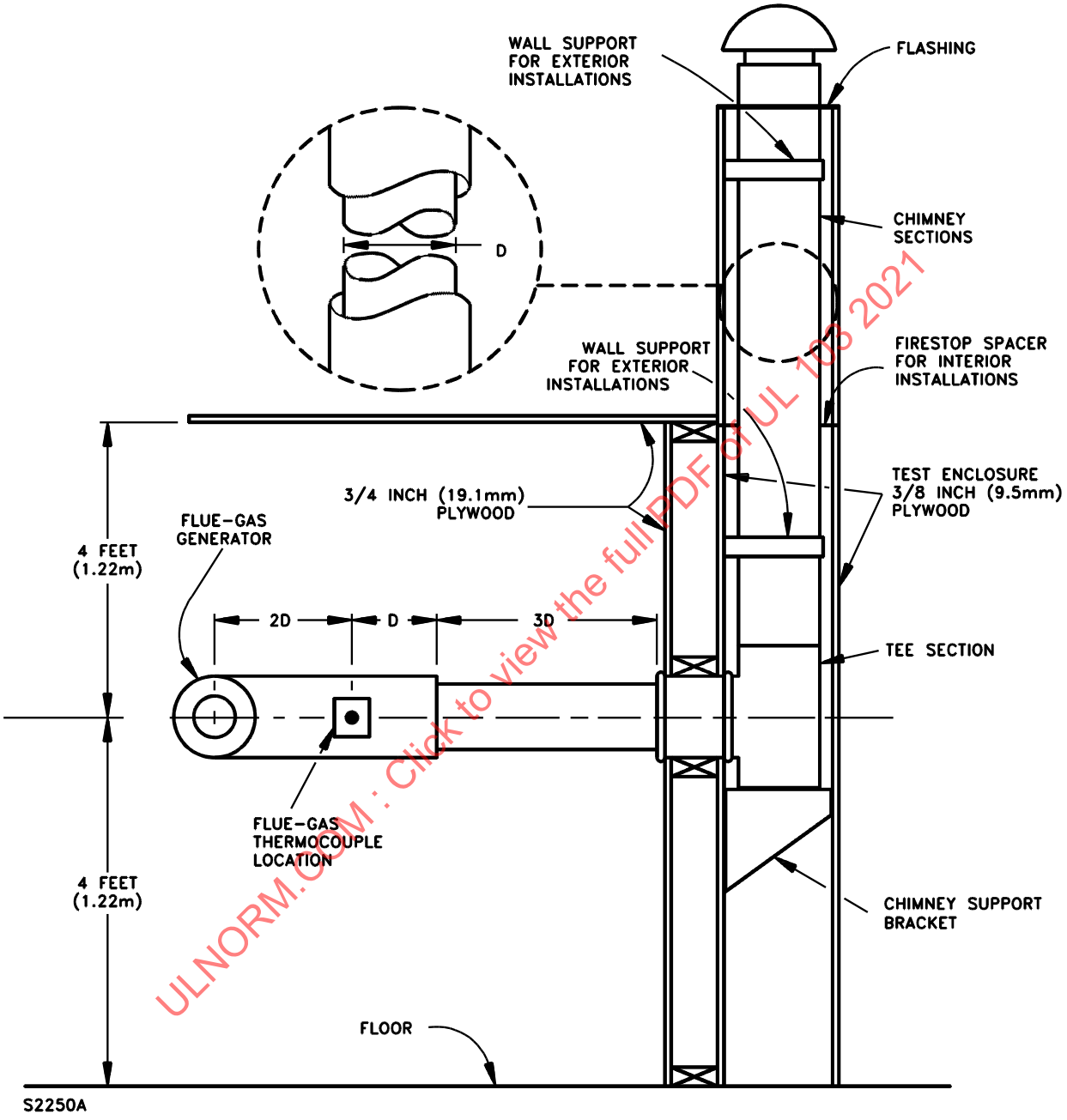
e) All joints intended to be sealed for field installation.

The peel adhesion characteristics of the tape on fibrous (wood) combustible enclosure materials shall comply with the Standard for Adhesion of Pressure-Sensitive Tape to Fiberboard at 90 Degree Angle and Constant Stress, ASTM D2860, at elevated temperatures of 150°F (66°C).

17.2.14 A chimney intended for a "through-the-wall" installation shall be tested as illustrated in Figure 17.13. The chimney is to be enclosed at the minimum clearance specified by the manufacturer. The installation is to include all spacers, supports, flashings, and other components described in the manufacturer's installation instructions.

Figure 17.13

Test structure for through-the-wall chimney installation



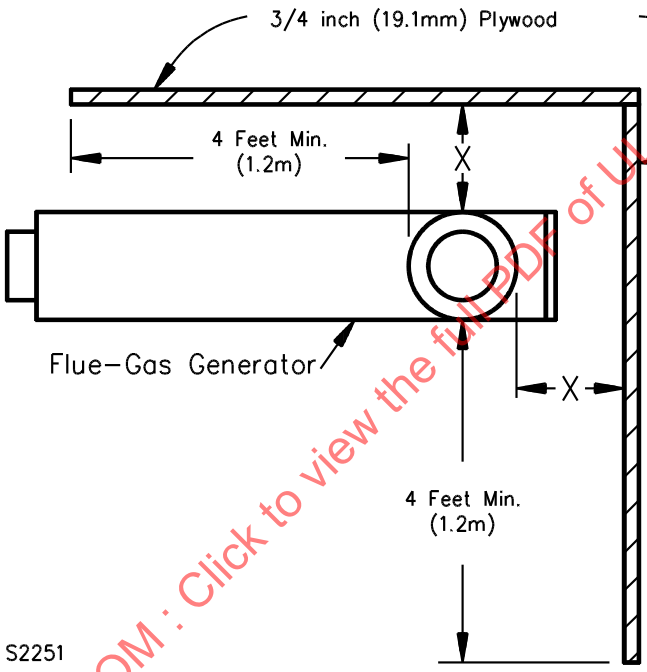
17.2.15 When a chimney is intended for both interior and enclosed exterior installations, tests are to be conducted with the chimney installation producing the highest temperature condition.

17.3 Unenclosed chimney installations (building heating appliance type chimney only)

17.3.1 A chimney is to be tested as illustrated in Figure 17.14 and Figure 17.15 when a roof-jack assembly is provided. When a roof-jack assembly is not provided, the chimney is to be tested as illustrated in Figure 17.16.

Figure 17.14

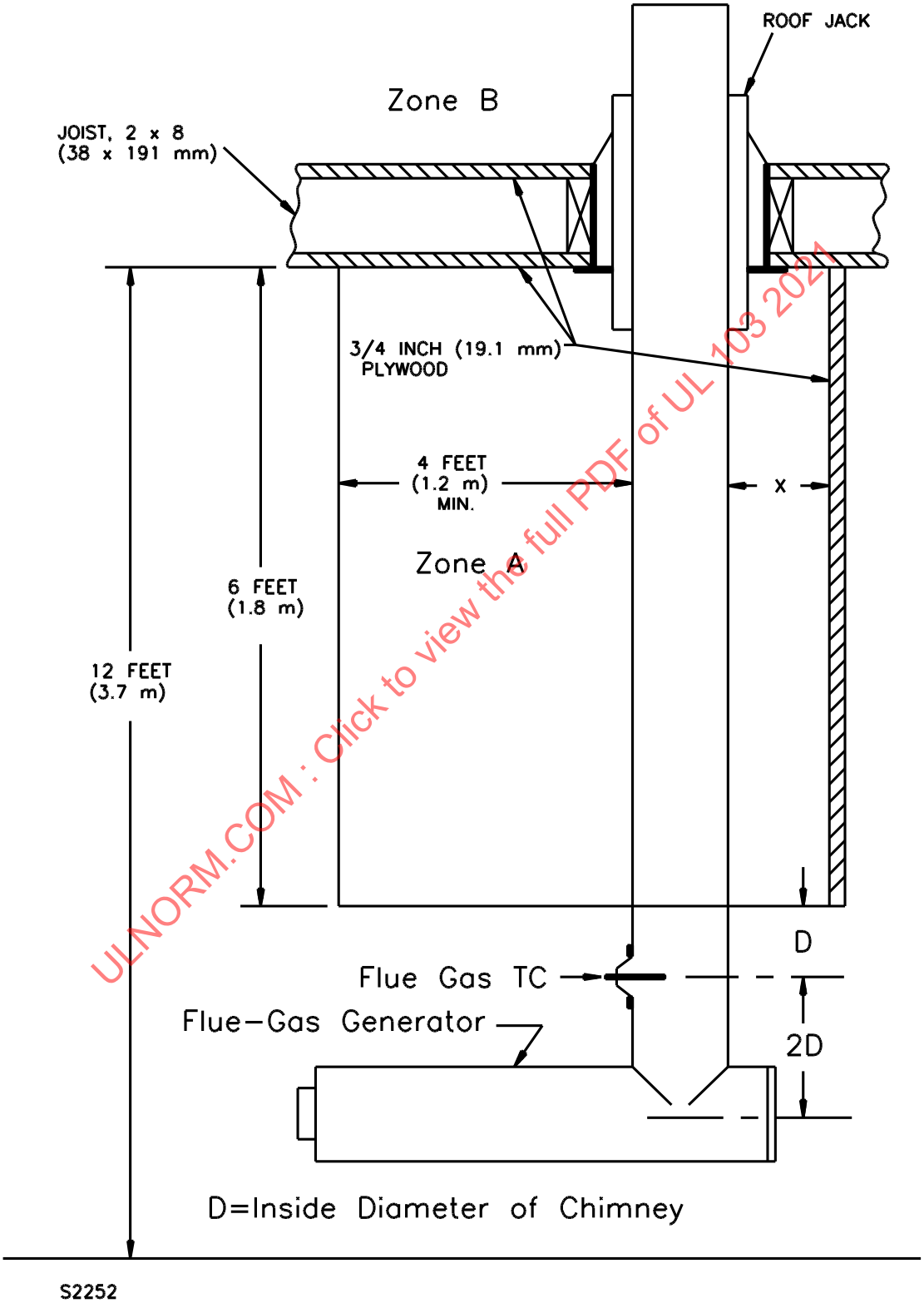
Unenclosed corner installation plan view



Combustible Construction Shown at Specified Clearance Denoted by "X"

Figure 17.15

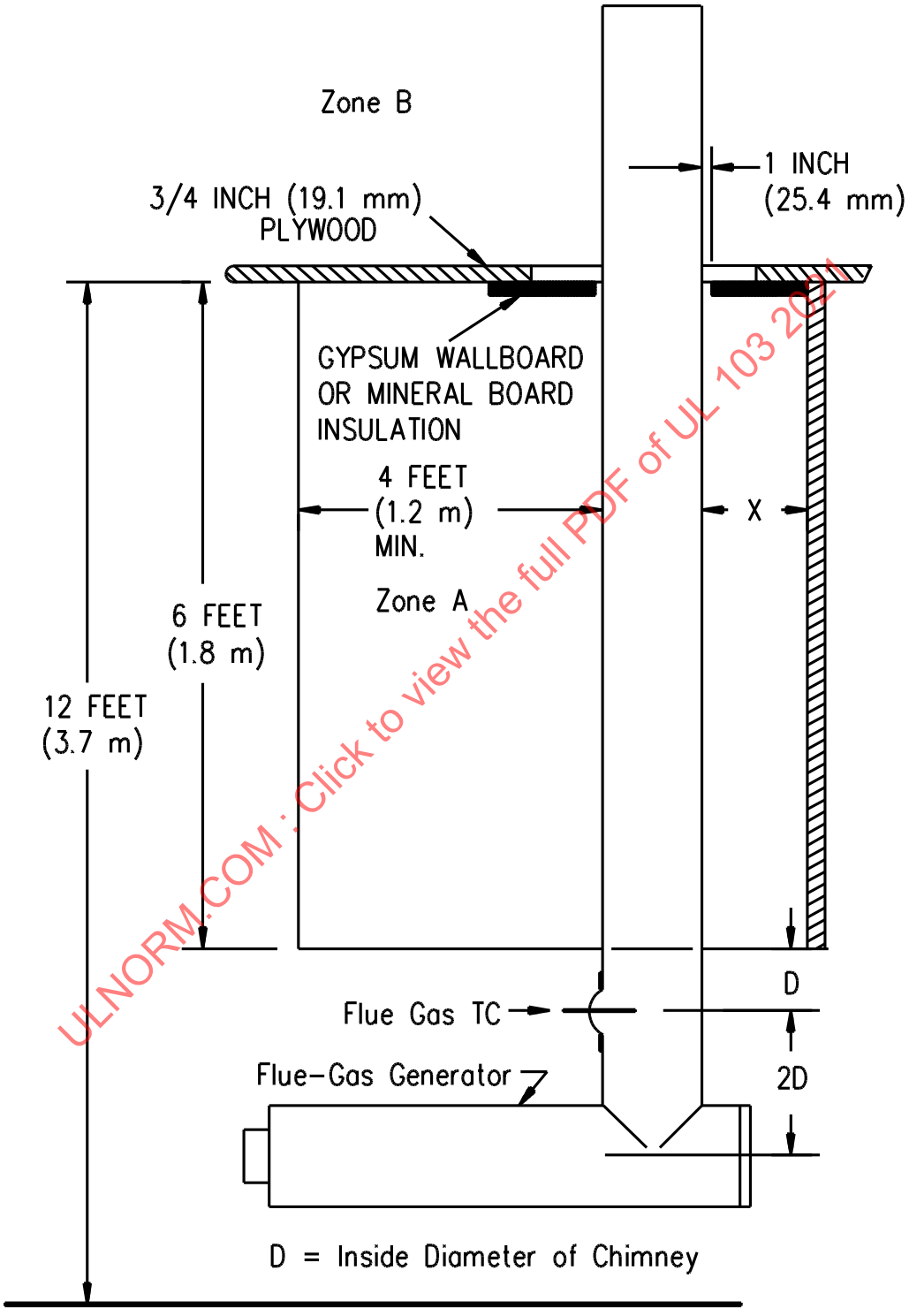
Unenclosed corner installation with roof jack



Combustible Construction Shown at Specified Clearance Denoted by "X"

Figure 17.16

Unenclosed corner installation with firestop



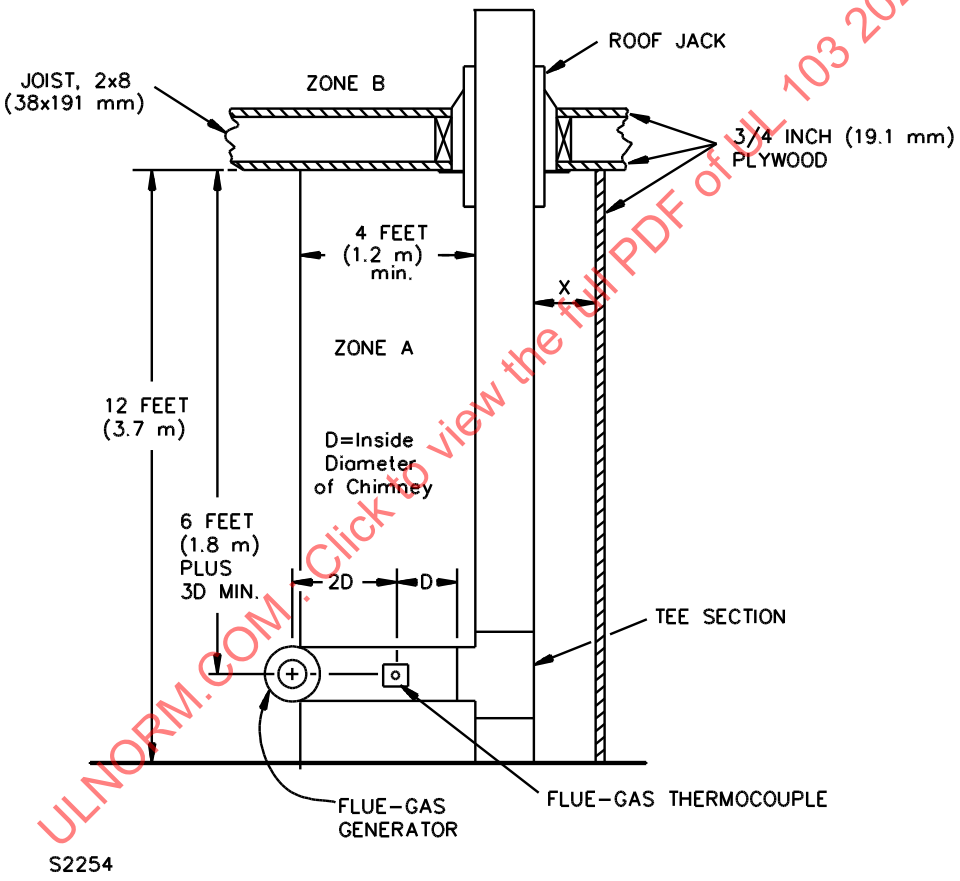
Combustible Construction Shown at Specified Clearance Denoted by "X"

17.3.2 When tee sections are provided, the chimney is to be tested both as illustrated in Figure 17.17 using the tee sections and as illustrated in Figure 17.15 and Figure 17.16 using straight chimney sections.

17.3.3 The chimney is to terminate 18 feet (5.5 m) above the floor of the test structure unless the design of the chimney is such that other heights produce higher temperatures. The chimney is to be placed in a test structure consisting of two 3/4 inch (19 mm) thick plywood walls placed at right angles to each other. The chimney is to be located in the corner thus formed so as to provide the horizontal clearance specified by the manufacturer's installation instructions, or at a distance of 18 inches (460 mm), whichever is less. See Figure 17.14.

Figure 17.17

Unenclosed corner installation with tee and roof jack



Combustible Construction Shown at Specified Clearance Denoted by "X"

17.3.4 The corner formed by the walls is to be covered by a flat roof constructed of trade size 2- by 8-inch [nominal 1-1/2 by 7-1/2 inches (38.1 by 191 mm)] joists covered at the ceiling and roof lines with 3/4 inch (19 mm) thick plywood as illustrated in Figure 17.15. Roof joists and headers are to be provided to form a box section around the chimney where it penetrates the roof and sized to provide a clearance to the roof-jack assembly.

17.3.5 A chimney that is not provided with a roof-jack assembly is to be installed in a test structure as illustrated in Figure 17.16. The roof is to be cut away to provide an opening 36 inches (0.9 m) larger in diameter than the outside diameter of the chimney. The opening is to be closed with 3/8 inch (9.5 mm) thick noncombustible mineral board, and a 1 inch (25.4 mm) wide annular ventilating opening is to be provided between the chimney and the mineral board.

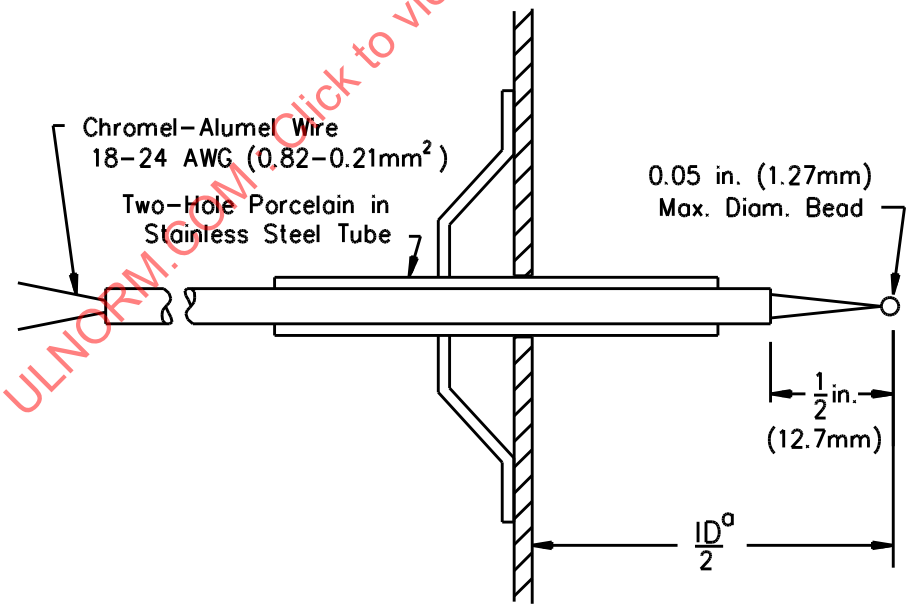
17.3.6 The chimney is to be connected directly to the flue-gas generator as illustrated in Figure 17.15 – Figure 17.17.

18 Temperature Measurement

18.1 Flue-gas temperatures are to be determined for the tests in Sections 19 – 23 by a thermocouple, such as illustrated by Figure 18.1. The thermocouple is to be located within the insulated outlet of the flue-gas generator as illustrated in Figure 17.11. 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 18.1

Flue-gas thermocouple and support bracket



[a]ID = Internal Diameter of Flue Pipe

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18.2 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.

18.3 The gas burner then is to be operated as for the Temperature Test – 1000°F (538°C) Flue Gases, Section 20, and the dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple is 930°F (517°C) above room temperature by using the flue-gas generator input illustrated in Column 2 of Table 17.1, for the size of chimney being tested.

18.4 The dilution air adjustments for tests described in Sections 19 – 23 are to be set as required to obtain the specified flue-gas temperatures for the individual test as measured by the thermocouple located as described in 18.2.

18.5 Temperatures, other than those of flue-gases and metal surfaces, are to be measured using either Type K (chromel-alumel) or Type J (iron-constantan) thermocouples not larger than 24 AWG (0.21 mm^2). For test enclosure elements in contact with chimney parts, junctions of thermocouples are to be placed on the chimney part surfaces, except that at a point or line contact of a spacer not over 1/8 inch (3.2 mm) diameter, or width, thermocouples are to be placed on the test enclosure at points 1/2 inch (12.7 mm) from the center line of such point or line contact. Thermocouples are to be:

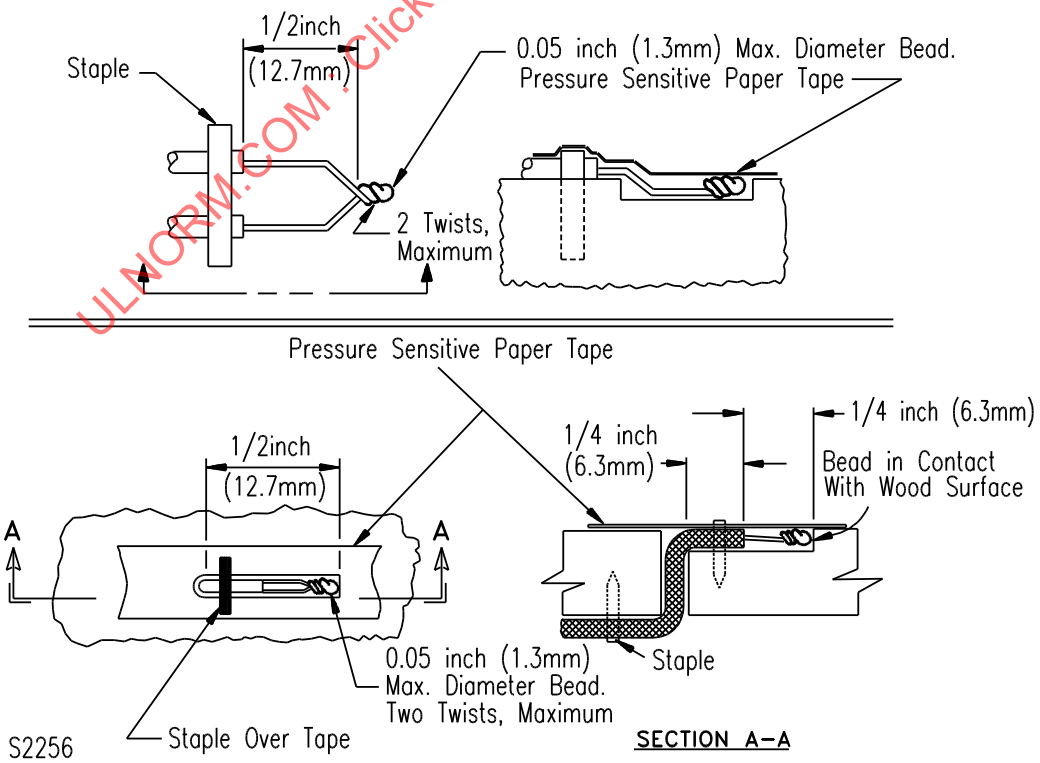
a) Attached to test enclosure elements having a surface adjacent to the chimney parts and onto ceilings or roof areas adjacent to the chimney so as to have 1/2 inch (12.7 mm) of wire exposed; and

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 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 18.2.

Figure 18.2

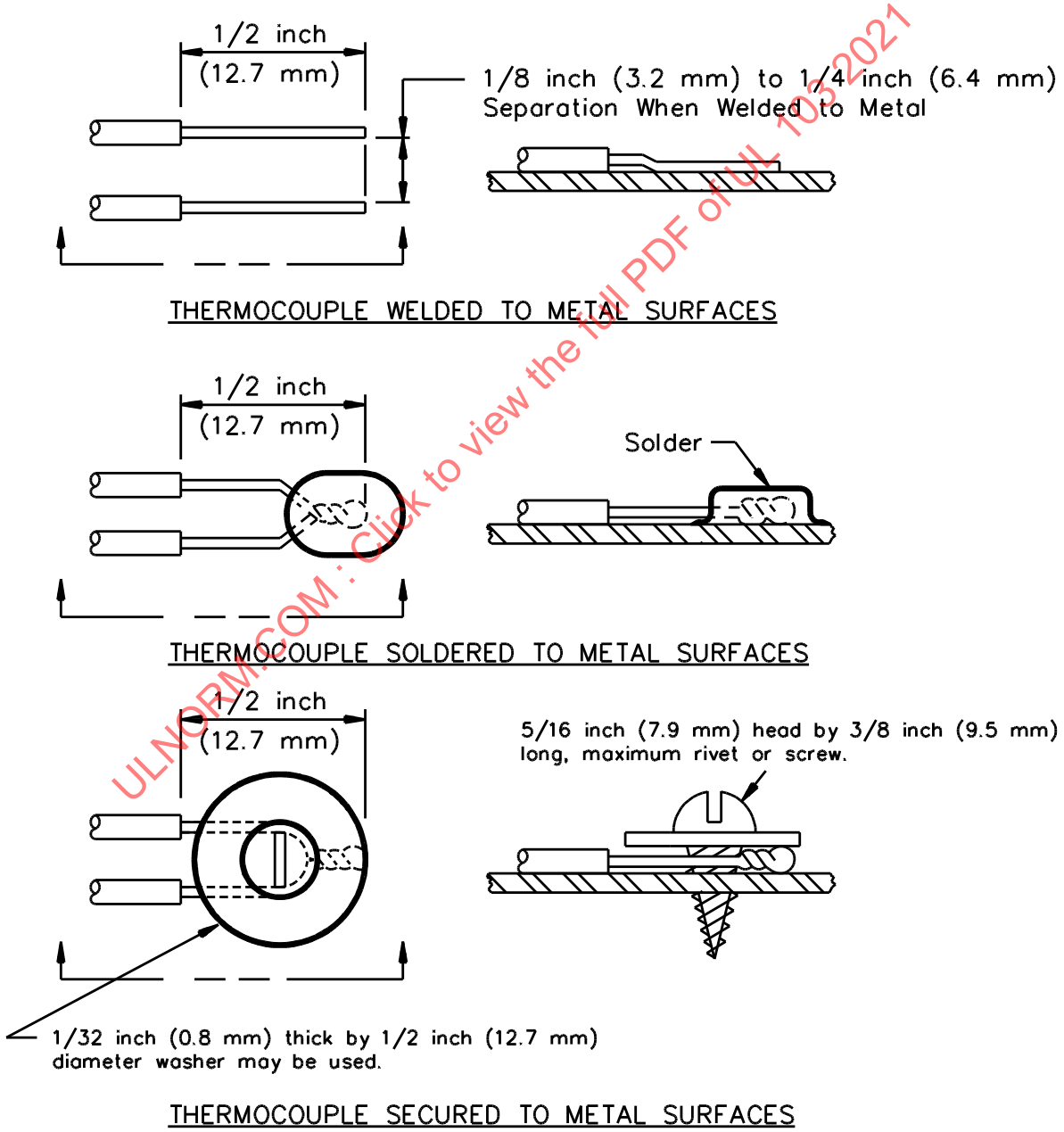
Thermocouple installation methods on wood surfaces



18.6 Temperatures attained by surfaces of parts of the chimney 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 18.3. 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 embedded 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 placed at other locations that are in contact with or subject to radiation from surfaces of the chimney.

Figure 18.3

Thermocouple installation methods on metal surfaces



18.7 Ambient temperatures of a zone are to be determined by a shielded thermocouple located centrally within a vertically oriented 6 inch (152 mm) length of aluminum-painted 2 inch steel pipe (ASME B36.10M) 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.

18.8 For a chimney tested in an enclosure, ambient temperature in Zone A in Figure 17.1 is to be determined by the average of two such thermocouples located 1 foot (305 mm) below the ceiling and 2 feet (610 mm) away from the right- and left-hand sides of the chimney enclosure. The flue-gas temperature rise is to be based on the ambient temperature at the level of the flue-gas generator.

18.9 For a chimney tested in an enclosure, the ambient temperature in Zones B, C, and D, above Zone A in Figure 17.1, is to be determined by a thermocouple located 2 feet (610 mm) away from the front centerline of the enclosure and 4 feet (1.2 m) above the floor.

18.10 For a chimney tested in an enclosure, the ambient temperature in the space above a roof line is to be determined by a thermocouple located 2 feet (610 mm) away from the front center line of the chimney or roof assembly and 1 foot (305 mm) above the roof.

18.11 For a chimney tested unenclosed, the ambient temperature in Zone A in Figure 17.14 – Figure 17.16 is to be determined by a thermocouple located 6 feet (1.8 m) below the ceiling, 6 inches (150 mm) from the rear wall, and 4 feet (1.2 m) from the chimney surface.

18.12 For a chimney tested unenclosed, the ambient temperature in Zone B is to be determined by a thermocouple located 4 feet (1.2 m) from the front surface of the chimney and 1 foot (305 mm) above the roof line.

18.13 For purposes of determining temperature rises on chimney parts, on an enclosure, and on the test structure, the temperatures are to be referenced to ambient temperatures as determined in 18.1 – 18.12. 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.

18.14 During the Temperature Test – 1400°F (760°C) Flue Gases, Section 21, Temperature Test – 1700°F (927°C) Flue Gases, Section 22, and the Temperature Test – 2100°F (1149°C) Flue Gases, Section 23, temperature rises are to be based on the ambient or room temperature recorded at the end of the firing period prescribed for the test.

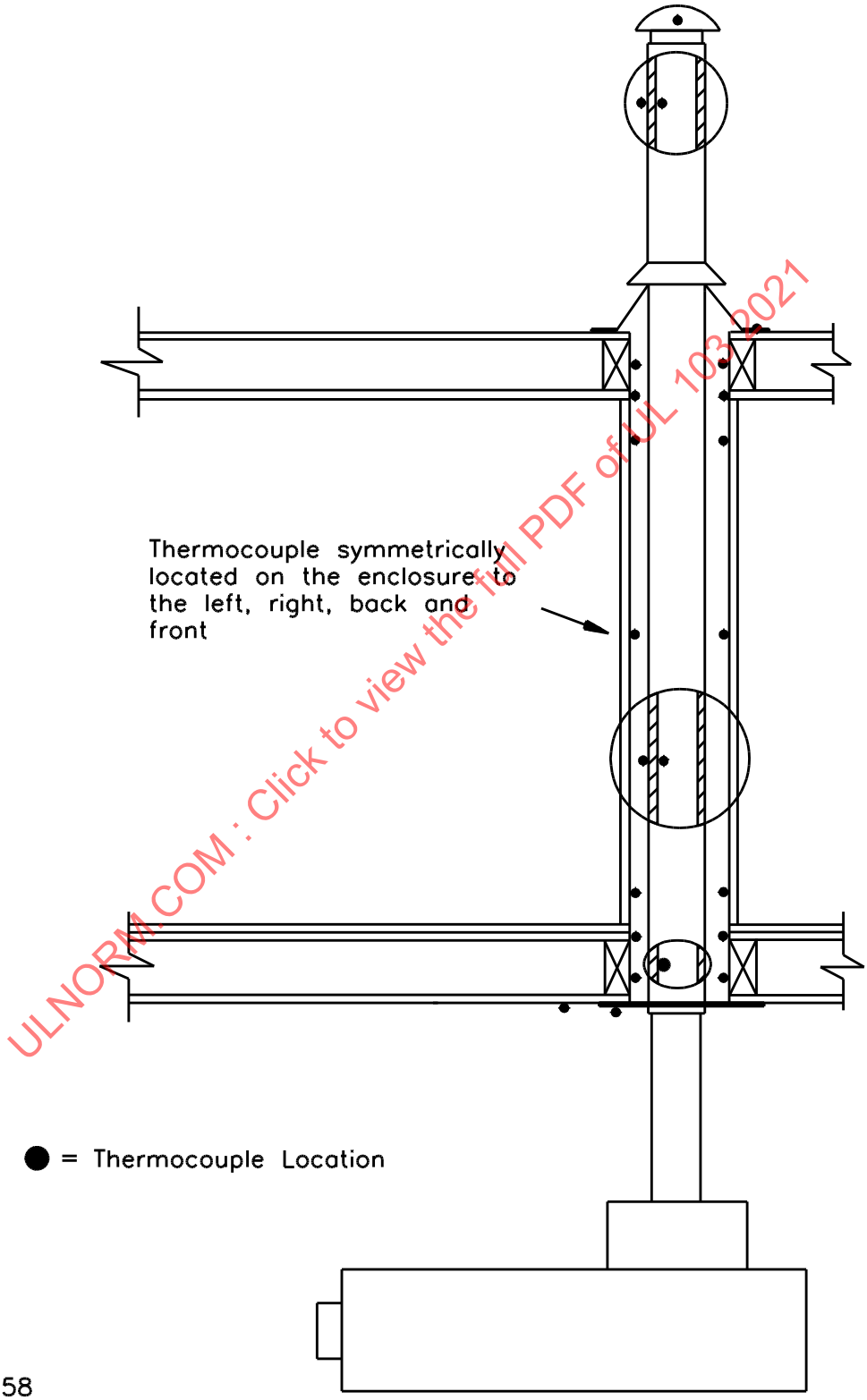
18.15 For a chimney designed to take air from the outside of a building to cool the chimney, the ambient temperature of the space into which the chimney exhausts is to be measured by a thermocouple located on the same horizontal plane as the opening provided for the admission of outside air, 3 feet (0.9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

18.16 A minimum number of typical thermocouple locations on wood surfaces is shown in Figure 18.4 – Figure 18.6. Additional thermocouples are to be used when required because of the construction and method of installation.

18.17 Thermocouples are to be attached to the wood surfaces of a chimney enclosure without an attic as shown in Figure 18.4.

Figure 18.4

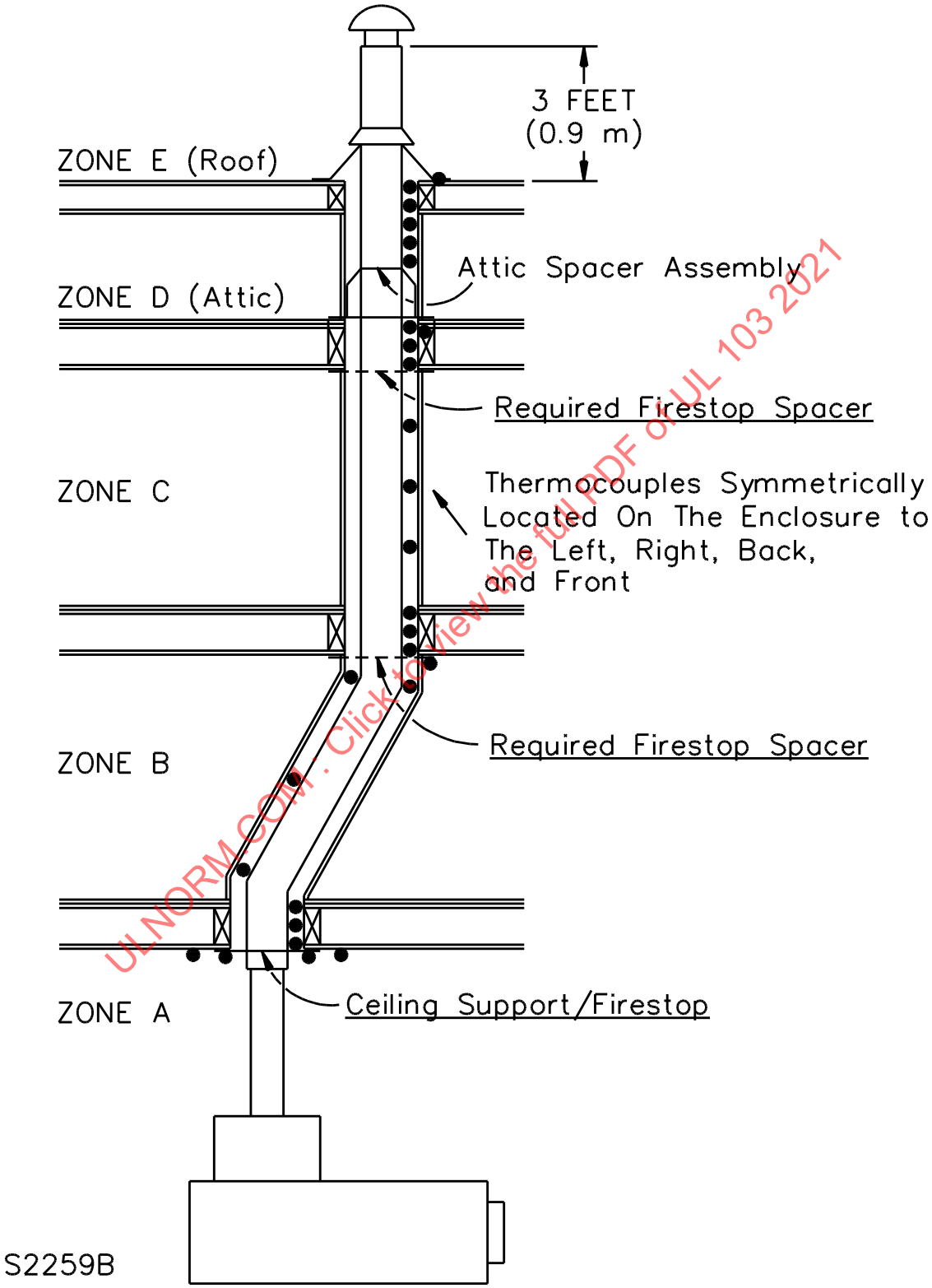
Typical thermocouple locations



(Chimney Enclosure Without an Attic)

Figure 18.5

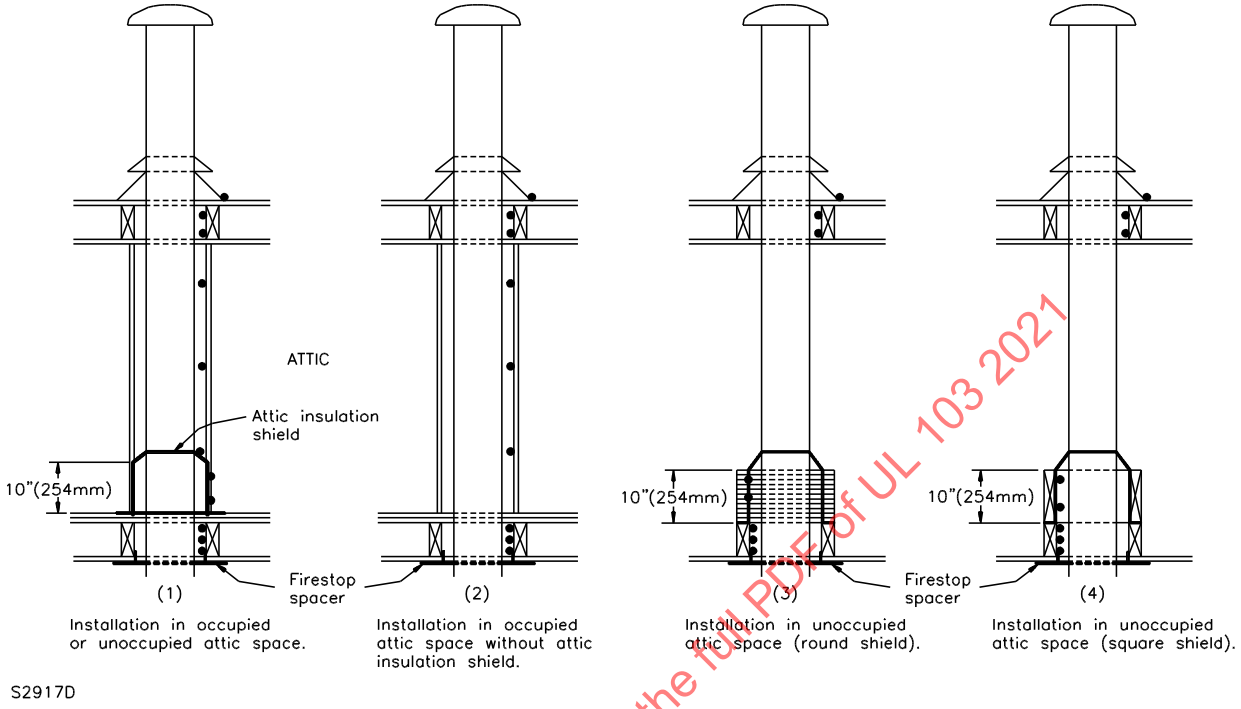
Typical thermocouple locations



(Tall Chimney Height with Firestops)

Figure 18.6

Typical thermocouple locations for attic installations



18.18 Thermocouples are to be attached to the wood surfaces of a tall chimney enclosure as shown in Figure 18.5.

18.19 Thermocouples are to be attached to the chimney surfaces as shown in Figure 18.4.

19 Thermal Shock Test

19.1 At the conclusion of this test, a chimney shall be free of cracks, distortion, or other damage.

19.2 This test is to be conducted in all cases prior to conducting the tests covered in Sections 20 – 23.

19.3 The test is to be started with the test chimney and the test structure at room temperature. The flue-gas generator then is to be fired to at least the input specified in Column 1 of Table 17.1, and regulated to produce flue gases at a temperature of 1630°F (906°C) above room temperature at the flue-gas thermocouple location illustrated in Figure 17.11. The test is to be continued for 10 minutes, exclusive of the time taken to attain 1630°F (which shall not exceed 15 minutes), at which time the burner is to be shut off.

19.4 This test is to be conducted three times, and at the start of the first test the chimney is to be at room temperature. At the end of each test the chimney is to be allowed to cool to room temperature or to cool for 4 hours, whichever occurs first, before the next trial.

19.5 No temperature readings other than flue-gas temperature are recorded for the tests described in 19.3.

19.6 At the conclusion of this test, the interior of the chimney is to be visually inspected for cracks, distortion or other damage to determine compliance with 19.1 by lowering a light throughout its length.

20 Temperature Test – 1000°F (538°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 parts at points of zero clearance to the test structure, shall be not 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 of the chimney shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 20.1.

Table 20.1
Maximum temperature rises

Material	Maximum rise above room temperature			
	Column 1		Column 2	
	°F	°C	°F	°C
1. Aluminum alloys –				
11100 (2S)	330	183	430	239
3003 (3S)	430	239	530	294
2014, 2017, 2024, 2052[a]	530	294	630	350
2. Aluminum-coated steel, heat-resistant type[b]	1030	572	1275	708
3. Carbon steel-coated with Type A19 ceramic	1030	572	1130	628
4. Galvanized steel[c]	480	267	630	350
5. Low-carbon steel, cast iron[d]	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] These and other 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.

[b] When the reflectivity of aluminum-coated steel is utilized to reduce the risk of fire, the maximum allowable temperature rise shall be 830°F (461°C).

[c] The specified maximum temperature rise shall apply when the galvanizing is required as a protective coating or when the reflectivity of the surface is utilized to reduce the risk of fire.

[d] The specified maximum temperature rises apply to parts whose malfunction results in the product being incapable of further use.

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 and the test structure at room temperature. The flue-gas generator then is to be fired at the input specified in Column 2 of Table 17.1, and regulated to produce flue gases at a temperature of 930°F (517°C) above room temperature at the location designated in Figure 17.11. The test is to be continued until equilibrium temperatures are attained on surfaces of the test chimney parts and the test enclosure.

21 Temperature Test – 1400°F (760°C) Flue Gases

21.1 The maximum temperature attained on surfaces of the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of the chimney 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 21.2. The temperature on any part of the chimney shall not exceed the maximum temperature specified for the materials used. See Column 2 of Table 20.1.

21.2 After equilibrium temperatures are attained under the test conditions described in 20.3, the flue-gas generator is to be fired at the input specified in Column 3 of Table 17.1, and regulated to produce flue gases at a temperature of 1330°F (739°C) above ambient temperature at the location designated in Figure 17.11. The test duration is to be 60 minutes.

22 Temperature Test – 1700°F (927°C) Flue Gases

22.1 The maximum temperature attained on the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of the chimney assembly 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 22.3 – 22.5 or after the flue-gas generator is shut off.

22.2 A chimney shall comply with the requirements specified in 16.2 and 16.3 after being tested in accordance with 22.3 – 22.5.

22.3 The test is to be started with the test chimney and the test structure at room temperature; or, when conducted immediately following the Temperature Test – 1400°F (760°C) Flue Gases, Section 21, the test chimney and test structure are to be allowed to cool below the temperatures of the structure and chimney parts recorded during the Temperature Test – 1000°F (538°C) Flue Gases, Section 20.

22.4 The test conditions for the Temperature Test – 1000°F (538°C) then are to be established and maintained to produce flue gas at a temperature of 930°F (517°C) above ambient temperature and the operation continued until equilibrium temperatures are attained on surfaces of chimney parts and the test structure.

22.5 After equilibrium temperatures are attained under the test conditions described in 22.4, the input to the flue-gas generator is to be increased to that specified in Column 1 of Table 17.1 and regulated to produce a temperature of 1630°F (906°C) above room temperature at the location designated in Figure 17.11. The test is to be continued for 10 minutes, at which time the flue-gas generator is to be shut off.

23 Temperature Test – 2100°F (1149°C) Flue Gases

23.1 The maximum temperature attained on the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of the chimney assembly 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 23.3 – 23.6 or after the flue-gas generator is shut off.

23.2 A chimney shall comply with the requirements specified in 16.2 and 16.3 after being tested in accordance with 23.3 – 23.6.

23.3 The test is to be started with the test chimney and the test structure at room temperature.

23.4 The test conditions then are to be established at the inputs shown in Column 2 of Table 17.1, and maintained to produce flue gas at a temperature of 930°F (517°C) above room temperature as measured by means of a flue-gas thermocouple as shown in Figure 18.1 and located centrally in the generator. The

operation is to be continued until equilibrium temperatures are attained on surfaces of chimney parts and the test structure.

23.5 After equilibrium temperatures are attained under the test conditions described in 23.4, the input to the flue-gas generator is to be increased to that specified in Column 4 of Table 17.1 and regulated to produce a temperature of 2030°F (1128°C) above room temperature at the location designated in Figure 17.10 and Figure 17.13. The test period shall be 10 minutes, exclusive of the time taken to reach the 2030°F temperature rise above room temperature (which shall not exceed 15 minutes). At the end of the test period the flue-gas generator is to be shut off.

23.6 The test specified in 23.5 is to be conducted three times. 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 (1079°C). The insulation is to be applied to the chimney connector after equilibrium temperatures are attained as described in 23.5 and 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.

24 Positive Pressure Applications Test

24.1 A chimney system intended for installation in positive pressure applications where the chimney is subject to positive rather than negative or neutral pressure in the chimney flue shall be evaluated as described in 24.2 – 24.7.

24.2 Individual chimney sections with joints are to be assembled in a manner that creates a straight assembly incorporating a minimum ratio of 50 inches (1270 mm) of seal per cubic foot of sealed sample. The diameter of the chimney system tested shall be at least 40 percent of the maximum diameter of the series of chimney diameters being evaluated.

24.3 The chimney assembly is to have its ends capped (sealed), then be pressurized to a 60 inch water column (14934 Pa) or the manufacturer's rated pressure, whichever is greater. If any leakage occurs, the leakage rate is to be noted.

24.4 The end caps are to be removed and the chimney assembly is to be subjected to an exposure as described in Section 19, Thermal Shock Test. The chimney assembly is not required to be enclosed during these exposures. Following the Thermal Shock Test, the chimney assembly is to be subjected to flue gas temperatures consistent with the Temperature Test, Section 20. This test is to be conducted for a period of 4 hours at which time the gas is to be shut off.

24.5 Following the exposure described in 24.4, the chimney assembly is again to be pressurized to a 60 inch water column (14934 Pa) or the manufacturer's rated pressure, whichever is greater. The length of time for the pressure to drop 10 inches water column (2489 Pa) is to be noted.

24.6 If leakage occurs following the temperature testing, the acceptance criteria is to be determined based on the following equation.

$$426.7\,(L / V) < 50\ ppm$$

In which:

L = Leakage rate determined lb/hr

V = Volume of test sample, ft^3

(If leakage is quantified in ft^3 /hr, it is to be converted to lb/hr by multiplying by 0.075 lb/ft^3 air, before using the above equation.)

24.7 The manufacturer's rated pressure or 60 inch water column (14934 Pa) shall not be shown on the marking and installation instructions unless the calculated test results comply with the equation shown in 24.6.

25 Draft Test

25.1 A chimney shall produce a draft of not less than 0.006 inch (0.15 mm) water column per foot (300 mm) of vertical chimney when tested as described in 25.2 and 25.3.

25.2 The test is to be conducted with the chimney erected and prepared for test as described in the Temperature Test – 1000°F (538°C) Flue Gases, Section 20. Starting with the chimney at room temperature, the flue-gas generator is to be fired to at least an input indicated in Column 2 of Table 17.1, and the secondary air regulated to produce flue gases at a temperature of 930°F (517°C) above room temperature, measured at the location in the flue pipe designated in Figure 17.11. The draft at the inlet to the chimney is to be measured within 15 minutes of the start of firing.

25.3 Draft is to be measured by a draft gauge that reads directly to 0.005 inch (0.10 mm) water column and that has an accuracy of ±0.0025 inch (0.050 mm). The gauge is to be checked for zero reading at the beginning and at the end of each test.

26 Vertical Support Test

26.1 An assembly intended to support the chimney shall not be damaged nor shall the security of its attachment to the building structure be impaired when tested as described in 26.2.

26.2 The support assembly is to be installed as described in the manufacturer's installation instructions and in a framework simulating a typical installation. A section of the chimney is to be placed on the support, and the assembly is to be loaded by means of weights or by a machine. The maximum static load applied is to be equal to four times the load imposed by the heaviest chimney that the support is required to sustain in service. The load is to be applied for a minimum of 60 minutes.

27 Strength Test

27.1 General

27.1.1 A chimney or its parts shall not break, disassemble, or become damaged to the extent that they are not capable of being further used as a result of three impacts of a sand bag applied as described in 27.2.1 – 27.2.4.

27.1.2 Chimney parts shall not break, disassemble, or become damaged to the extent that they are not capable of being further used when subjected to a longitudinal force of 100 pounds (445 N) applied as described in 27.3.1 and 27.3.2.

27.1.3 A support for an elbow shall sustain a load equivalent to four times the weight of the longest chimney section between adjacent supports. See 27.4.1.

27.1.4 A chimney joint of an offset chimney shall sustain a load equivalent to four times the weight of the vertical portion of the chimney length between the supports applied as described in 27.5.1.

27.1.5 Chimney parts shall not separate or disengage when subjected to torsional forces exerted by chimney cleaning brushes as described in 27.6.1.

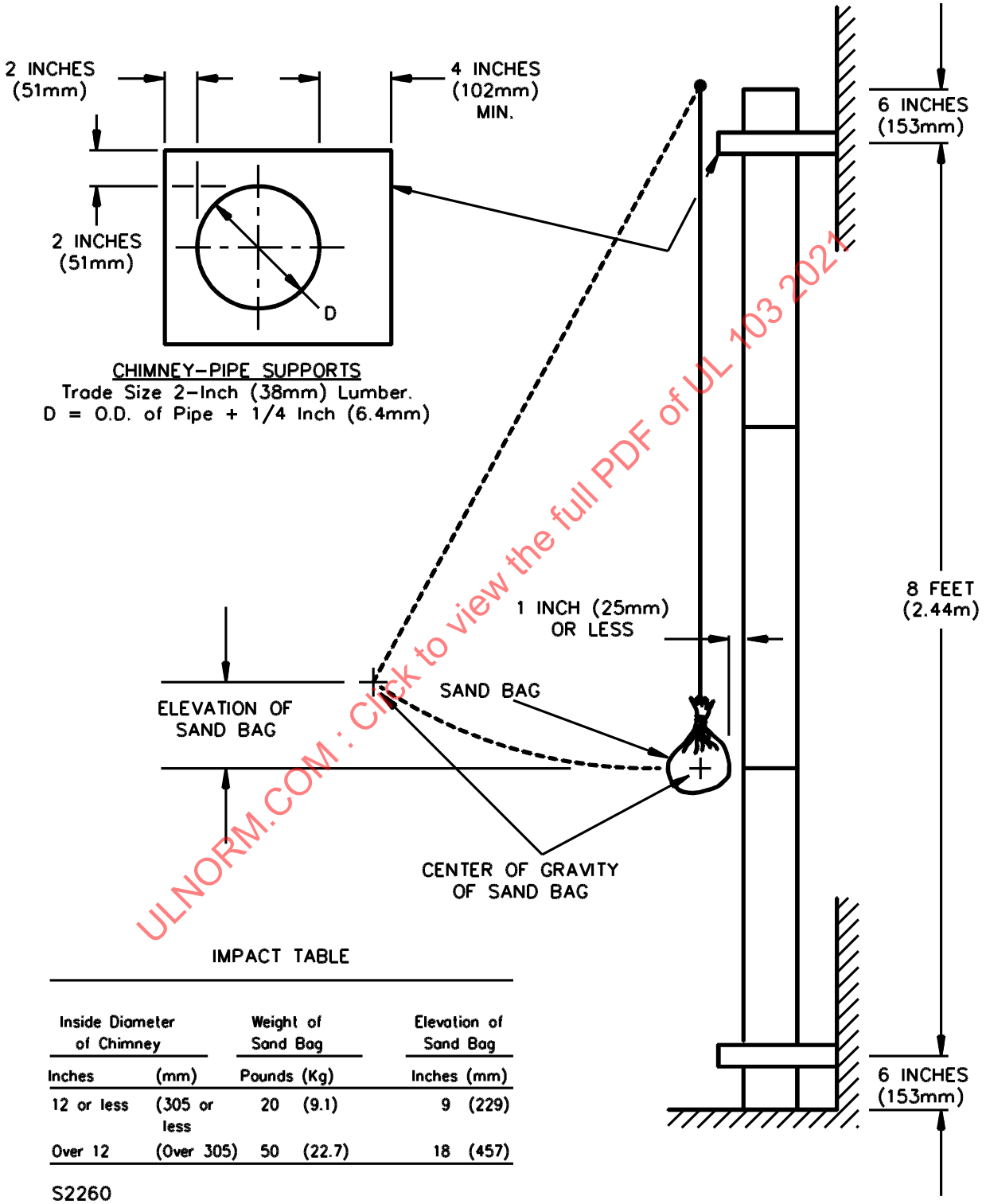
27.2 Impact test

27.2.1 With reference to the requirements in 27.1.1, the impact is to be applied to an unenclosed chimney installed as shown in Figure 27.1. Tests shall be conducted on samples of each chimney size. Each section is to be joined together as specified by the manufacturer. When cemented joints are included in an assembly, the cement is to be allowed to dry before the test is conducted.

27.2.2 The impact is to be produced by a pendulum consisting of a rope suspending a cloth bag filled with sand and having the weight as shown in Figure 27.1. The bag is to be formed by tightly drawing up all sides and corners of a flat section of canvas around the sand and tying the excess canvas. The bag is to have an at-rest position with not more than 1 inch (25.4 mm) distance between the edge of the bag and the surface of the chimney. The point of impact is to be on the same horizontal plane as the center of gravity of the bag at rest. The distance of swing is to be that required to raise the center of gravity of the bag to the elevation specified in Figure 27.1 above the center of gravity of the bag at its at-rest position.

Figure 27.1

Strength test



IMPACT TABLE

Inside Diameter of Chimney		Weight of Sand Bag		Elevation of Sand Bag	
Inches	(mm)	Pounds	(Kg)	Inches	(mm)
12 or less	(305 or less	20	(9.1)	9	(229)
Over 12	(Over 305)	50	(22.7)	18	(457)

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27.2.3 The length of the pendulum varies, based on the intended of impact.

27.2.4 The three impacts are to be made successively at the following points:

a) At the level of a joint;

b) At the level halfway above the first joint tested and the next joint; and

c) At the same level as in (b), and rotated around the axis of the chimney by 90 degrees from the impact in (b).

27.3 Longitudinal force test

27.3.1 With reference to the requirements in 27.1.2, the longitudinal force is to be applied on a number of chimney assemblies, as required to provide for representative samples of each size of part intended to be field-joined together. The force is to be exerted on the assembly in a direction tending to pull the assembly apart. When cemented joints are included in an assembly, the cement is to be allowed to dry before the test is conducted.

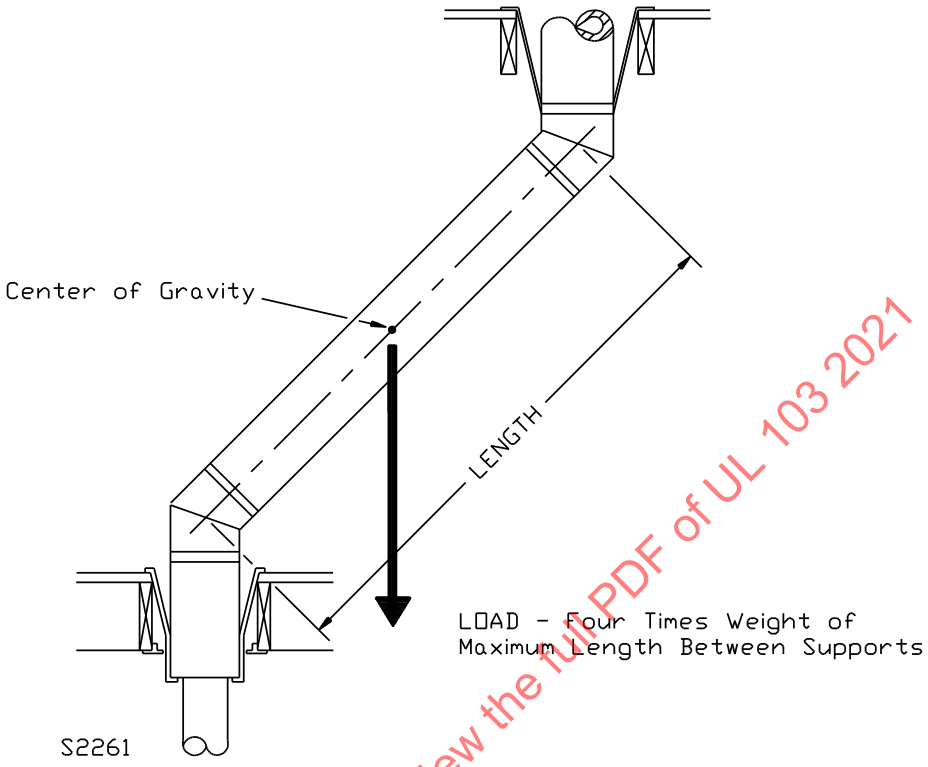
27.3.2 Two or more companion parts are to be joined in accordance with the manufacturer's instructions. A longitudinal force of 100 pounds (445 N) is to be applied first to the flue-gas-conveying conduit, then to the outer jacket or casing.

27.4 Load test for chimney elbows

27.4.1 The test to determine compliance with the requirements of 27.1.3 is to be performed as illustrated in Figure 27.2. Elbows are to be tested using an elbow chimney section having the greatest angle from the vertical specified by the manufacturer and installed directly on the chimney section. A vertical load, equivalent to four times the weight of the longest supported section of the chimney that is intended to be attached to the elbow, is to be applied through the center of gravity of the section. The load is to be sustained for 5 minutes.

Figure 27.2

Load test for chimney elbows

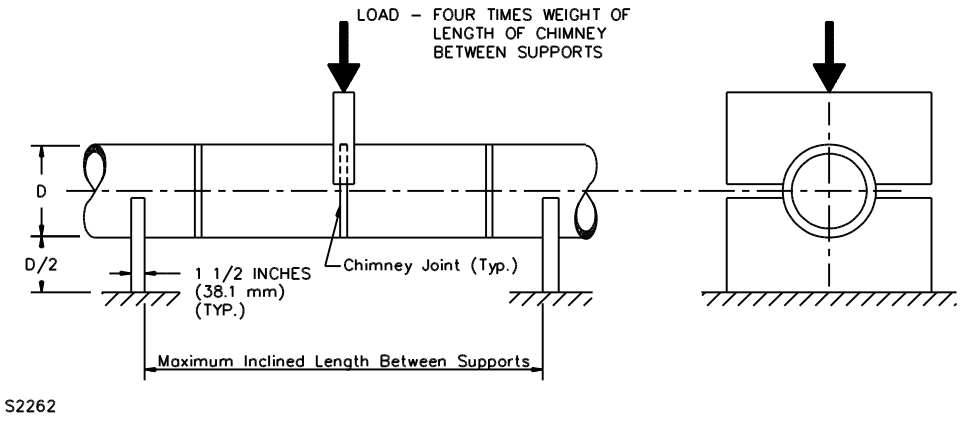


27.5 Chimney joint load test

27.5.1 The test to determine compliance with the requirements of 27.1.4 is to be performed as illustrated in Figure 27.3. The maximum inclined length of flue-pipe between supports is to be assembled and installed on supports as shown. A vertical load, equal to four times the weight of the length of the chimney between supports, is to be applied at the joint located centrally between the supports. The load is to be sustained for 5 minutes.

Figure 27.3

Chimney joint load test



27.6 Chimney joint torsion test

27.6.1 With reference to the requirements in 27.1.5, the torsion is to be applied to a minimum of three chimney sections of the maximum length, secured to the support assembly. A metal chimney cleaning brush sized to fit the chimney flue is to be inserted to the midpoint of the top section and turned ten times to simulate cleaning methods. The chimney parts shall not separate or disengage.

28 Wind Load Test

28.1 General

28.1.1 A roof assembly shall resist, without damage or opening of joints, a load equivalent to 30 pounds per square foot (146 kg/m^2) of exposed area applied to any surface extending above the roof, when tested as described in 28.2.1 – 28.2.3.

28.1.2 A lateral support (such as a wall band) for exterior chimney installations shall resist, without damage, displacement, separation, or distortion, a load equivalent to 30 pounds per square foot (146 kg/m^2) of exposed area applied to any surface when tested as described in 28.3.1.

28.2 Roof assemblies

28.2.1 The test is to be conducted on the tallest roof assembly representative of each style furnished by the manufacturer. The assembly is to be installed in a flat roof deck as described in the manufacturer's installation instructions.

28.2.2 The projected area of the largest surface of the roof assembly exposed to wind is to be computed by multiplying the diameter or the widest average dimension of the roof assembly, whichever is greater, by the greatest height of the assembly measured from the roof to the top of the chimney.

28.2.3 A load equivalent to the product of the projected area, expressed in square feet, multiplied by an assumed wind pressure of 30 pounds per square foot (146 kg/m^2) and expressed in pounds-force is to be applied to the surface of the assembly in a horizontal direction. When a uniform surface load is not applied, the load is to be applied at the middle of the height used to calculate the projected area so that the load is evenly distributed over the surface. See Figure 28.1. The load is to be sustained for 60 minutes.