UL 2561

STANDARD FOR SAFETY

1400 Degree Fahrenheit Factory-Built Chimneys

UL Standard for Safety for 1400 Degree Fahrenheit Factory-Built Chimneys, UL 2561

Second Edition, Dated January 22, 2016

Summary of Topics

This revision of ANSI/UL 2561 is being issued to reaffirm approval as an American National Standard. No changes in requirements are involved.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated February 9, 2018

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UL 2561

Standard for 1400 Degree Fahrenheit Factory-Built Chimneys

First Edition – July, 2009

Second Edition

January 22, 2016

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through April 19, 2018.

The most recent designation of ANSI/UL 2561 as a Reaffirmed American National Standard (ANS) occurred on April 19, 2018. 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 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 1400 degree Fahrenheit chimneys intended for venting gas, liquid, and solid-fuel-fired appliances in which the maximum continuous flue-gas temperatures do not exceed 1400°F (760°C).

1.2 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, and the Uniform Mechanical Code.

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b) Is superseded by a requirement in this standard.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.

5.3 1400° FAHRENHEIT APPLIANCE – As used in these requirements, this term is 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 that cause detrimental galvanic action at any location.

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

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	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	6.6	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	6.6	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)

Table 6.1 Continued on Next Page

Table 6.1 Continued

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)
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	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)

6.3 A flue-gas conveying conduit 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 24 – 27.

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, Series 300 or 400 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; or

b) 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.

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 Table 1 of 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 may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the Tests for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, 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. 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 for 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, support element, or 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. 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 or private labeler's instructions, a chimney shall be positioned securely and resistant to wind damage. See Vertical Support Test, Section 20; Strength Test, Section 21; and Wind Load Test, Section 22.

8 Chimney Caps

8.1 A cap shall be provided.

Exception: A chimney that does not incorporate unprotected ventilation openings terminating exterior to the building does not require 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 23.

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 obstructs 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 Joints

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

9.2 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, it shall be a quick-setting type. Cement, screws, and instructions shall be furnished. A screw shall not extend into a flue gas passage.

9.3 A joint shall not retain condensation or permit condensation to flow from the interior to the exterior of the flue-gas conveying conduit.

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

9.5 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.

9.6 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 19.

10 Radiation Shields

10.1 A radiation shield provided to comply with the maximum temperature limits of these requirements shall:

a) Be an integral part of a roof jack; and

b) Provide a continuous barrier for a vertical distance, referenced to the roof level, of not less than 12 inches (305 mm).

10.2 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.

11 Roof Jacks

11.1 When installed in accordance with the manufacturer's instructions, a roof assembly and 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 23.

11.2 The height of a roof assembly or a roof jack 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.

11.3 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.

12 Support Assembly

12.1 A support assembly shall sustain, without damage or giving way, 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 20.

12.2 A support assembly may be constructed to be installed on the noncombustible floor of a building or on a field-constructed noncombustible base.

12.3 A support assembly intended for attachment to combustible construction shall establish and maintain the minimum required clearance between a chimney section and combustible construction.

12.4 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.

12.5 An offset chimney section shall be supported at or immediately above the vertical return elbow.

PERFORMANCE

13 General

13.1 All factory-built chimneys shall be tested to the following temperature tests in the following order:

a) Thermal Shock Test 1800° F (980° C)

b) Temperature Test – 1400° F (760° C) Flue Gases, Continuous

c) Temperature Test – 1800° F (980° C) Flue Gases, 10 Minute.

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

13.3 After being subjected to the tests for Thermal Shock and Temperature as specified in Sections 16 – 18 a chimney shall be capable of being further used.

13.4 Test results indicating compliance with the requirement of 13.3 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.

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

13.5 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.

13.6 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.

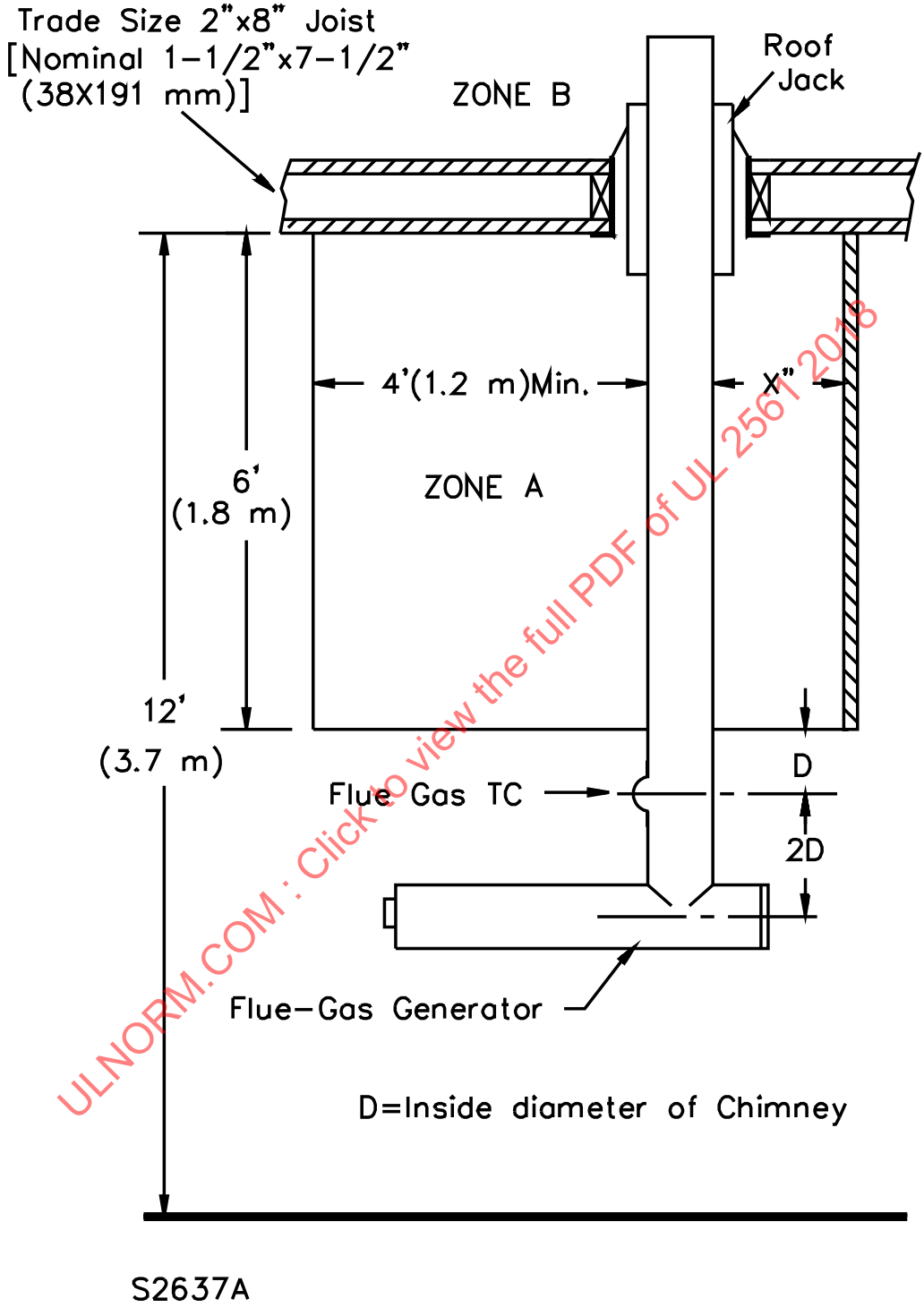
13.7 During the temperature tests, thermocouples are to be located on each chimney section and test enclosure adjacent to any voids in the chimney that result from settling of insulation during the vibration specified in 13.6.

14 Test Installation

14.1 The general form of a test structure for a chimney is to be as illustrated in Figure 14.1 when a roof jack is provided for use with the chimney, or in Figure 14.2 when a roof jack is not provided. Tests are to be conducted as described in 14.2 – 14.13 on a chimney assembly of each type. When the chimney is manufactured in more than one size, tests are to be conducted on as many sizes as required to determine conformance with these requirements.

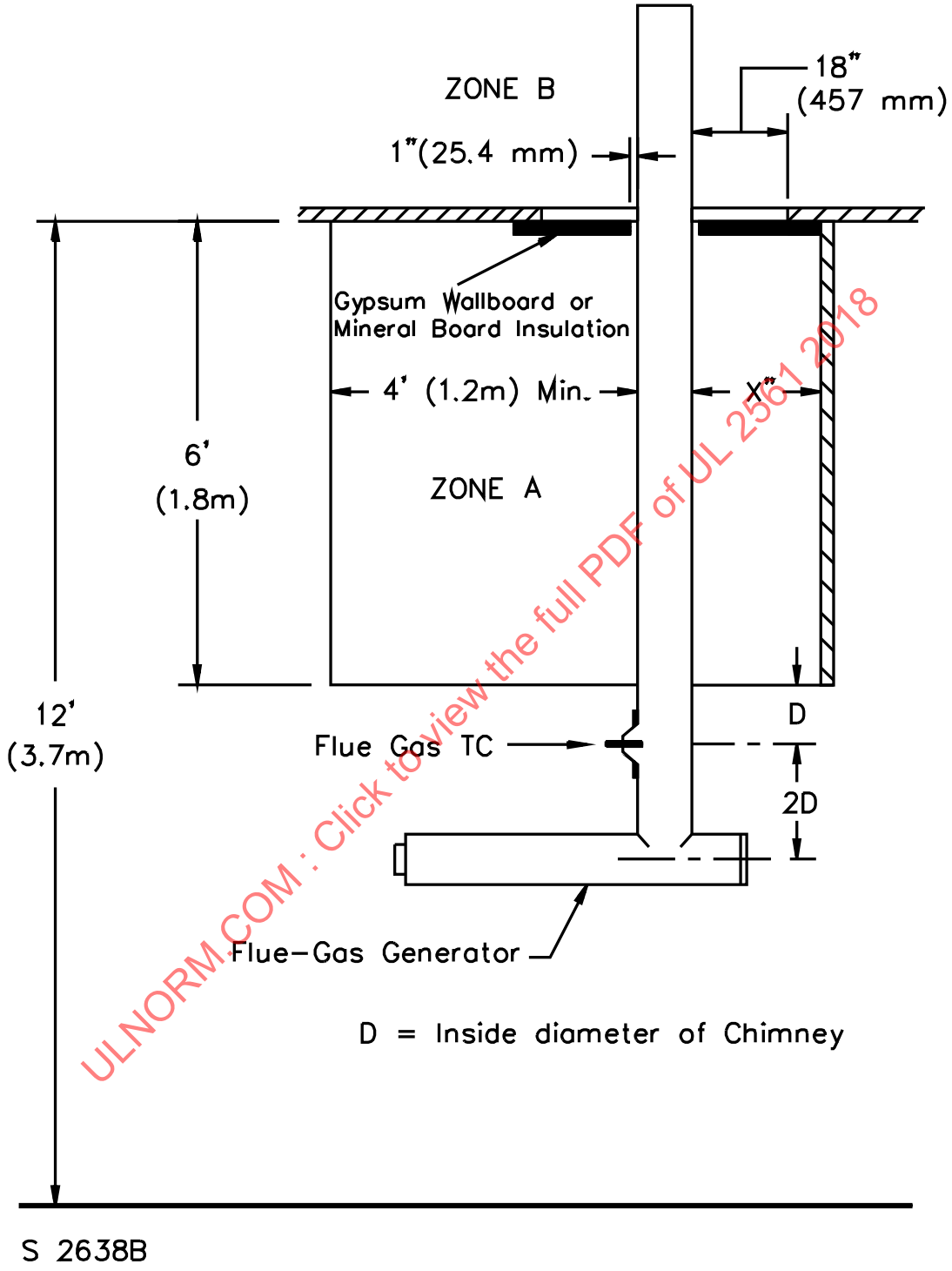
14.2 When tee sections are provided, tests, in addition to those of straight chimney sections installed as illustrated in Figures 14.1 and 14.2, are to be conducted with the tee sections installed as illustrated in Figure 14.3.

Figure 14.1
Corner installation with roof jack



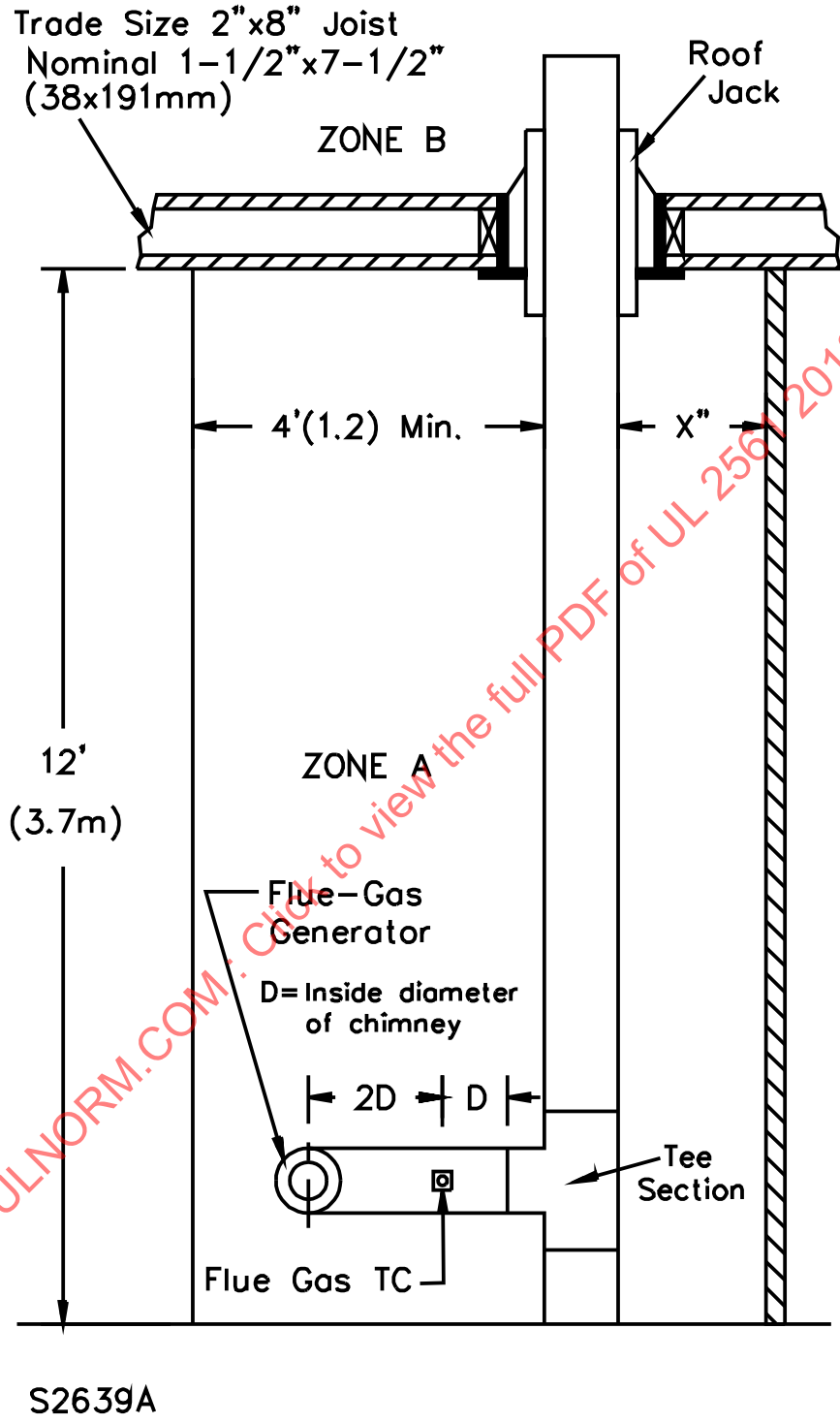
Enclosure shown at specified clearance denoted by "X"

Figure 14.2
Corner installation without roof jack



Enclosure shown at specified clearance denoted by "X"

Figure 14.3
Corner installation with tee and roof jack



Enclosure shown at specified clearance denoted by "X"

14.3 The test structure is to be erected within a room that is free of drafts, and the chimney is to exhaust into the same space or into a space freely communicating with that from which the combustion air is taken.

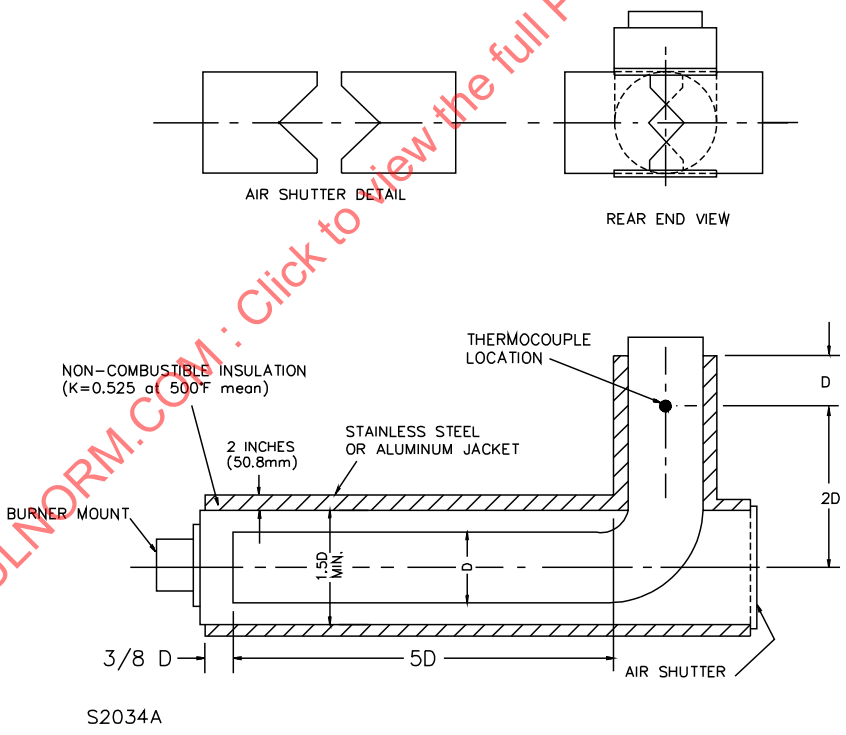
14.4 When a chimney is constructed for taking air from an occupied space and exhausting such air to the outside of a building to cool the chimney, all the openings in the parts as assembled, intended to provide such air flow and which are within an occupied space of the building, are to be closed during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

14.5 When a chimney is constructed for taking air from the outside of a building to cool the chimney, the test arrangement is to provide means for maintaining the temperature of such air between 70 and 90°F (21 and 32°C).

14.6 The test chimney is to consist of a vertical assembly composed of standard chimney sections and other furnished parts erected according to the manufacturer's installation instructions. Other parts constituting functional parts of the chimney are to be used in the test.

14.7 A gas-fired flue-gas generator as illustrated in Figure 14.4 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 15.1.

Figure 14.4
Flue-gas generator

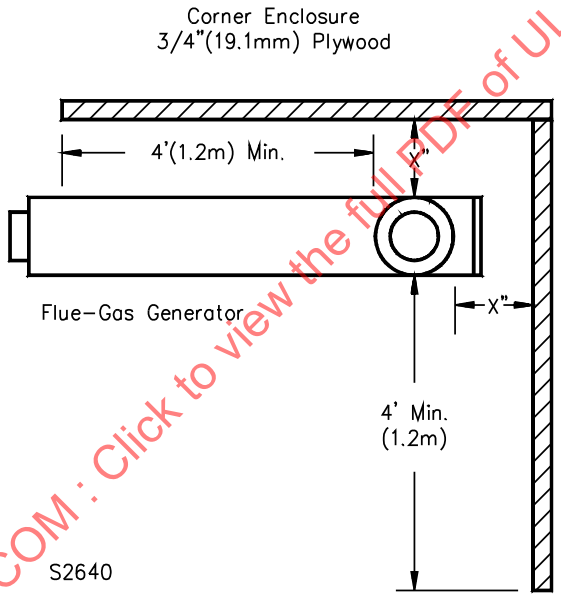


14.8 A premix type burner assembly, such as an Eclipse brand, or the equivalent, capable of supplying an air-gas mixture, with not less than 70 percent primary combustion air (70 percent of premixed theoretical air), to a flame retention burner nozzle tip is to be used. Combustion is to be complete within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

14.9 The test chimney is to terminate 18 feet (5.5 m) above the floor of the test structure unless the construction of the chimney is such that other heights do not comply with the requirements in this standard, in which case the other heights are to be the chimney termination point. The chimney is to be placed in a test structure consisting of two 3/4 inch (19.1 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, and not more than 24 inches (610 mm). See Figure 14.5.

Figure 14.5
Corner installation plan view



Enclosure shown at specified clearance denoted by "X"

14.10 The corner formed by the walls is to be covered by a flat roof made up with nominal 2- by 8-inch joists (1-1/2 by 7-1/2 inch) (38 by 191 mm) covered at the ceiling and roof lines with 3/4 inch (19.1 mm) thick plywood. 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 zero clearance to the roof-jack assembly. See Figures 14.1 and 14.5.

14.11 A chimney that is not provided with a roof jack assembly and that is intended for installation with a ventilating thimble constructed and installed in accordance with nationally recognized codes as required for a metal chimney, see 1.2, is to be installed in a similar fashion as specified in 14.9 and 14.10, except the roof is to consist of one thickness of 3/4 inch (19.1 mm) plywood. The roof is to be cut away to provide an opening 36 inches (914 mm) larger in diameter than the outside diameter of the chimney, the opening closed with noncombustible material having a 3/8 inch (9.5 mm) minimum thickness, and a 1 inch (25.4 mm) wide annular ventilation opening provided between the chimney and the noncombustible materials. For this test arrangement, temperatures are not to be recorded on the plywood roof. See Figure 14.2.

14.12 All joints and openings between parts of the assembly contacting the enclosure and in the test enclosure are to be sealed with paper masking tape unless otherwise indicated.

14.13 The chimney is to be connected directly to the flue-gas generator as illustrated in Figures 14.1 – 14.3.

15 Temperature Measurement

15.1 Flue-gas temperatures are to be determined for the tests for Thermal Shock and Temperature as specified in Sections 16 – 18 by a thermocouple, such as illustrated by Figure 15.1. The thermocouple is to be located within the insulated outlet of the flue-gas generator as illustrated in Figure 14.4. 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.

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

15.3 The gas burner then is to be operated as described either in:

a) Temperature Test – 1400°F (760°C) Flue Gases, Section 17, with the following conditions:

1) The dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple is 1330°F (739°C) above room temperature.

2) The burner input is to be as specified in Column 1 of Table 15.1 for the size of chimney being tested.

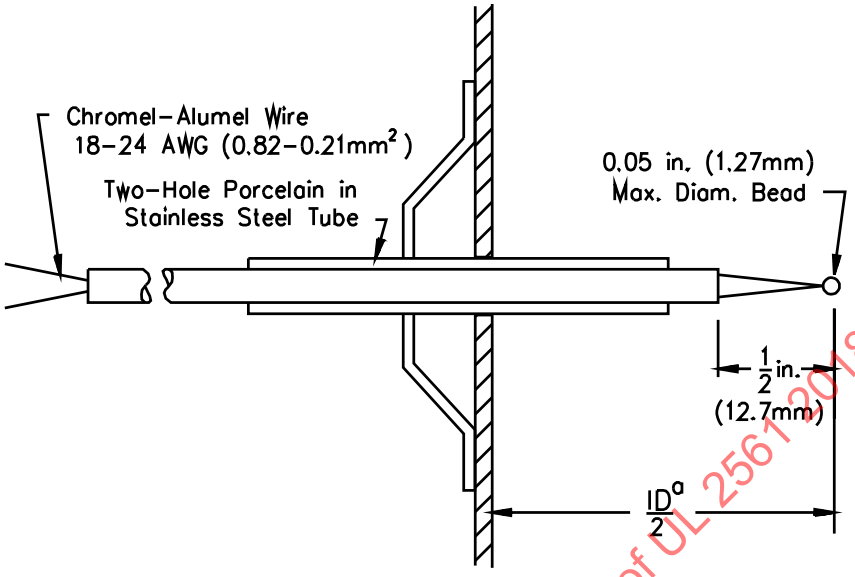
b) Temperature Test – 1800°F (980°C) Flue Gases, Section 18 with the following conditions:

1) The dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple is 1730 °F (960°C) above room temperature.

2) The burner input is to be as specified in Column 2 of Table 15.1 for the size of chimney being tested.

15.4 The dilution air adjustments for tests for Thermal Shock and Temperature as described in Sections 16 – 18 are to be set as required to obtain the specified flue-gas temperature for the individual tests as measured by the thermocouple located as described in 15.1 and 15.2.

Figure 15.1
Flue-gas thermocouple and support bracket



[a] ID = Internal Diameter of Flue Pipe

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Table 15.1
Flue gas generator inputs

Equivalent nominal diameter of chimney		Column 1		Column 2	
		Temperature test – 1400°F (760°C) flue gases		Temperature test – 1800°F (982°C) flue gases	
Inches	(mm)	BTU/Hr x 1,000	(kW)	BTU/Hr x 1,000	(kW)
6	(150)	59.2	(17.4)		
7	(180)	80.5	(23.6)		
8	(200)	106	(31.1)		
9	(230)	133	(39.0)		
10	(250)	165	(48.4)	281.1	(82)
12	(300)	238	(69.8)	413.4	(121)
14	(360)	323	(94.7)		
16	(410)	421	(123)	727.5	(213)
18	(460)	533	(156)	930.1	(273)
20	(510)	658	(193)	1136.8	(333)
22	(560)	796	(233)	1653.6	(485)
24	(610)	947	(278)	1653.6	(485)
26	(660)	1,111	(326)		
28	(710)	1,289	(378)		
30	(760)	1,480	(434)	2583.7	(757)
36	(900)	2,131	(625)	3720.6	(1091)

15.5 Temperatures, other than those of flue-gases and metal surfaces, are to be measured using either Type K (chromel-alumel) or Type J (iron-constantan) thermocouples not larger than 24 AWG (0.21 mm^2). For test enclosure elements in contact with the chimney, junctions of thermocouples are to be placed on the chimney 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 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 (12.7 mm) into the wood so as to be flush with the wood surface at the point of measurement and held in thermal contact with the surface at that point by the use of flat black pressure-sensitive paper tape. See Figure 15.2.

15.6 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 15.3. Thermocouples to be attached to surfaces of nonmetallic or nonwood parts are to have junctions and at least 1 inch (25.4 mm) of the lead wires imbedded flush with the surface of the material. Furnace cement is to be smoothed over such indentations to maintain thermal contact. Such thermocouples are to be located at points attaining maximum temperatures. Additional thermocouples are to be placed at other locations that are in contact with or subject to radiation from surfaces of the chimney.

Figure 15.2
Thermocouple installation methods on wood surfaces

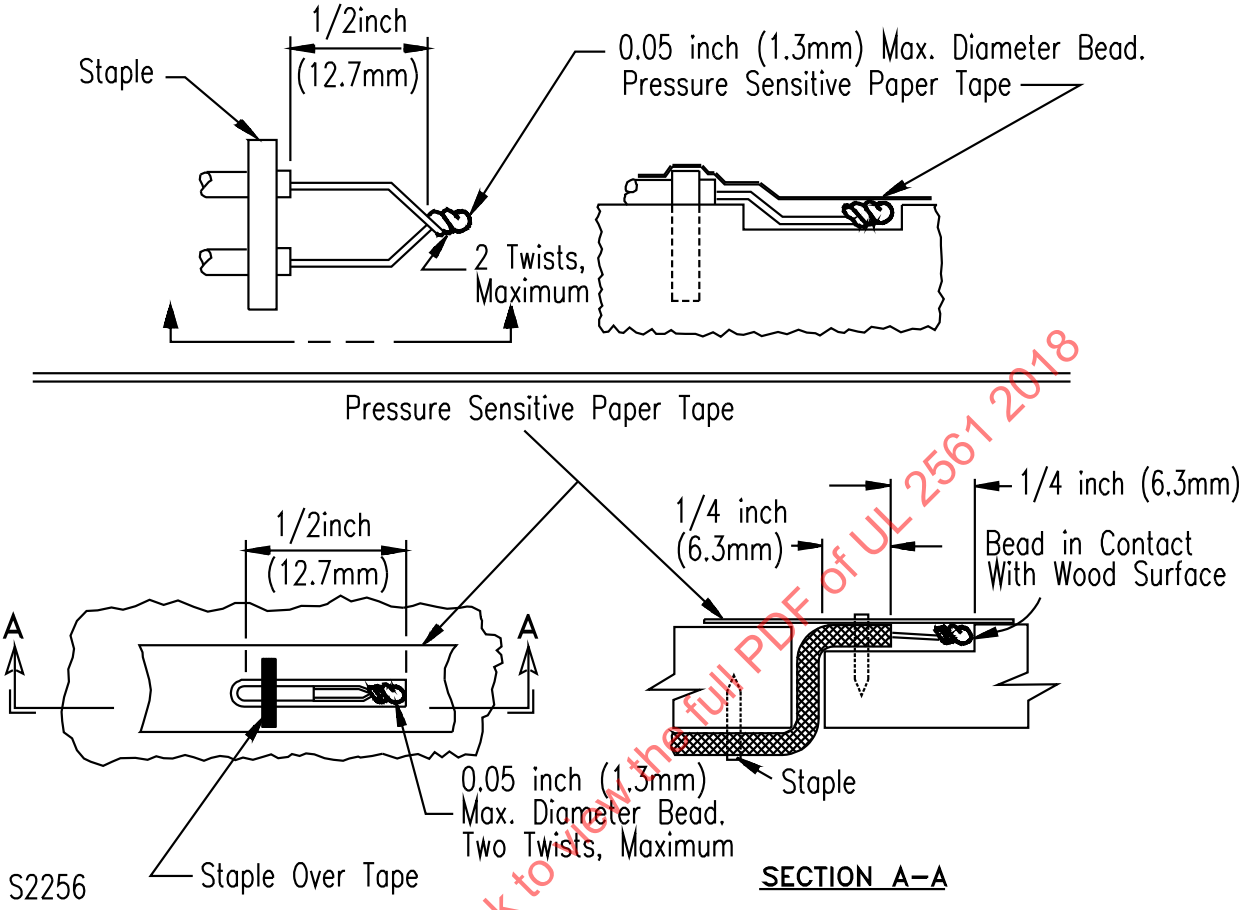
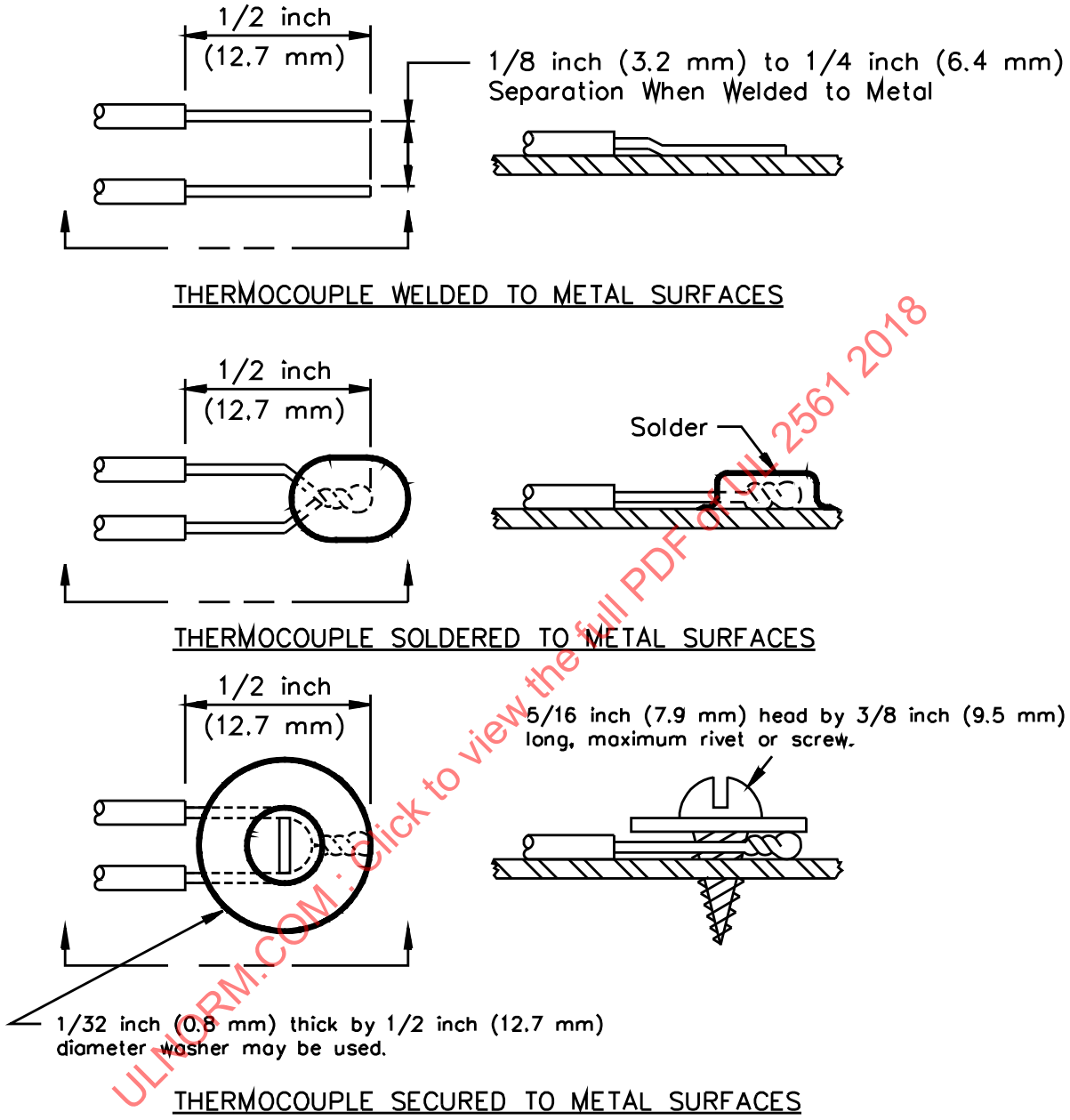


Figure 15.3
Thermocouple installation methods on metal surfaces



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15.7 The room or ambient temperature is to be determined by a shielded thermocouple located centrally within a vertically oriented 6 inch (152.4 mm) length of aluminum-painted 2 inch steel pipe (ANSI B36.10) open at both ends. The shielded thermocouple is to be located 4 feet (1.2 m) horizontally from the chimney at the elevation of the horizontal axis of the flue-gas generator. The shield is to be placed in a manner to avoid direct radiation to the thermocouple.

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

16 Thermal Shock Test

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

16.2 This test is to be conducted in all cases prior to conducting the tests covered in Section 17, 1400°F (760°C) Flue Gases Temperature Test (See 13.2).

16.3 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 15.1, and regulated to produce flue gases at a temperature of 1730°F (961°C) above room temperature at the flue-gas thermocouple location illustrated in Figures 14.1 – 14.3. The test is to be continued for 10 minutes exclusive of the time taken to attain 1730°F (961°C) (which shall not exceed 15 minutes), at which time the burner is to be shut off.

16.4 This test is to be conducted one time.

16.5 No temperature readings other than the flue-gas temperature shall be recorded for the tests described in 16.3.

16.6 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 16.1 by lowering a light throughout its length.

17 Temperature Test – 1400°F (760°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 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 17.3. The temperature on any part of the chimney shall not exceed the maximum temperature specified for the materials used. See Column 1 of Table 17.1.

Table 17.1
Maximum temperature rises

Material		Maximum rise above room temperature	
		°F	(°C)
1.	Aluminum alloys –		
	11100 (2S)	330	(183)
	3003 (3S)	430	(239)
	2014, 2017, 2024, 2052[a]	530	(294)
2.	Aluminum-coated steel, heat-resistant type[b]	1030	(572)
3.	Carbon steel-coated with Type A19 ceramic	1030	(572)
4.	Galvanized steel[c]	480	(267)
5.	Low-carbon steel, cast iron[d]	830	(461)
6.	Stainless steel –		
	Types 302, 303, 304, 321, 347	1235	(686)
	Type 316	1200	(667)
	Type 309S	1560	(867)
	Types 310, 310B	1610	(894)
	Type 430	1310	(728)
	Type 446	1730	(961)

[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 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.

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 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 1330°F (739°C) above room temperature at the location designated in Figure 14.1 – 14.4. The test is to be continued until equilibrium temperatures are attained on surfaces of the test chimney parts and the test enclosure.

18 Temperature Test – 1800°F (980°C) Flue Gases, 10 Minutes

18.1 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 18.3 – 18.5 or after the flue-gas generator is shut off.

18.2 A chimney shall comply with the requirements specified in 13.3 and 13.4 after being tested in accordance with 18.3 – 18.5.

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

18.4 The test conditions for the Temperature Test – 1400°F (760°C) Flue Gases, Section 17, then are to be established and maintained to produce flue gas at a temperature of 1370°F (761°C) above ambient temperature and the operation continued until equilibrium temperatures are attained on surfaces of chimney parts and the test structure.

18.5 After equilibrium temperatures are attained under the test conditions described in 18.4, the input to the flue-gas generator is to be increased to that specified in Column 4 of Table 15.1 and regulated to produce a temperature of 1730°F (961°C) above room temperature at the location designated in Figure 14.1 – 14.4. The test is to be continued for 10 minutes, at which time the flue-gas generator is to be shut off.

19 Positive Pressure Applications Test

19.1 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 19.2 – 19.7.

19.2 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.

19.3 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.

19.4 The end caps are to be removed and the chimney assembly is to be subjected to an exposure as described in Section 16, Thermal Shock Test. Following the Thermal Shock Test, the chimney assembly is to be subjected to flue gas temperatures consistent with the Temperature Test – 1400°F (760°C) Flue Gases, Section 17. This test is to be conducted for a period of 4 hours at which time the gas is to be shut off.

19.5 Following the exposure described in 19.4, 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.

19.6 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.)

19.7 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 19.6.

20 Vertical Support Test

20.1 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 20.2 and 20.3.

20.2 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.

20.3 Assemblies incorporating refractory, cementitious, or other nonmetallic materials as load-bearing members are to be tested following exposure to the conditions of the appropriate tests (see 13.1) for Thermal Shock and Temperature as specified in Sections 16 – 18. In addition, the test load is to be increased by 15 percent to compensate for usual variation in such materials.

21 Strength Test

21.1 General

21.1.1 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 21.2.1 – 21.2.4.

21.1.2 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 21.3.1 and 21.3.2.

21.1.3 A support for an elbow shall sustain a load equivalent to four times the weight of the longest chimney section between adjacent supports. See 21.4.1.

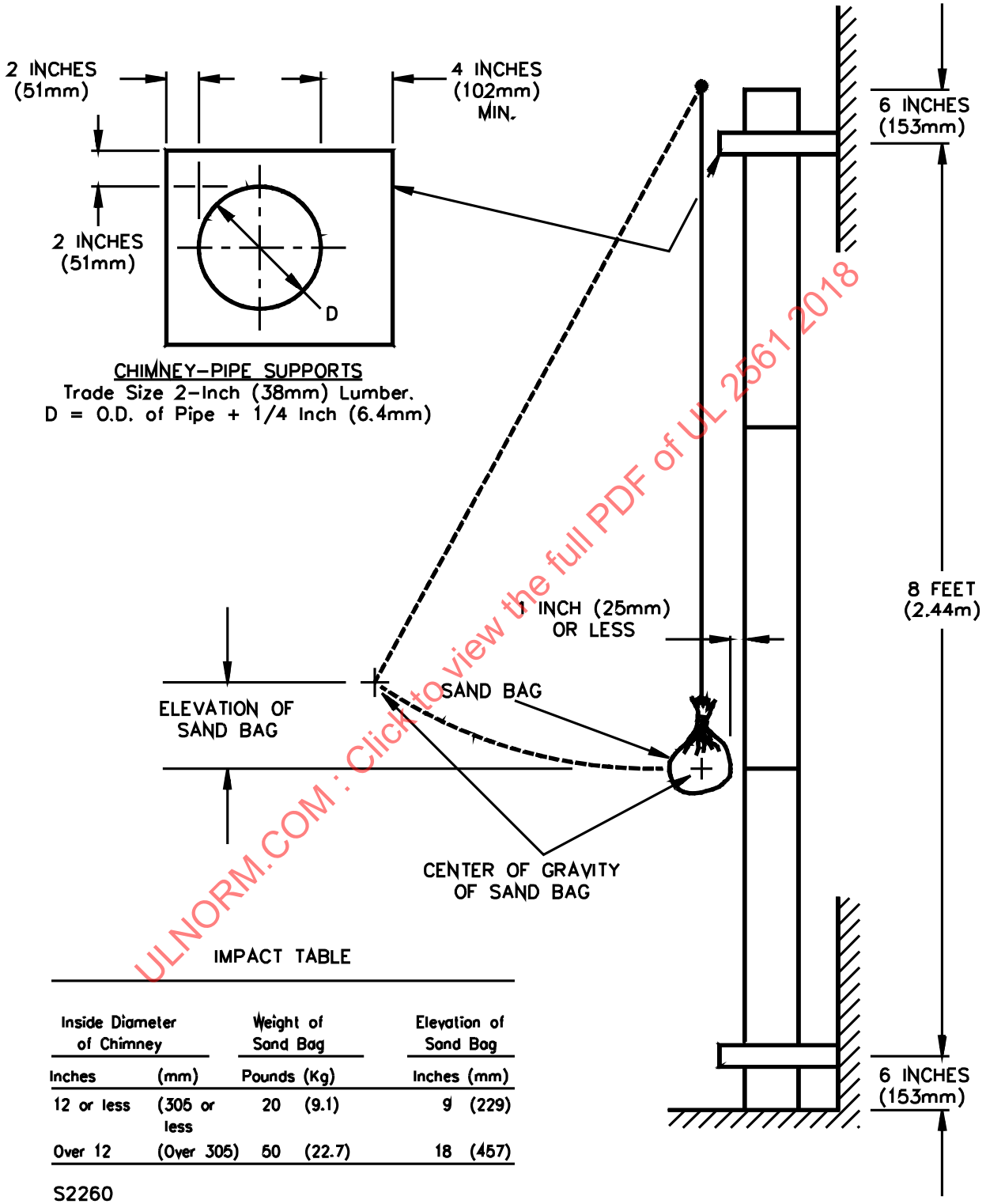
21.1.4 A chimney joint of an offset chimney shall sustain a load equivalent to four times the weight of the vertical portion of the chimney length between the supports applied as described in 21.5.1.

21.2 Impact test

21.2.1 With reference to the requirements in 21.1.1, the impact is to be applied to an unenclosed chimney installed as shown in Figure 21.1. Tests are to 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.

21.2.2 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 21.1. 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 21.1 above the center of gravity of the bag at its at-rest position.

Figure 21.1
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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21.2.3 The length of the pendulum varies, based on the intended point of impact.

21.2.4 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).

21.3 Longitudinal force test

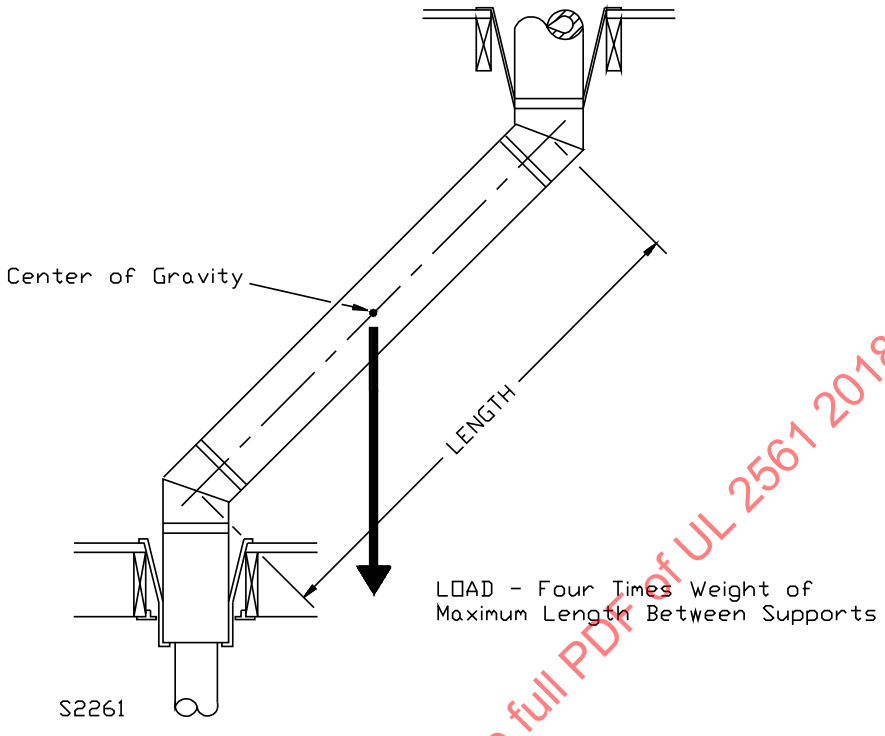
21.3.1 With reference to the requirements in 21.1.2, the longitudinal force is to be applied on a number of chimney assemblies, as required to provide for representative samples of each size of part intended to be field-joined together. The force is to be exerted on the assembly in a direction tending 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.

21.3.2 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.

21.4 Load test for chimney elbows

21.4.1 The test to determine compliance with the requirements of 21.1.3 is to be performed as illustrated in Figure 21.2. 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.

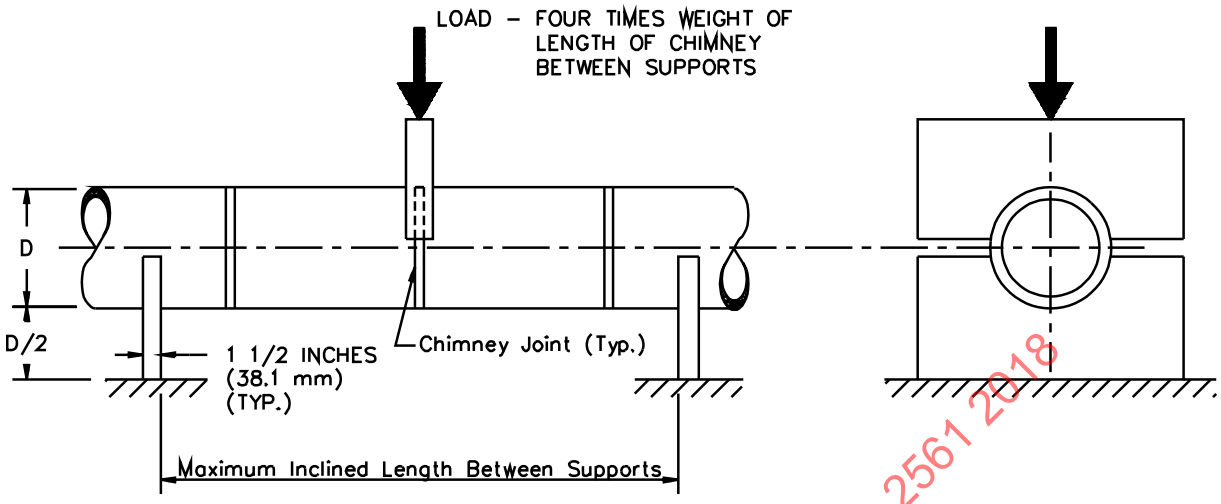
Figure 21.2
Load test for chimney elbows



21.5 Chimney joint load test

21.5.1 The test to determine compliance with the requirements of 21.1.4 is to be performed as illustrated in Figure 21.3. 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 21.3
Chimney joint load test



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22 Wind Load Test

22.1 General

22.1.1 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 22.2.1 – 22.2.3.

22.1.2 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 22.3.1.

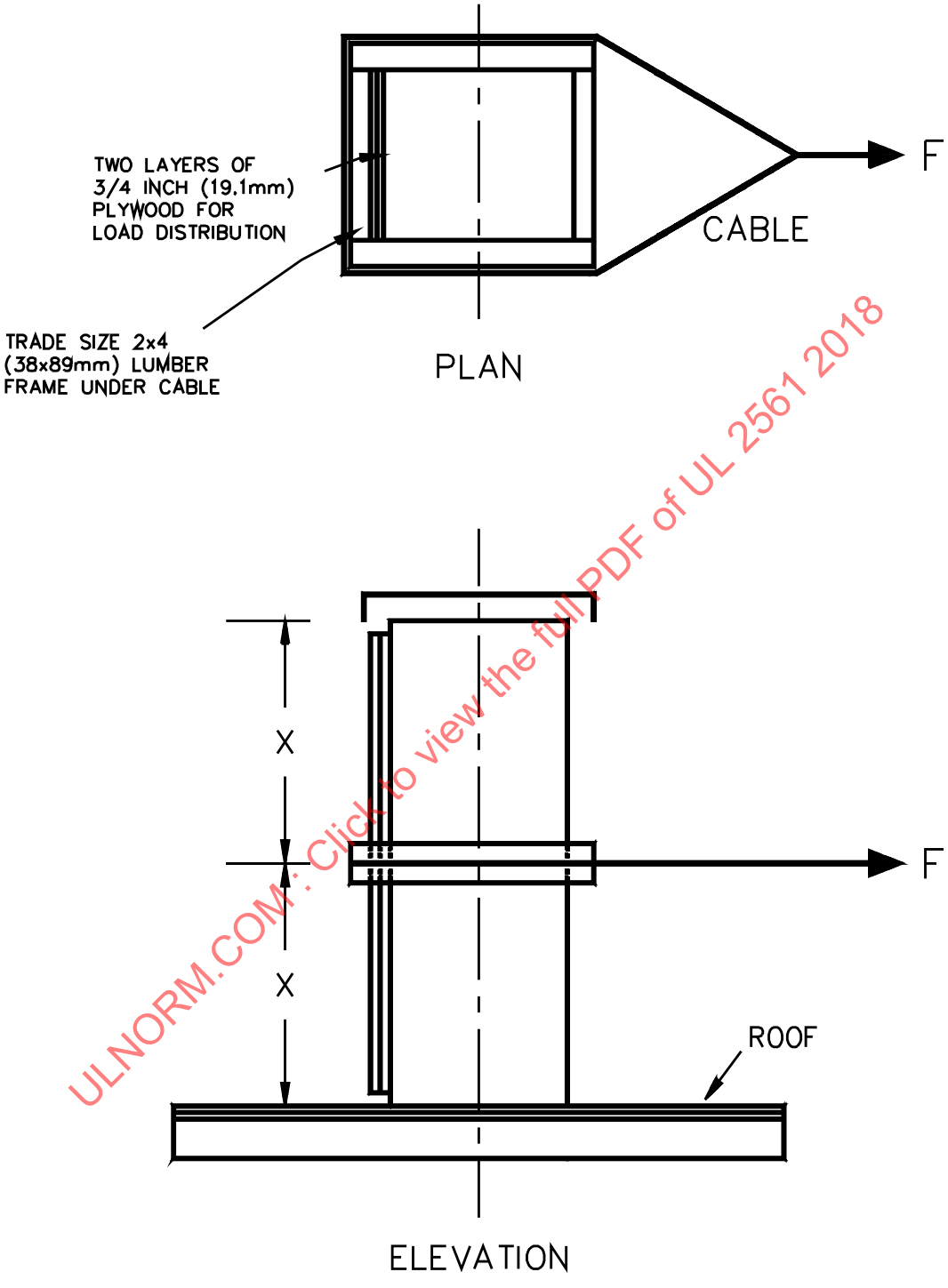
22.2 Roof assemblies

22.2.1 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.

22.2.2 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.

22.2.3 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 able to be 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 largest surface. See Figure 22.1. The load is to be sustained for 60 minutes.

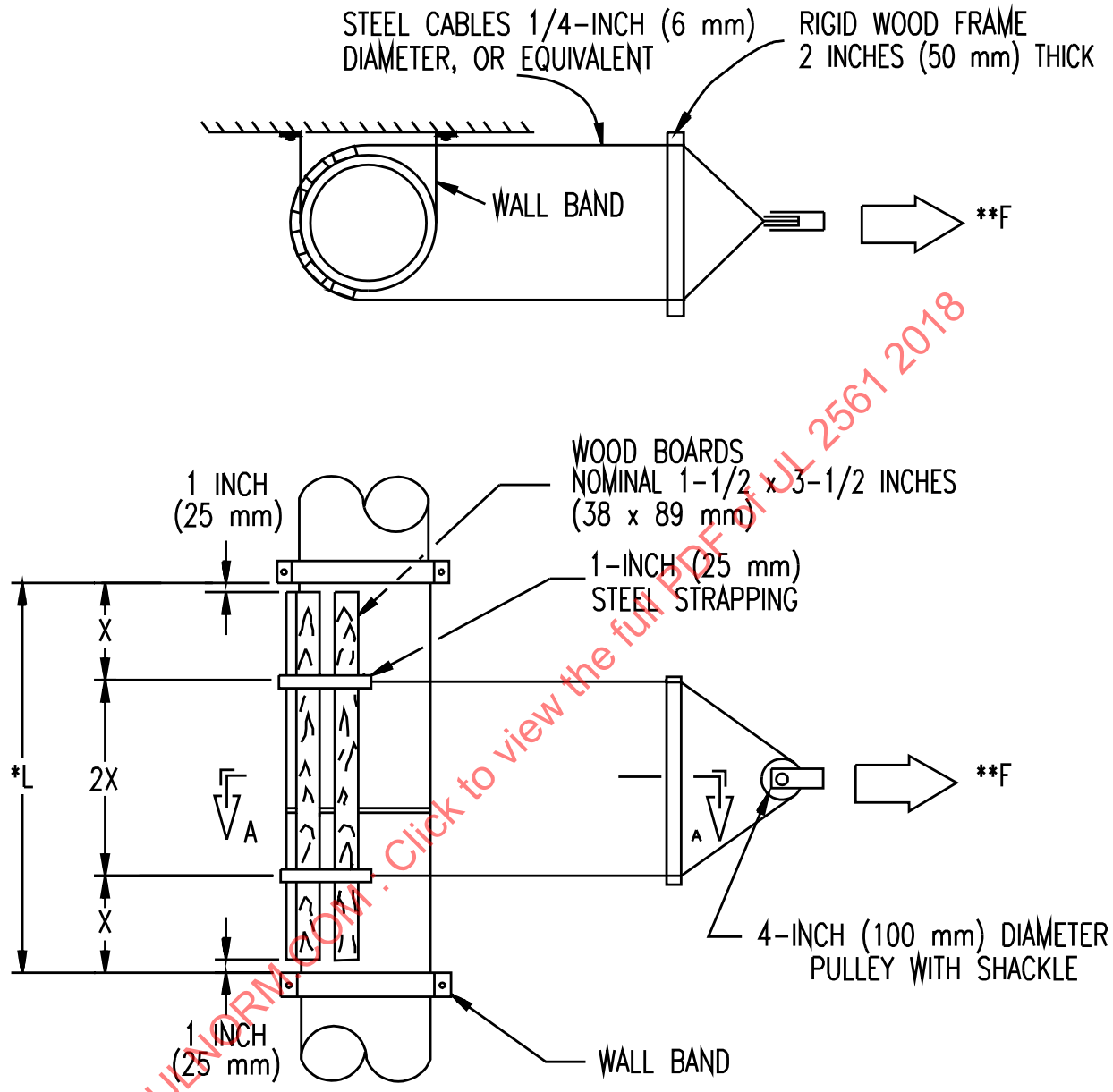
Figure 22.1
Wind load test on roof assembly



22.3 Lateral supports

22.3.1 For a chimney intended for an exposed exterior installation, this test is to be conducted on an assembly consisting of one or more chimney sections installed with two lateral supports spaced at the maximum distance specified by the manufacturer and mounted on a 3/4 inch (19 mm) thick plywood vertical surface. The projected area of the largest surface of the chimney between the supports, and exposed to the wind, is to be calculated in square feet. A load equivalent to the product of the projected area, expressed in square feet, multiplied by 30 pounds per square foot (146 kg/m^2) and expressed in pounds-force is to be applied in a horizontal direction as illustrated in Figure 22.2. The load is to be sustained for 60 minutes.

Figure 22.2
Wind load test for chimneys intended for exposed exterior installation



*L = Maximum spacing, according to manufacturer's instructions
**F = Horizontal force applied to assembly

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