UL 441

STANDARD FOR SAFETY

Gas Vents

UL Standard for Safety for Gas Vents, UL 441

Eleventh Edition, Dated April 8, 2016

Summary of Topics

This revision of ANSI/UL 441 dated April 2, 2024 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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

The requirements are substantially in accordance with Proposal(s) on this subject dated February 16, 2024.

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UL 441

Standard for Gas Vents

First Edition – September, 1958
Second Edition – January, 1969
Third Edition – January, 1971
Fourth Edition – July, 1973
Fifth Edition – July, 1979
Sixth Edition – March, 1986
Seventh Edition – September, 1991
Eighth Edition – October, 1994
Ninth Edition – January, 1996
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Eleventh Edition

April 8, 2016

This ANSI/UL Standard for Safety consists of the Eleventh Edition including revisions through April 2, 2024.

The most recent designation of UL 441 as a Reaffirmed American National Standard (ANS) occurred on April 2, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 441 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 ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

INTRODUCTION

1 Scope

1.1 These requirements cover Types B and BW gas vents and Types B and BW gas vent roof jacks intended for venting gas appliances equipped with draft hoods to burn only gas. Type B vents are also intended for use with other Category I appliances that specify they are for use with Type B gas vents.

1.2 The gas vents covered by these requirements are intended for installation in accordance with the National Fire Protection Association Standards for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances, NFPA 211 the National Fuel Gas Code, NFPA 54, the Department of Housing and Urban Development Mobile Home Construction and Safety Standards, Chapter II of 24 CFR, Part 280, 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 need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed 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 recognized rating established for the intended conditions of use.

2.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

3 Units of Measurement

3.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

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 CATEGORY I APPLIANCE – An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

5.3 COMBUSTIBLE MATERIAL – Material made of or surfaced with wood, compressed paper, plant fibers, or other material that ignites and burns, as applied to materials adjacent to or in contact with heat-

producing appliances, chimney connectors and vent connectors, steam and hot water pipes, and warm air ducts. Such material shall be identified as combustible even though flameproofed, fire-retardant treated, or plastered.

5.4 NONCOMBUSTIBLE MATERIAL – A material that, in the form in which it is used and under the conditions anticipated, does not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

5.5 ROOF JACK – A factory-built assembly for conveying flue gases through a roof and that includes a flue gas passageway, an insulating means, flashing, and a cap.

5.6 TYPE B GAS VENT – A gas vent for venting gas appliances with draft hoods and other Category I gas appliances listed for use with Type B gas vents.

5.7 TYPE BW GAS VENT – A gas vent for venting gas-fired vented wall furnaces.

CONSTRUCTION

6 Materials

6.1 A gas-vent and a roof-jack part shall be made of noncombustible corrosion-resistant materials. Metals shall not be used in combinations that result in galvanic action at any location within the assembly.

6.2 The minimum thickness of sheet metal, including any coatings, shall be as referenced in Table 6.1 unless otherwise specified.

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

6.4 A flue-gas conveying conduit shall be of a material having durability and resistance to corrosion and heat equivalent to that of Type 1100 aluminum, Series 300 or Types 430 and 446 stainless steel, or porcelain-coated steel complying with the requirements contained herein. Except as noted in 6.5, parts in contact with flue gases or flue gas-air mixtures, or subject to condensation, shall be of material having durability and resistance to corrosion and heat equivalent to Type 1100 aluminum or Series 300 or Types 430 and 446 stainless steel.

Table 6.1
Minimum metal thickness

	Inch	(mm)
Aluminum alloys (1100, 3003) – inner pipe	0.012	(0.30)
Aluminum alloys (1100, 3003) – other than inner pipe	0.016	(0.41)
Steel	0.016	(0.41)
Galvanized steel (G90 coating class)	0.018	(0.46)
Aluminum-coated steel (0.40 ounces per square foot)	0.018	(0.46)
Stainless steel (Type 430)	0.012	(0.30)

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

a) Deterioration or corrosion of the part results in the venting system to collapse or otherwise increase the risk of injury to persons;

b) The part adjoins firestopping material; or

c) The part is subject to condensation.

Exception: This requirement does not apply to the flue-gas conveying conduit or other parts in contact with flue-gases or flue-gas air mixtures. See 6.4.

6.6 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 in the Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, ASTM A653/A653M-94, 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, ANSI/ASTM A90. Aluminum-coated steel shall be of Type T1-40 (regular) [0.40 ounce per square foot (0.12 kg/m^2)].

6.7 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, has corrosion resistance equivalent to that required by 6.5. Paint coatings shall remain intact at the maximum temperatures obtained on the part during the tests specified in these requirements.

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

6.9 Thermal insulation shall be in accordance with the following conditions when the gas vent or roof jack is tested in accordance with these requirements:

a) The products resulting from the combustion or volatilization of any combustible binder shall be discharged to the vent 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) Thermal insulation shall not show evidence of softening, melting, or other evidence of malfunction or deterioration.

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

6.11 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 that adhesive attains when tested in accordance with these requirements and at 0°F (minus 18°C).

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

7 Assembly

7.1 Each part of a gas vent shall be constructed for ready attachment of one to the other without requiring alteration, cutting, threading, drilling, welding, or similar task by the installer.

Exception: A length of gas-vent pipe shall be shortened by cutting when means are provided to permit the shortened length to be coupled to any companion part.

7.2 Two or more parts of a gas vent 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 gas-vent part, such as gas-vent pipe section, an elbow, coupling, or tee, shall be completely assembled by the manufacturer at the factory.

7.4 A Type B or BW gas-vent roof jack shall be completely assembled by the manufacturer at the factory and shall include, in addition to the flue gas carrying conduit, an outer jacket or body and insulating means, a rain cap, and a roof flashing.

Exception No. 1: An adjustable pitch roof flashing for use on a roof with a maximum slope of 3/12 shall not be provided for use on a Type B or BW gas-vent roof jack unless the roof jack outer body incorporates integral mechanical stops to prevent a decrease of clearance from the roof to the lowest flue gas discharge opening as evaluated in test structures Forms IV, V, or VI. See Section 18, Test Installation.

Exception No. 2: An adjustable roof flashing is not required to be an integral part of the roof jack when:

a) The adjustable roof flashing is marked with a specific catalog designation; and

b) The roof jack body is marked to specify that the flashing identified by the catalog designation is required for installation.

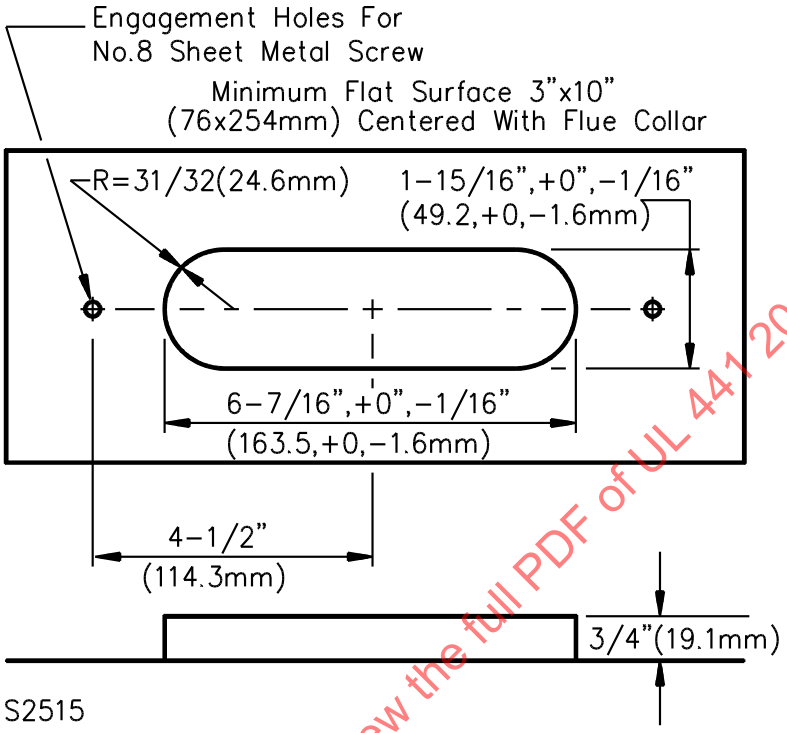
7.5 A double wall gas-vent connector for use with Type B gas-vent roof jack shall be packaged separately for field assembly to a gas vent roof jack, when it is marked as required by 33.1.

7.6 A Type B gas vent shall be capable of attachment to appliance flue outlets having diameters of integral inches (25 mm).

7.7 A Type BW gas vent shall be capable of attachment to the gas-vent support and flue collar for vented wall furnaces illustrated by Figure 7.1.

Figure 7.1

Standardized details for vent support and flue collar for vented wall furnaces for use with Type BW vents



7.8 A Type B gas-vent roof jack shall permit the attachment of a flue pipe having a diameter of integral inches (25 mm) unless it is furnished as part of a complete heating appliance, gas-vent connector, and roof jack assembly. A double wall gas-vent connector for use with a Type B gas vent roof jack shall comply with the requirements as detailed for a gas vent and shall be capable of attachment to the roof jack and to appliance flue outlets having diameters of integral inches (25 mm).

Exception: The test specified in 25.1.2 is not required to be conducted on a double wall gas-vent connector intended for use with a Type B gas vent roof jack.

7.9 A Type BW gas-vent roof jack shall be capable of attachment to a Type BW gas-vent pipe section.

7.10 The design of a gas-vent part shall not void the firestopping required between spaces of a building when the part is installed in accordance with the manufacturer's instructions.

7.11 The design of a gas-vent roof jack shall not void the firestopping required for a concealed space when the roof jack is installed in accordance with the manufacturer's instructions.

7.12 The annulus between any two walls of a multiple-wall gas-vent pipe section or gas-vent pipe fitting shall be not less than 1/4 inch (6.4 mm) in width.

8 Caps

8.1 A cap shall be provided to resist the entrance of debris and rain into the flue-gas conveying conduit and into any cooling-air passage terminating exterior to the building. See Rain Test, Section 27.

8.2 A cap shall be constructed so that leaves and debris falling or blown onto it are not retained so as to obstruct flue-gas or cooling-air passages.

9 Firestops

9.1 Joints between factory-made parts that provide for firestopping 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 with construction for a height of not less than 1 inch (25 mm).

9.2 A joint between factory-made parts that provide for firestopping shall have a through opening (total eccentricity) not larger than 1/8 inch (3.2 mm) wide.

10 Spacers

10.1 A Type B and a Type BW gas vent for installation within a 2- by 4-inch (38- by 89-mm) or a 2- by 6-inch (38- by 140-mm) stud space, with other than zero clearance, shall be provided with ceiling plate spacers constructed to locate the gas-vent centrally in the stud space. Each length of pipe for such gas-vents shall include integral spacers that maintain the minimum required clearance between the pipe and the inner surfaces of walls. Such spacers are to be located so that they are directly adjacent to each joint when pipe lengths are joined.

Exception: A base plate in lieu of integral spacers meets the intent of the requirement when used with a Type BW gas vent for single-story installation only.

10.2 A ceiling-plate spacer shall constitute a complete firestop. A ceiling-plate spacer installed at the lowest ceiling level with a Type BW gas vent is not a complete firestop.

10.3 All spacers shall have the strength and bearing surface to maintain the required clearance from gas-vent parts to joists, ceiling and floor material, and the inner surface of walls.

11 Joints

11.1 Parts of gas vent and roof jacks shall be joined and secured so that they do not disengage when tested in accordance with these requirements.

11.2 When screws are employed to field-joint assemblies, the assemblies to be joined shall provide for use of screws without being field-punched or drilled. 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.

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

12 Radiation Shields

12.1 A radiation shield for a gas vent provided to comply with the maximum temperature limits of the requirement 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 (250 mm) for gas vents having an internal diameter of 12 inches (300 mm) or less, and not less than 12 inches for all other sizes.

12.2 The assembly referenced in 12.1 shall fit into a framed joist area not larger than the sum of:

a) 1/2 inch (13 mm) greater than the outside diameter of the gas vent; and

b) Twice the dimension to be specified in the installation instructions for clearance between gas-vent pipe sections and combustible enclosures.

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

12.4 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.

13 Roof Assemblies

13.1 The height of a roof assembly shall be such that the flue-gas exit is not less than 2 feet (0.61 m) above the roof.

13.2 A roof assembly installed in accordance with the installation instructions shall resist the entrance of excess water and debris into the building at the point where the gas vent passes through the roof. See Rain Test, Section 27.

13.3 A gas-vent roof assembly shall resist the accumulation of soot and debris when such accumulation obstructs flue-gas or cooling-air passages.

14 Roof Jacks

14.1 A roof jack constructed for placement in contact with combustible roof, rafter, insulation, or 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).

14.2 When installed in accordance with the manufacturer's instructions, a roof jack shall protect against the entrance of excess water and debris into the building where the gas vent passes through the roof. See Rain Test, Section 27.

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

15 Fittings

15.1 The nominal cross-sectional area of the flue-gas passage of a gas-vent pipe fitting shall be equivalent to that of the vent piping with which it is intended to be used.

16 Sizes

16.1 A gas-vent pipe or fitting or a roof jack shall have an internal cross-sectional area of not less than 7-1/16 square inches (45.6 cm^2).

16.2 The internal cross-sectional area of a gas vent pipe or fitting shall be equivalent to a round pipe having an internal diameter of integral inches or in units of 25 mm.

16.3 The internal dimension of the cross section of an oval or rectangular gas-vent pipe or fitting, or of a roof jack, measured across the minor axis, shall be not less than 1-1/2 inches (38 mm).

17 Support Assembly

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

17.2 A support assembly shall sustain a load equivalent to four times the weight imposed upon it by all the gas-vent parts it is intended to support. See Vertical Support Test, Section 24.

17.3 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.

PERFORMANCE

18 General

18.1 When a gas vent or roof jack is tested in accordance with these requirements, specified temperatures on combustible construction shall be maintained.

18.2 After being subjected to the tests specified in Sections 21, Temperature Test – Structures and 22, Temperature Test – Gas Vent Pipe Surfaces, as applicable, a gas vent or roof jack shall be capable of being further used.

18.3 Test results indicating compliance with the requirement of 18.2 include the following:

a) No part of the gas vent or roof jack has become damaged or permanently distorted to an extent that it shall 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.

19 Test Installation

19.1 General

19.1.1 The test installation for Type B gas vent is to be based on the following factors:

a) Size and type (round, oval, or other) of gas vent.

b) Height in feet (m) of gas vent.

c) Minimum clearance of gas vent to combustible construction (Test Structure, Form I) and, when manufacturer so elects, with enclosure in stud space (Test Structure, Form II).

19.1.2 The test installation for Type BW gas vent is to consider the following factors:

a) Maximum appliance input.

b) Enclosure in stud space (Test Structure, Form III).

c) Single or multistory buildings.

19.1.3 The test installation for Type B or BW gas-vent roof jack is to be based on the following factors:

a) Size and type of roof jack.

b) Maximum appliance input (Type BW).

c) Zero clearance of roof jack to combustible construction (Test Structure, Forms IV, V, and VI).

d) Length of roof jack body.

19.1.4 The test structure for a Type B gas vent is to be similar to one of those illustrated by Figure 19.1 and Figure 19.2. The structure is to provide for various sizes and designs following the details as shown by Figure 19.3, Figure 19.4, and Figure 19.5.

19.1.5 The test structure for a Type BW gas vent is to be similar to that illustrated by Figure 19.6.

19.1.6 The test structure for a Type B gas vent roof jack is to be similar to one of those illustrated by Figure 19.7 and Figure 19.8, as appropriate for the length of the roof jack body that projects below the rooftop surface.

19.1.7 The test structure for a Type BW gas-vent roof jack is to be similar to that illustrated by Figure 19.9.

Figure 19.1

Test structure – Form I – for Type B vents

Enclosure shown at a specified clearance denoted by "X"

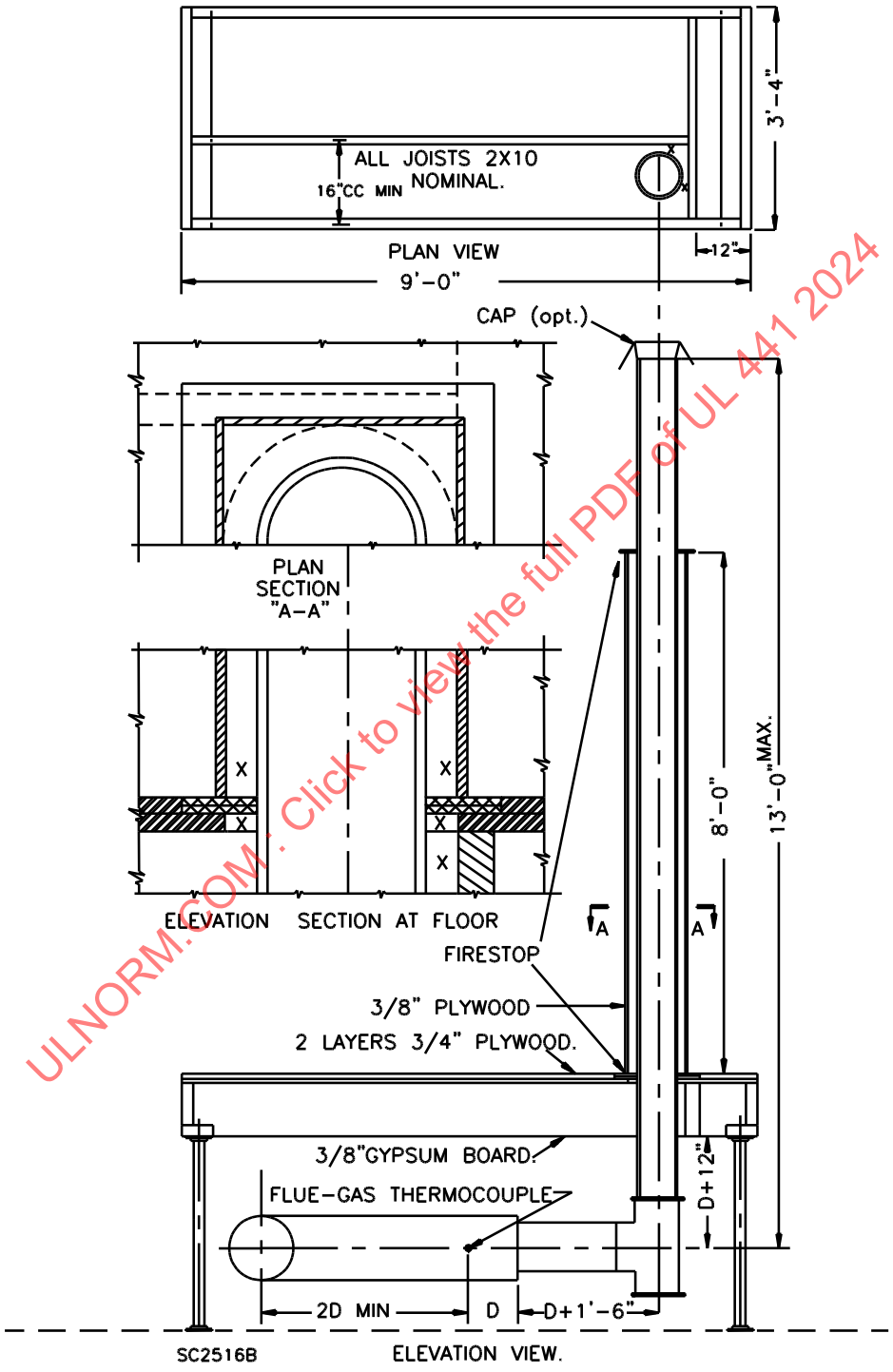


Figure 19.2

Test structure – Form II – for Type B vents

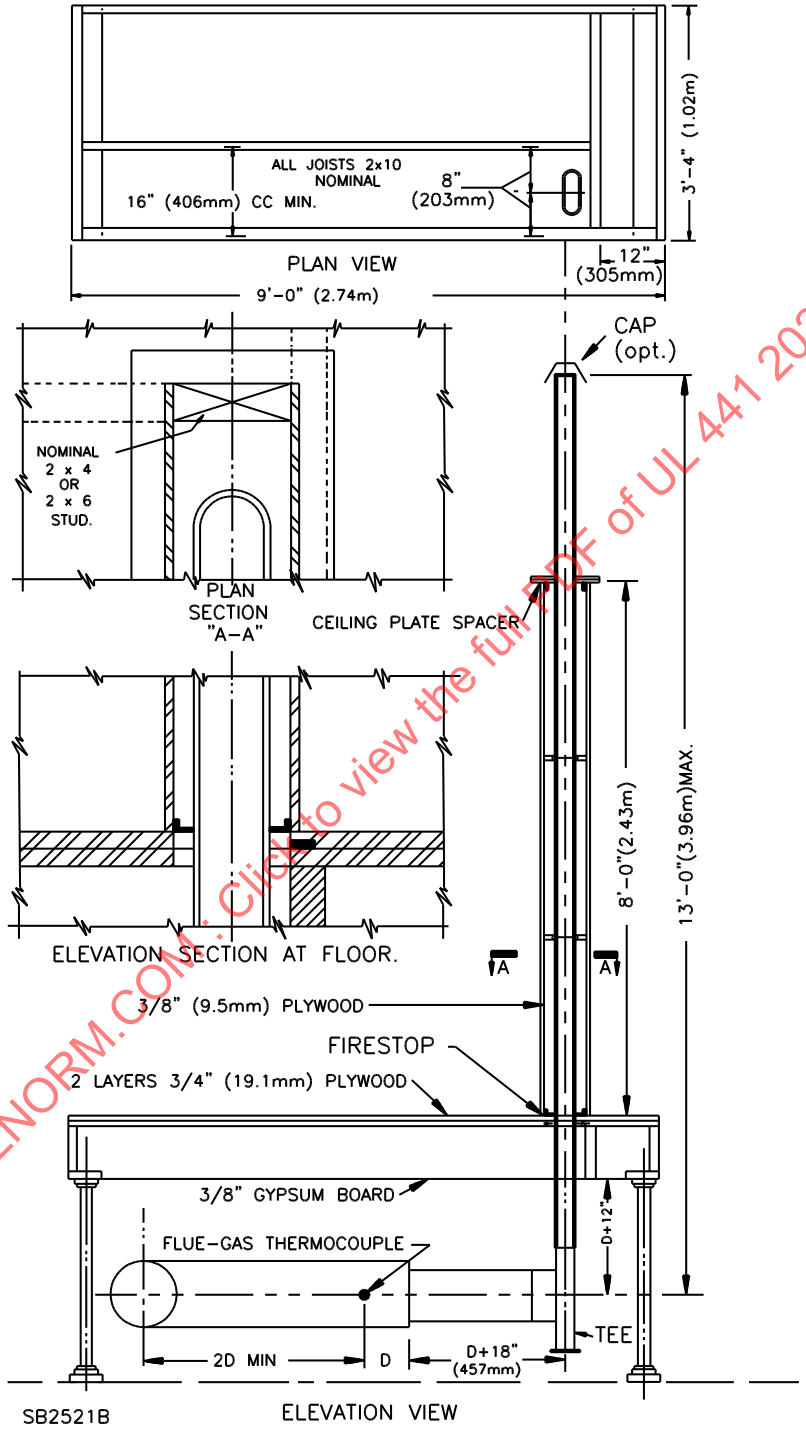
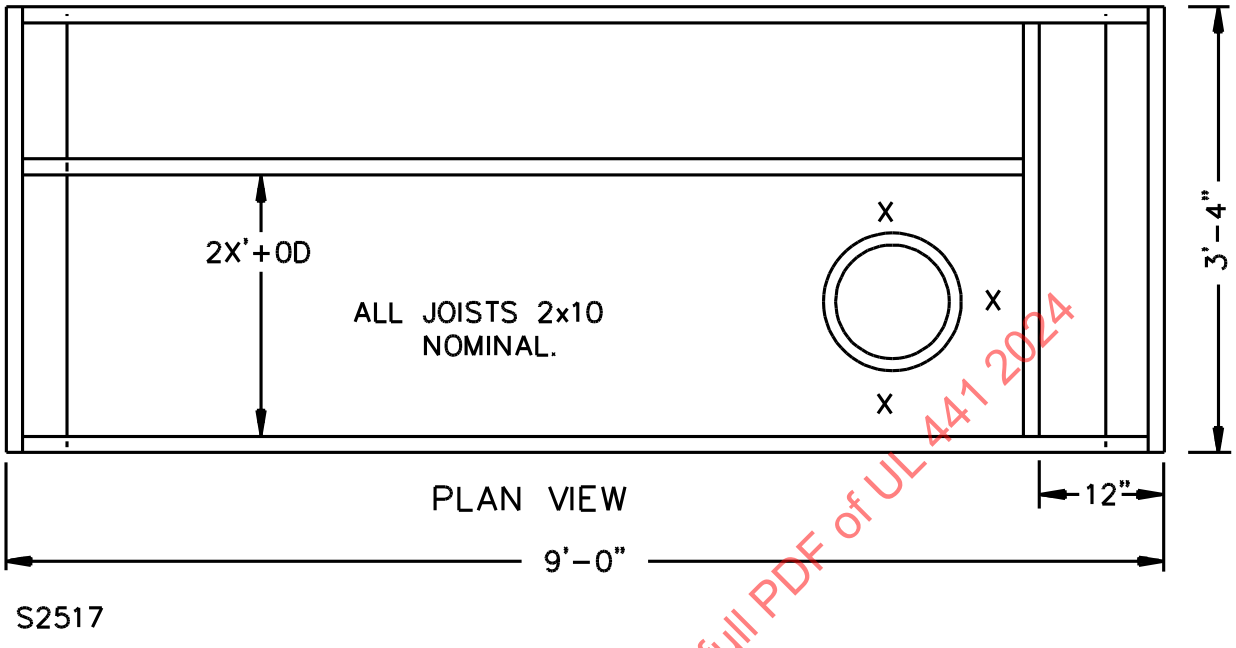


Figure 19.3

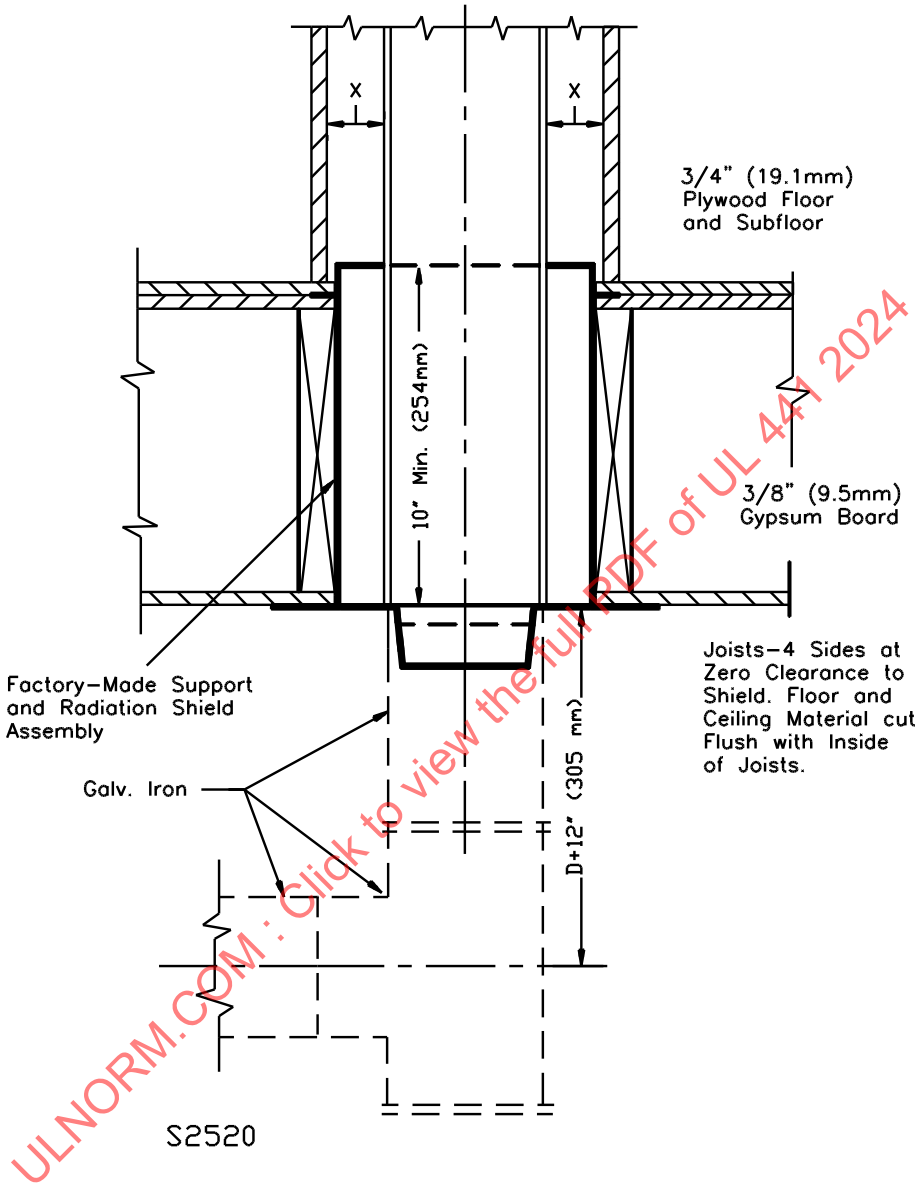
Test structure details – Form I – for large diameter Type B vents



Enclosure shown at specified clearance denoted by "X"

Figure 19.4

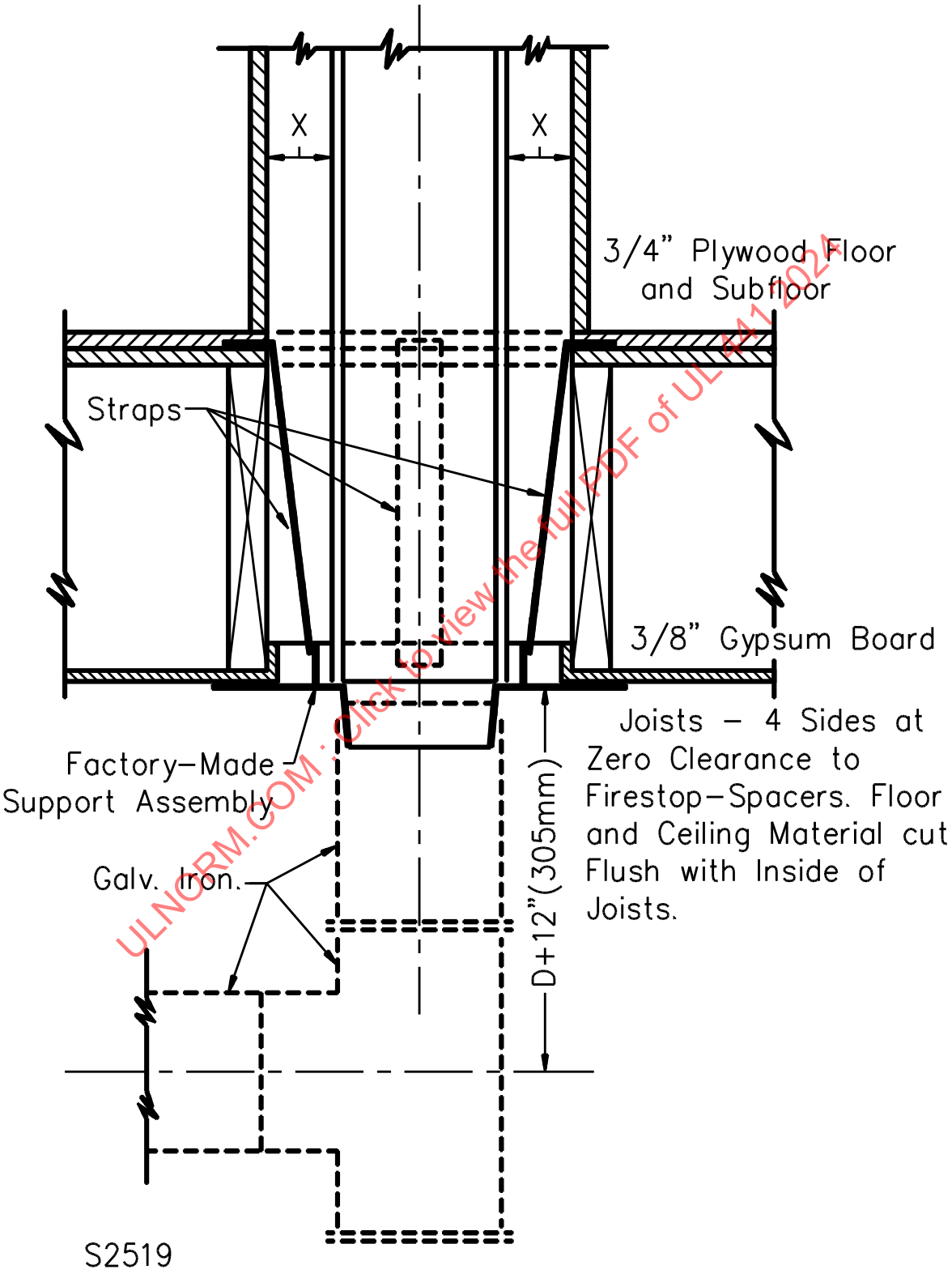
Test structure details – Form I – for support assembly with radiation shield



Enclosure shown at specified clearance denoted by "X"

Figure 19.5

Test structure details – Form I – for support assembly



Enclosure shown at specified clearance denoted by "X"

Figure 19.6

Test structure – Form III – for Type BW vents

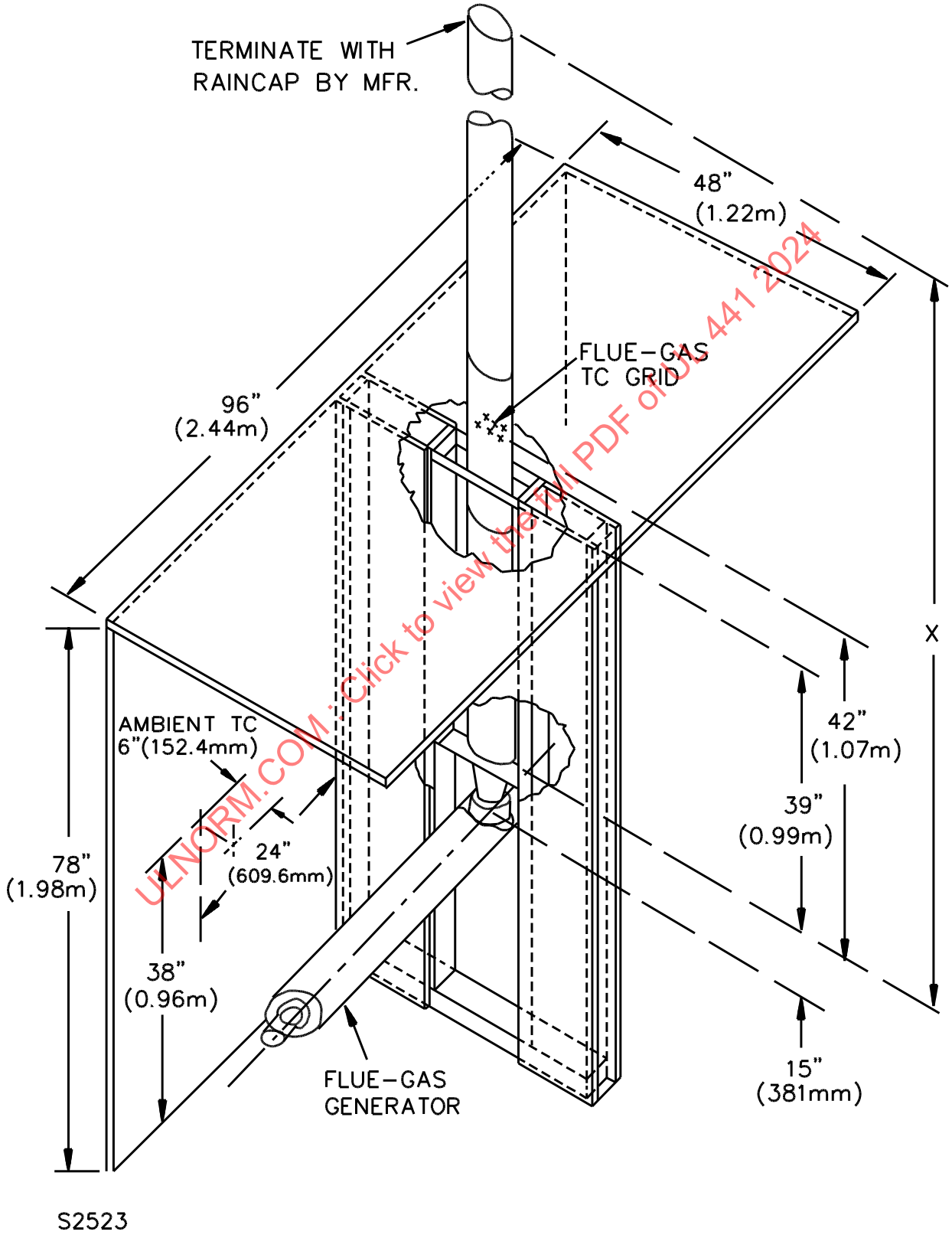


Figure 19.7

Test structure – Form IV – for Type B gas vent roof jacks

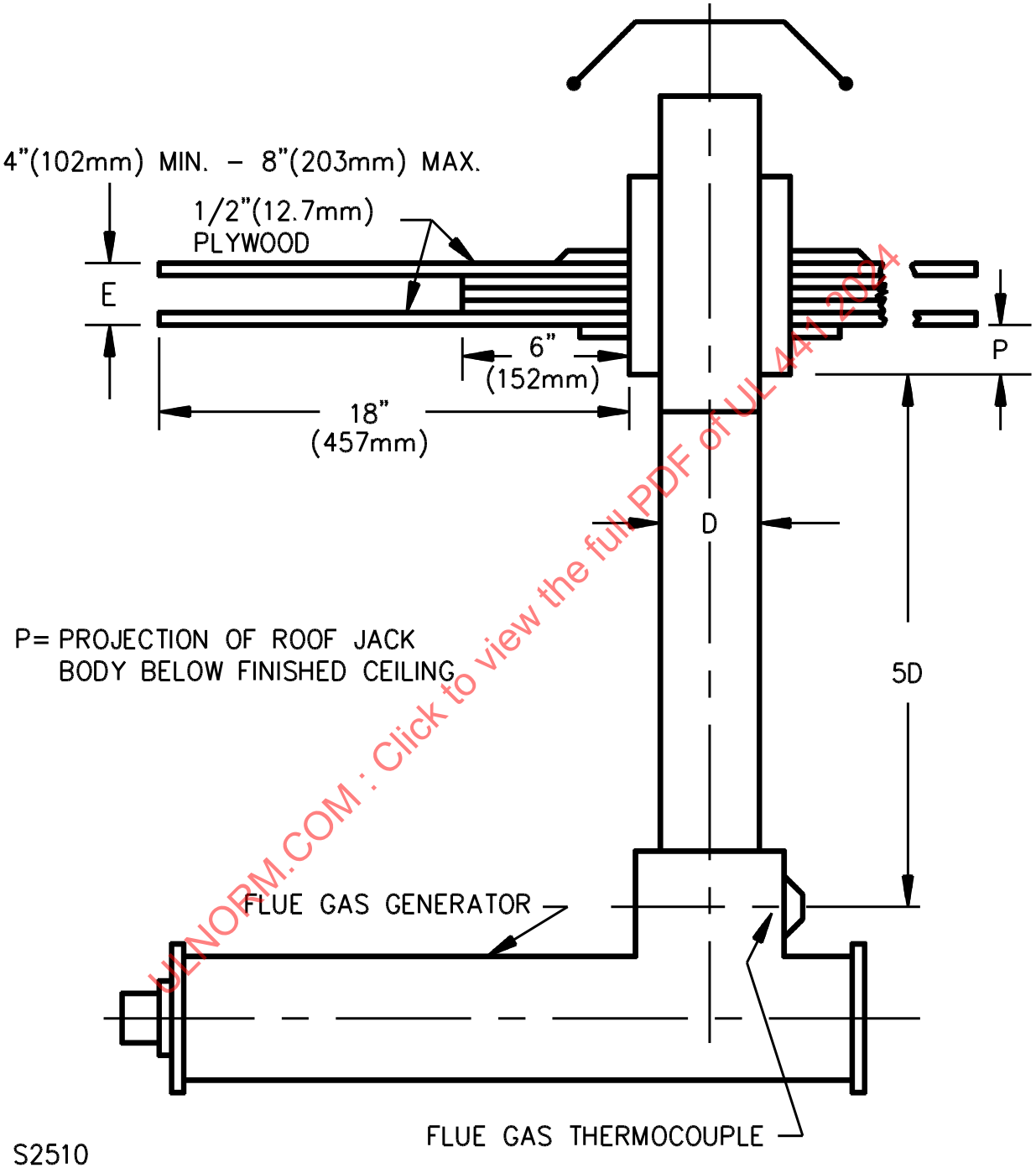


Figure 19.8

Test structure – Form V – for Type B gas vent roof jacks, roof and ceiling

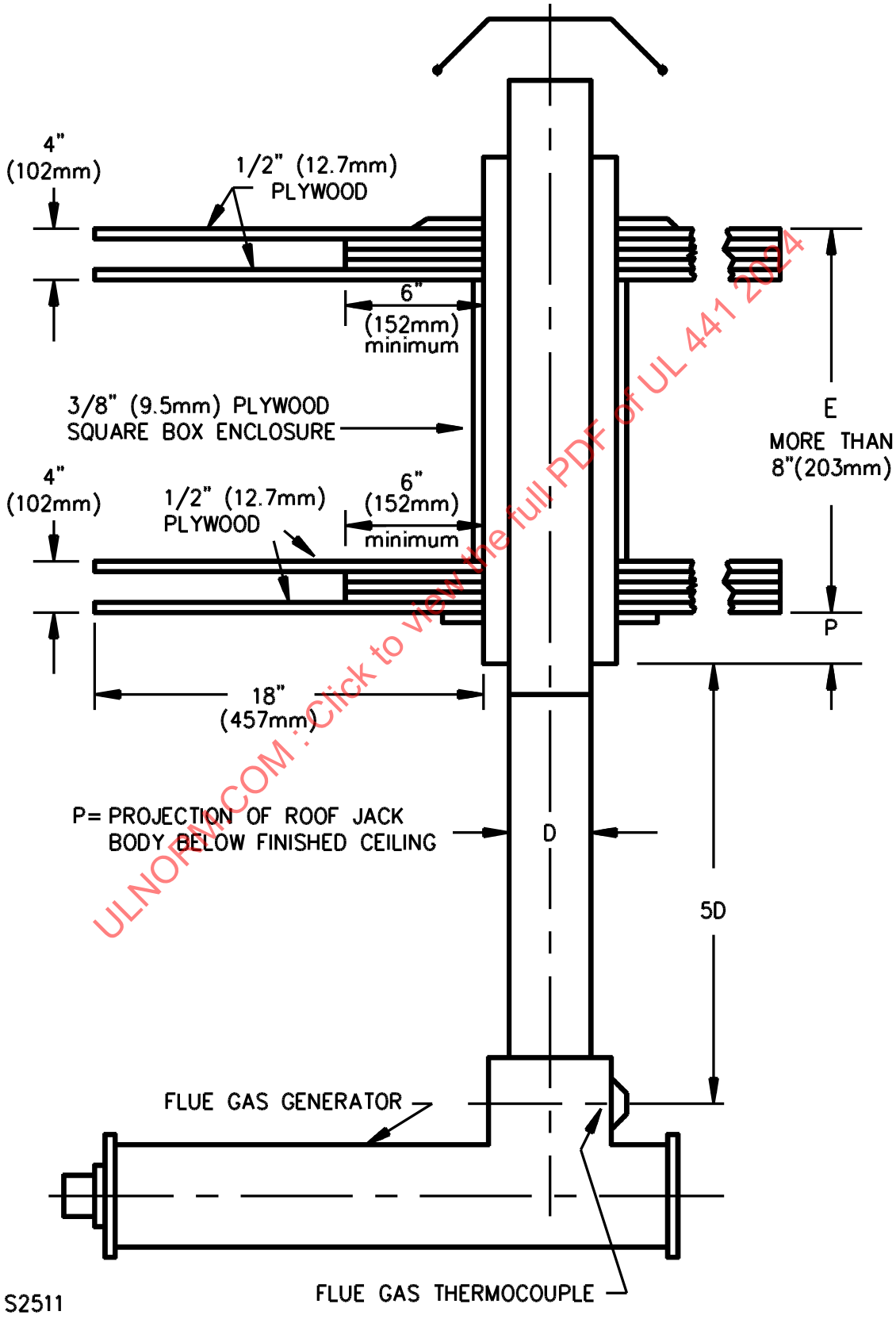
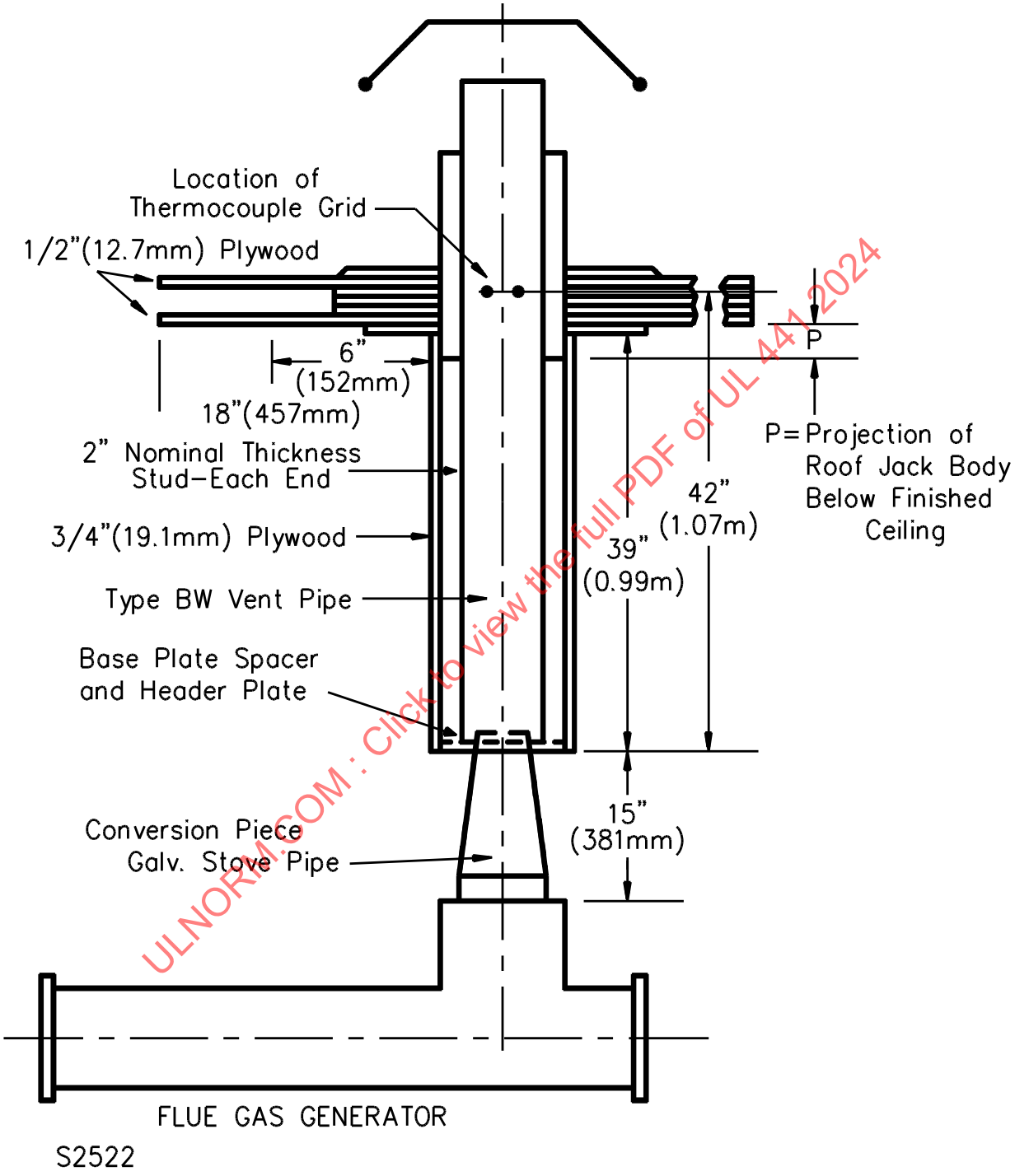


Figure 19.9

Test structure – Form VI – for Type BW gas vent roof jacks



19.1.8 The test structure is to be erected within a room having ventilation capable of maintaining the buildup of carbon monoxide to less than 50 parts per million[a] (ppm) throughout the period of any tests. The room is to be 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. The room is to be such that during any one test the room temperature does not increase more than 20°F (11°C) above the room temperature recorded at the beginning of the test.

[a] Threshold Limit Value as specified by the American Conference of Governmental Industrial Hygienists.

19.1.9 When a gas vent or roof jack is designed to be cooled by taking air from an occupied space and exhausting that air to the outside of a building, all the openings in the assembled parts that are intended to provide such air flow and that are located within an occupied space of the building are to be sealed closed during the tests.

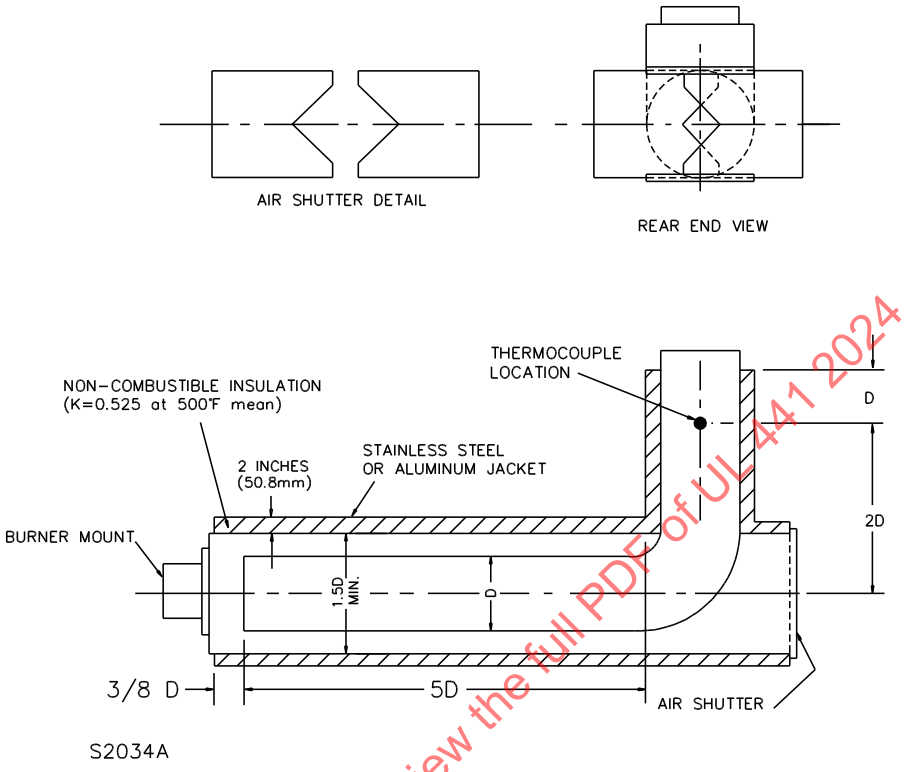
19.1.10 When a gas vent or roof jack is designed to be cooled by taking air from the outside of a building, the test arrangement is to provide means for maintaining the temperature of such air between 70 and 90°F (21 and 32°C).

19.1.11 A Type B or BW test gas vent is to consist of a vertical assembly composed of standard pipe sections and other furnished parts, all erected according to the manufacturer's installation instructions. The top of the test gas vent is to be terminated by the roof assembly when the roof assembly is always provided as a functional part of the gas vent. Other functional parts of the gas vent, such as a support, baseplate, ceiling plate spacer, or firestop are to be used during a test. The height of the gas vent for a single-story test structure is to be as shown in Figure 19.1, Figure 19.2, or Figure 19.6, whichever is applicable.

19.1.12 A gas-fired flue-gas generator as illustrated by Figure 19.10 is to be used to supply flue gases to the gas vent or roof jack being tested. The generator is to produce flue gases at the specified test temperature when fired at the test input specified in Table 21.1 or Table 21.2, as applicable.

Figure 19.10

Flue-gas generator



19.1.13 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 gas vent or roof jack by means of a stainless steel or galvanized pipe having a diameter equivalent to that of the gas vent or roof jack inlet. The connection is to be made using a section of galvanized stovepipe, together with other galvanized pipe fittings arranged as shown in Figure 19.1, Figure 19.2, Figure 19.6, Figure 19.7, Figure 19.8, and Figure 19.9. The stovepipe and fittings are to be uninsulated.

19.1.14 Joints between gas-vent pipe, roof jacks, or parts at a ceiling and at noncombustible firestop material employed at a floor are to be sealed with paper masking tape or plastic-coated or film-faced pressure-sensitive tape. Joints between two or more factory-made parts, which in combination provide a firestop, are to be similarly sealed.

19.1.15 A part used as a support, spacer, radiation barrier, or firestop intended to be in contact with construction is to be placed in contact with the structure in accordance with the manufacturer's instructions.

19.1.16 Plywood used for the test enclosure for a Type B gas vent or a Type B gas-vent roof jack is to be 3/8 inch (9.5 mm) thick. See Figure 19.1, Figure 19.2, Figure 19.7, and Figure 19.8. Plywood used for the test enclosure for a Type BW gas vent or a Type BW gas-vent roof jack is to be 3/4 inch (19 mm) thick. See Figure 19.6 and Figure 19.9. All joints in a test enclosure are to be sealed with paper masking tape or plastic-coated or film-faced pressure-sensitive tape.

19.1.17 Tests are to be conducted on each kind of gas vent assembly or roof jack. When more than one size gas vent assembly or roof jack is to be investigated, tests are to be conducted on as many sizes as required to determine compliance with these requirements. The entire assembly of a test gas vent is to be of uniform cross-sectional shape. When gas vents or roof jacks are produced to more than one cross-sectional shape (round, oval, polygonal, or similar shape), samples of each shape are to be tested.

19.1.18 One or more gas vent assemblies, based on the height limitations specified by the manufacturer and the design, are to be identified for test. Tests are to be conducted with the vent installed in a single-story structure, and shall be conducted also with the gas vent installed in a multistory test structure when the gas vent is intended for installation in multistory buildings.

19.2 Type B vents – Form I test structure

19.2.1 Tests are to be conducted in the basic test structure arranged as shown in Figure 19.1. Gas-vent pipe is to be tested on the basis of clearance to the enclosure of 0, 1, 1-1/2, 2, or 3 inches (0, 25, 38, 50, or 75 mm) as specified by the manufacturer, measured between the outer surface of the vent pipe and the interior surfaces of the enclosing material. Such clearance is designated by the dimension "X" in Figure 19.1, Figure 19.3, Figure 19.4, and Figure 19.5. The enclosing casing is to be of a square cross section for oval and rectangular pipe. The four sides of the enclosing casing are to be 3/8 inch (9.5 mm) thick plywood. The enclosing casing is to be tightly closed at the top and bottom, and is to employ 3/4 inch (19.1 mm) (two layers of 3/8 inch) noncombustible millboard as firestop material.

19.2.2 The vertical test gas vent is to be composed of pipe sections regularly furnished by the manufacturer, provided in such lengths that at least two joints between sections are located within the vertical test enclosure.

19.2.3 For a test in a multistory test structure, the height of the test gas vent is to be increased in increments of 9 feet (2.7 m) for each story, and each additional increment is to be encased by a joist and floor area and an enclosure duplicating that shown in Figure 19.1 and with thermocouples similarly placed. Each such additional enclosure is to be placed directly above the one below. Otherwise the arrangement and method of test are to be as described for the single-story test structure.

19.3 Type B vents – Form II test structure

19.3.1 Tests are to be conducted in a test-wall section constructed in accordance with commonly accepted building practices and similar to that shown in Figure 19.2. The test-wall section is to be made of nominal 2 by 4 (1-1/2- by 3-1/2-inch) (38- by 89-mm) clear lumber or of nominal 2 by 6 (1-1/2- by 5-1/2-inch) (38-by 140-mm) clear lumber, as specified by the manufacturer, sheathed on both sides with 3/8-inch (9.5 mm)-thick plywood. Ceiling plate-spacers are to be installed at ceiling and floors as indicated in Figure 19.2. Intermediate pipe sections are to be placed against one of the enclosing walls as close as the integral spacers permit. Otherwise, the arrangement is to include the detailed specifications outlined for the Form I Test Structure.

19.4 Type BW vents – Form III test structure

19.4.1 Tests are to be conducted in a test-wall section constructed in accordance with commonly accepted building practices and similar to that shown in Figure 19.6. The test-wall section is to be made of nominal 2 by 4 (1-1/2- by 3-1/2-inch) (38- by 89-mm) clear lumber or of nominal 2 by 6 (1-1/2- by 5-1/2-inch) (38- by 140-mm) clear lumber, as specified by the manufacturer, sheathed on both sides with 3/4-inch (19.1-mm) thick plywood. A steel header plate (gas-vent support and flue collar) similar to that shown in Figure 7.1 is to be secured in the stud space at the height shown in Figure 19.6. The 3/4 inch (19.1 mm) plywood sheathing is to overlap the header plate. Ceiling plate-spacers and baseplates that are regularly furnished with gas-vent pipe are to be installed at the ceiling and at the header plate, respectively, in accordance with the manufacturer's instructions.

19.4.2 The vertical test gas vent is to terminate 7 feet 6 inches (2.3 m) above the header plate, not including a cap or roof housing. The cap or roof assembly regularly furnished with the gas vent is to be in place during the test. When a test in a multistory test structure is to be conducted, the height of the test gas vent is to be increased in increments of 9 feet (2.7 m) for each story, and each additional increment is to be encased by a joist and floor area and an enclosure similar to that shown in Figure 19.6, except that the plywood sheathing shall be 3/8 inch (9.5 mm) thick, and have thermocouples similarly placed. Each such additional enclosure is to be placed directly above the one below. The ceiling plate-spacers installed at levels above the lowest story are to be of the type constituting a complete firestop. Otherwise, the arrangement and method of test are to be as described for the single-story test structure.

19.5 Type B Gas vent roof jacks – Forms IV and V test structures

19.5.1 Tests are to be conducted in a test-roof section (Form IV) or a test-roof and ceiling section (Form V) constructed similar to that shown by Figure 19.7 or Figure 19.8, based on the specified length of the roof jack body to be in contact with a roof or a roof-attic, and ceiling structure. See dimension "E" in Figure 19.7 and Figure 19.8. The roof and ceiling structures are to be solid sections of plywood for a distance of not less than 6 inches (150 mm) from the adjacent vertical surfaces of the roof jack. The top and bottom plywood members of each section are to extend a distance of not less than 18 inches (457 mm) from the adjacent vertical surfaces of the roof jack. For a Form V structure (Figure 19.8), that part of the roof jack between the roof and ceiling sections, based on whether the roof jack is round or square, is to be placed in line or in full contact with a square box enclosure of 3/8 inch (9.5 mm) thick plywood. In order that the roof jack be at zero clearance to the roof and ceiling sections, the openings in the roof and ceiling sections are to be cut to conform closely to the cross-sectional shape of the roof jack.

19.6 Type BW gas vent roof jacks – Form VI test structure

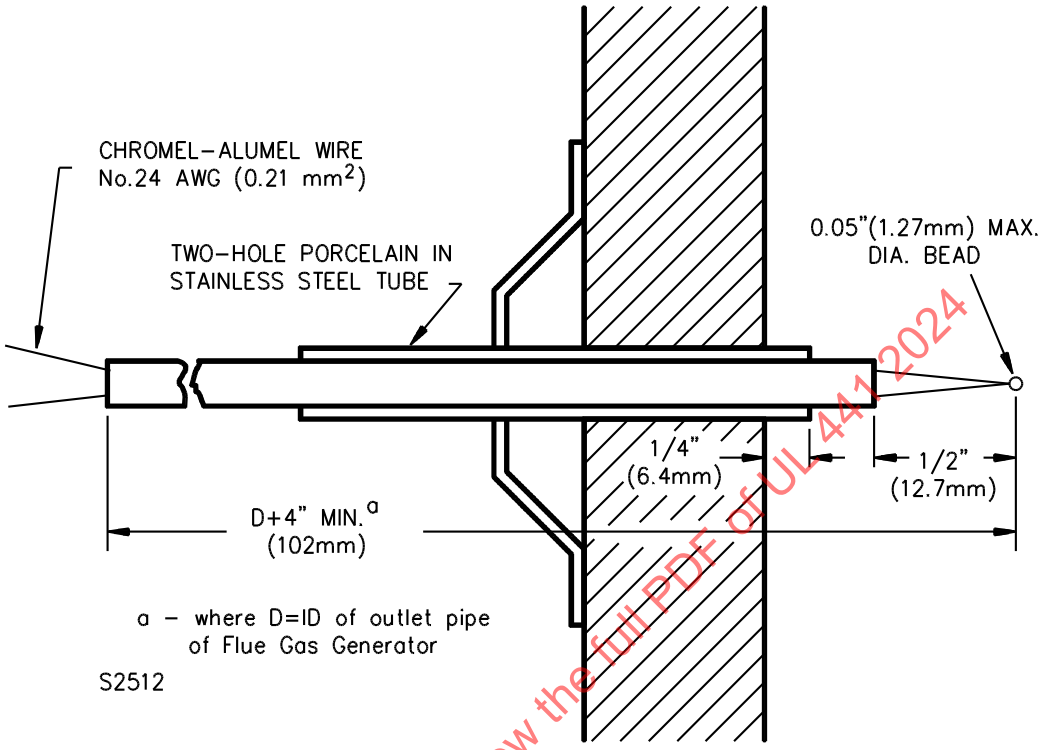
19.6.1 Tests are to be conducted in a test-roof and -wall structure similar to the wall structure illustrated in Figure 19.6, except with the modifications at the roof section as illustrated in Figure 19.9. The test-wall section is to be constructed as described in 19.4.1, except that the height of the wall section is to be as shown in Figure 19.9.

20 Temperature Measurement

20.1 For test structures Forms I, II, IV, and V, the inlet flue-gas temperature is to be determined for the tests in Sections 21 and 22 by a thermocouple such as illustrated by Figure 20.1. The thermocouple is to be located within the insulated portion of the outlet pipe connecting the outlet of the flue-gas generator to the gas vent under test. See Figure 19.1, Figure 19.2, Figure 19.7, and Figure 19.8. The thermocouple is to be Type K (chromel-alumel) of 18 – 24 AWG (0.82 – 0.21 mm^2) size with untwisted welded bare bead junction not more than 0.050 inch (1.27 mm) thick.

Figure 20.1

Flue-gas thermocouple and support bracket



20.2 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.

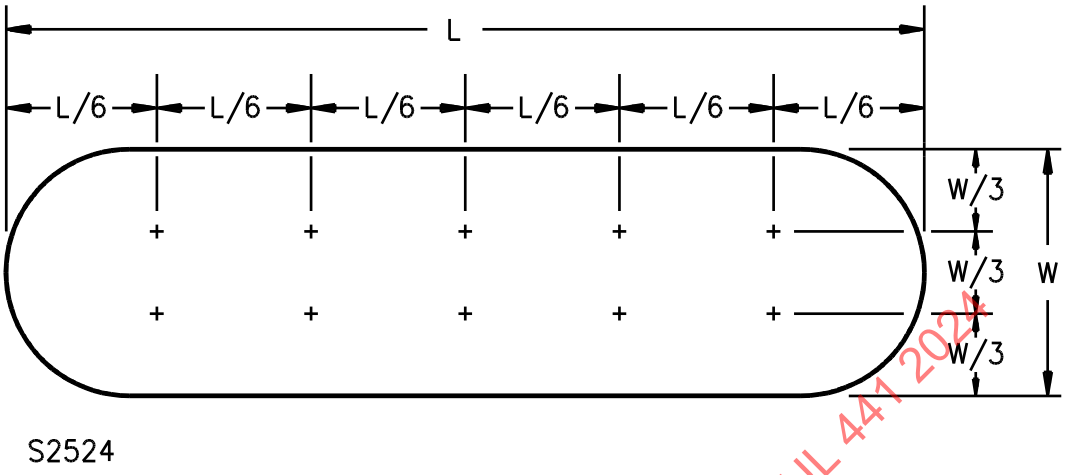
20.3 The gas burner then is to be operated as specified in the Temperature Test – Structures, Section 21, and the dilution air is to be regulated so that the temperature indicated by the center-point flue-gas thermocouple is 400°F (222°C) above room temperature by using the flue-gas generator input shown in Table 21.1 for the size of gas vent or roof jack being tested.

20.4 For the tests specified in Sections 21 and 22, the dilution air is to be adjusted as required to obtain the specified flue-gas temperatures as measured by the thermocouple located as described in 19.1.

20.5 For test structure Forms III and VI, the flue-gas temperature is to be measured by a thermocouple grid located in the test vent 3 feet 6 inches (1.1 m) above the header plate. See Figure 19.6 and Figure 19.9. The thermocouple grid is to consist of ten thermocouples of the type and size described in 20.1, connected in parallel and arranged in the pattern as shown in Figure 20.2.

Figure 20.2

Thermocouple grid pattern for flue-gas temperature test structure – Forms III and VI



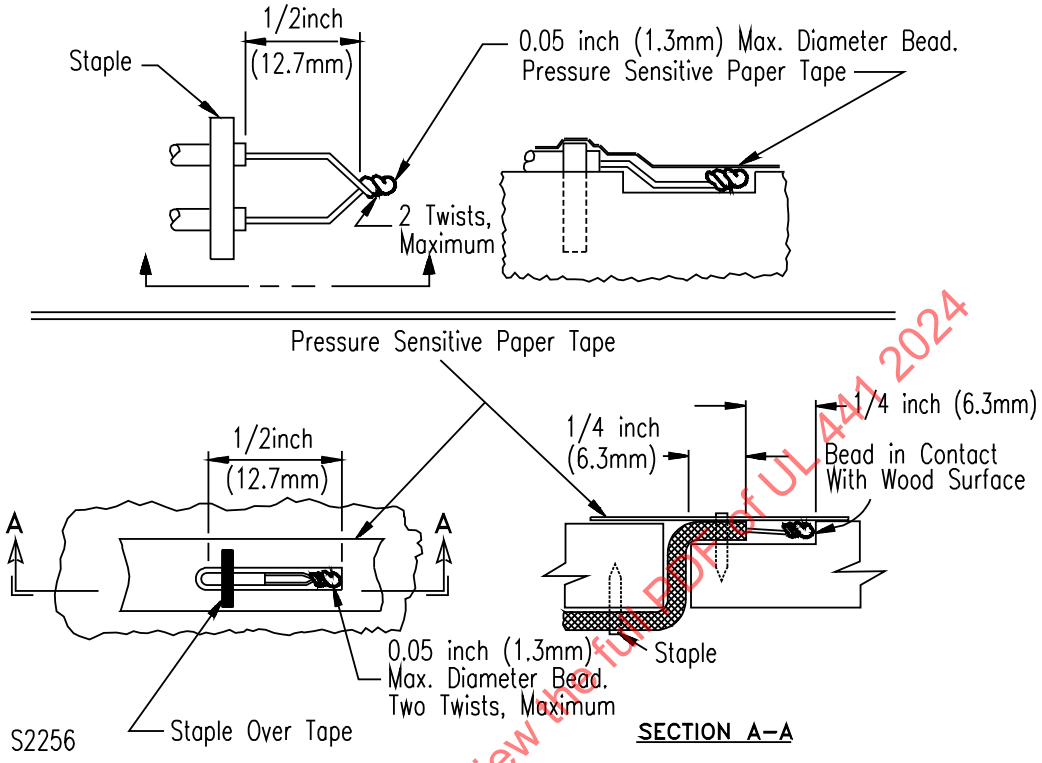
20.6 Temperatures, other than those of flue-gases and metal surfaces, are to be measured using either Type K (chromel-alumel) or Type J (iron-constantan) thermocouples not larger than 24 AWG (0.21 mm^2). For test enclosure elements in contact with gas vent parts or the roof jack, thermocouple junctions are to be placed on the gas-vent part or roof-jack 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 gas-vent parts or roof jack and onto ceilings or roof areas adjacent to the gas vent or roof jack so as to have 1/2 inch of wire exposed; and

b) Secured to wood surfaces by staples over the insulated portions 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 and held in thermal contact with the surface at that point by the use of flat black pressure-sensitive paper tape or its equivalent. See Figure 20.3.

Figure 20.3

Thermocouple installation methods on wood surfaces



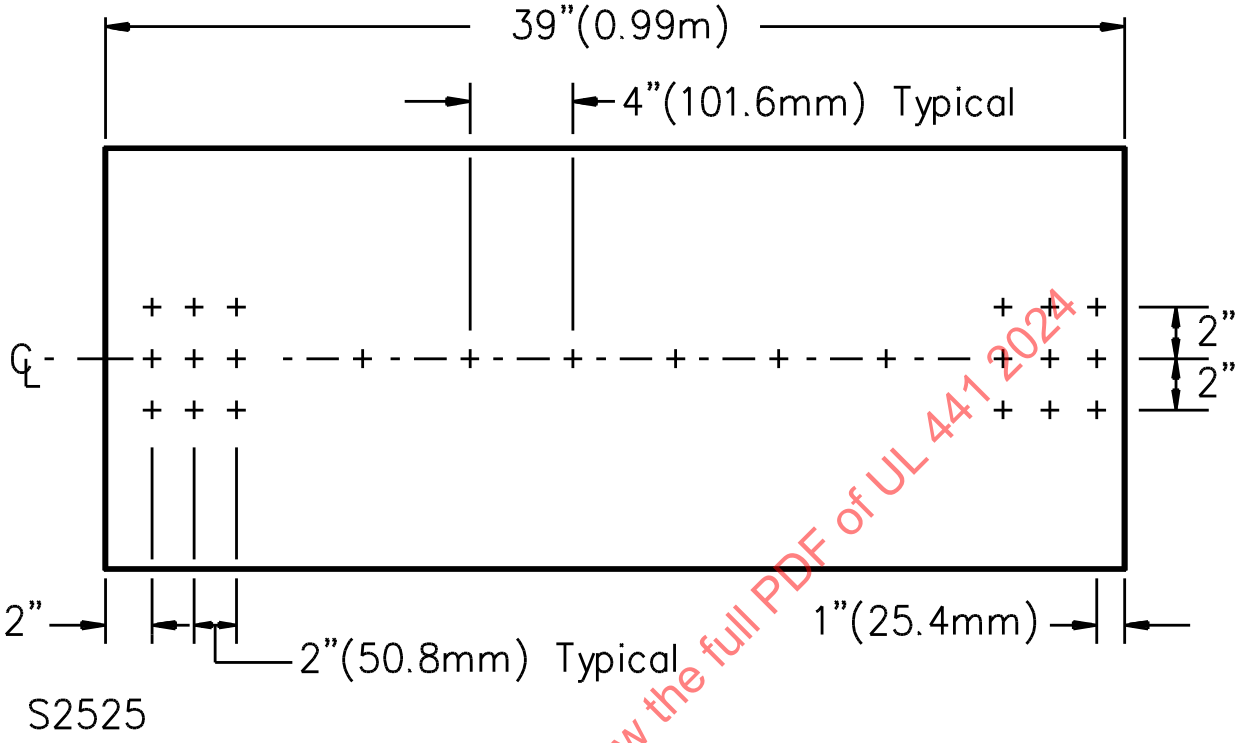
20.7 For test structures Forms I and II, thermocouples attached to interior surfaces of the test enclosure are to be located 3 inches (76 mm) above each floor level and 3 inches below each ceiling level and at the midpoint of the vertical enclosure. At least four thermocouples are to be placed at each level, so that one thermocouple is located on each interior face of the enclosure, at points of minimum clearance. Additional thermocouples are to be placed on joists, floor edges, and other locations as required.

20.8 For test structures Forms IV and V, thermocouples are to be placed on structural elements having surfaces adjacent to the roof jack and on ceiling or roof areas adjacent to the roof jack.

20.9 For test structures Forms III and IV, thermocouples are to be attached to interior surfaces of 3/4 inch (19.1 mm) plywood used for sheathing the stud space. The thermocouples are to be placed on each inside surface of the sheathing at the locations shown in Figure 20.4. Additional thermocouples are to be placed at other locations as required.

Figure 20.4

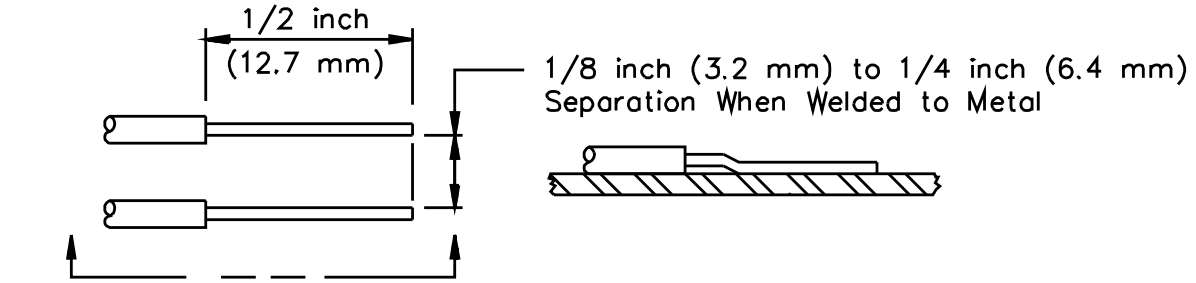
Thermocouple pattern for test structure – Forms III and VI



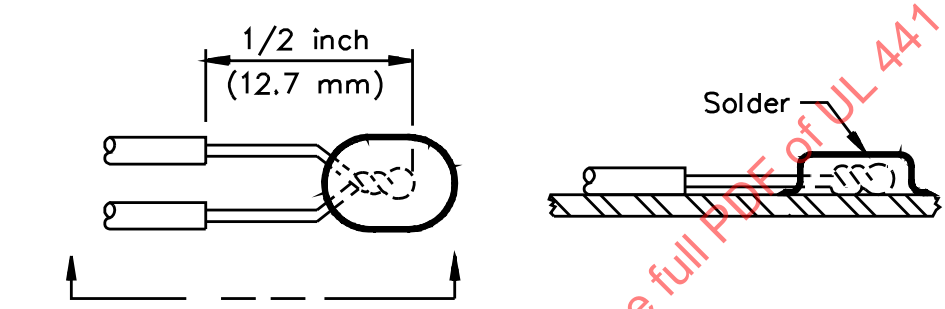
20.10 Temperatures attained by surfaces of parts of a gas-vent pipe or roof jack are to be obtained by means of thermocouples applied to the parts. Thermocouples are to be attached to metal surfaces by screws, rivets, silver soldering, brazing, or welding of the tip to the metal surfaces. See Figure 20.5. Thermocouples to be attached to surfaces of nonmetallic or nonwood parts are to have junctions and at least 1 inch (25 mm) of the lead wires imbedded flush with the surface of the material. Furnace cement is to be smoothed over such indentations to maintain thermal contact. Such thermocouples are to be located at points attaining maximum temperatures. Additional thermocouples shall be placed at other locations that are in contact with or subject to radiation from surfaces of the gas vent or roof jack.

Figure 20.5

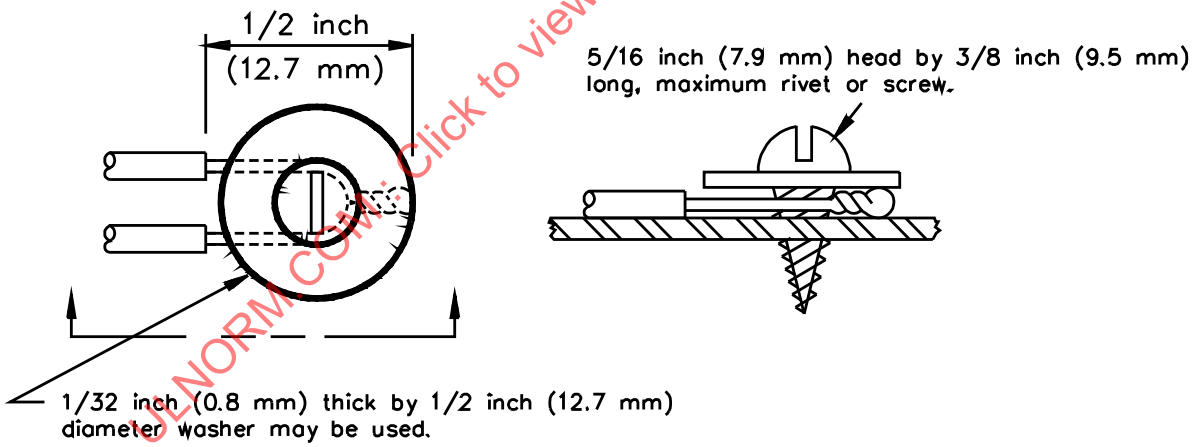
Thermocouple installation methods on metal surfaces



THERMOCOUPLE WELDED TO METAL SURFACES



THERMOCOUPLE SOLDERED TO METAL SURFACES



THERMOCOUPLE SECURED TO METAL SURFACES

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20.11 The room or ambient temperature is to be measured by a shielded thermocouple located centrally within a 6 inch (150 mm) length of aluminum-painted 2 inch steel pipe (ANSI B36.10) open at both ends.

20.12 For the test of a gas vent, the shielded thermocouple is to be located at the elevation of the horizontal axis of the flue-gas generator and also at an elevation of 4 feet (1.2 m) above any additional floor level, each to be on a vertical line located 2 feet (0.6 m) horizontally from the stovepipe tee or from the vertical test enclosure.

20.13 For the test of a roof jack, the shielded thermocouple is to be located at the elevation of the horizontal axis of the flue-gas generator and on a vertical line located 2 feet (0.6 m) horizontally from the connector between the generator and the roof jack.

20.14 The flue-gas temperature rise for the test of a gas vent is to be based on the room temperature at the level of the flue-gas generator. The temperature rise on surfaces of the test enclosure within a given story of the test structure is to be the observed temperature on the surface minus the room temperature in that story of the test structure.

20.15 The flue-gas temperature rise and the rise on surfaces of the roof-jack parts and test structure are to be based on the room temperature at the level of the flue-gas generator.

20.16 For a gas vent or roof jack intended to take air from the outside of a building to cool the gas vent, the ambient temperature of the space into which the gas vent 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. This temperature is to be maintained between 70 and 90°F (21 and 32°C) during all tests for temperatures.

21 Temperature Test – Structures

21.1 General

21.1.1 The maximum temperature attained on surfaces of the test enclosure, and on surfaces of test-assembly parts at points of zero clearance to the test structure, shall be not more than 90°F (50°C) above room temperature when a gas vent or roof jack is tested as described in 21.1.3 – 21.1.8.

21.1.2 The maximum temperature on surfaces of the test enclosure shall be not more than 90°F (50°C) above room temperature during the period ending 1-1/2 hours after the start of the test and not more than 117°F (65°C) above room temperature for any subsequent period. The maximum temperatures on gas-vent surfaces at points of zero clearance to the test structure shall be not more than 90°F (50°C) above room temperature during any period of the test.

21.1.3 The flue-gas generator inputs specified in Table 21.1 are based on developing flue gas temperatures typical of those developed by heating appliances for connection to a gas vent or roof jack of a given size, and are consistent with the heat loss to the gas vent or roof jack of a given size, and are consistent with the heat loss to the gas vent or roof jack by such heating appliances. The input is equivalent to the flue area in square inches multiplied by 900. The values for testing Type B gas vents and Type B gas-vent roof jacks having equivalent nominal diameters of from 3 to 12 inches (75 to 300 mm) are given in Table 21.1.

Table 21.1
Flue-gas generator inputs – Type B units

Equivalent nominal diameter of test vent		Input to flue-gas generator	
Inches	(mm)	Btu per hour	(kW)
3	(75)	6,350	(1.86)
4	(100)	11,300	(3.31)
5	(125)	17,600	(5.16)
6	(150)	25,300	(7.41)
7	(180)	34,500	(10.11)
8	(200)	45,200	(13.24)
9	(230)	57,100	(16.73)
10	(250)	70,500	(20.66)
12	(300)	101,000	(29.59)

21.1.4 The test is to be started with the test gas vent or roof jack and the test structure at (ambient) room temperature. The flue-gas generator is to be fired at the input given in Table 21.1 and the dilution air adjusted to produce a flue gas temperature of 400°F (222°C) above room temperature at the location specified in 20.1.

21.1.5 The test for compliance with the requirements of 21.1.1 is to be continued until equilibrium temperatures are attained on surfaces of the test assembly parts and test enclosure. See also 21.1.7.

21.1.6 The test for compliance with the requirements of 21.1.2 is to be started with the test assembly and the test structure at room temperature. The test is to be continued until equilibrium temperatures are attained on surfaces of the test assembly parts and test enclosure. See also 21.1.8.

21.1.7 The maximum temperature specified in 21.1.1 applies to:

a) Gas-vent pipe intended for installation at a clearance of 0 or 1 inch (0 or 25 mm) to enclosing material in test structure Form I (see 19.2.1);

b) Gas-vent pipe intended for installation in a stud space in test structure Form II (see 19.3.1); and

c) A roof jack.

21.1.8 The maximum temperature specified in 21.1.2 applies to gas-vent pipe intended for installation at a clearance of 1-1/2-, 2-, or 3-inches (38-, 51-, or 76-mm) to enclosing material in test structure Form I (see 19.2.1).

21.2 Test type BW gas vent or roof jack test structure Forms III and VI

21.2.1 The maximum temperatures attained on surfaces of the test enclosure, and on surfaces of test-assembly parts at points of zero clearance to the test structure, shall be not more than 90°F (50°C) above room temperature when a gas vent or roof jack is tested as described in 21.2.2 – 21.2.4.

21.2.2 The flue-gas generator inputs specified in Table 21.2 are based on values derived from the nominal rated capacity of five sizes of vented wall furnaces for connection to a Type BW gas vent or gas vent roof jack. The flue-gas generator inputs are consistent with the heat loss to the gas vent by such recessed heaters. The values for testing Type BW gas vents and roof jacks are to be those consistent with the limitation in maximum appliance input as given in the manufacturer's installation instructions. See 34.4(j).

Table 21.2
Flue-gas generator inputs – Type BW units

Maximum recessed heater input		Input to flue-gas generator	
Btu per hour	(kW)	Btu per hour	(kW)
20,000	(5.86)	5,400	(1.58)
35,000	(10.26)	9,450	(2.77)
50,000	(14.65)	13,500	(3.96)
65,000	(19.05)	17,550	(5.14)
85,000	(24.91)	23,000	(6.74)

21.2.3 The test is to be started with the test gas vent or roof jack and the test structure at (ambient) room temperature. The flue-gas generator is to be fired at the input specified in Table 21.2 and regulated to produce flue gases at a temperature of 480°F (265°C) above room temperature at the location in the vent pipe or roof jack designated in Figure 19.6 or Figure 19.9, whichever applied.

21.2.4 The test is to be continued until equilibrium temperatures are attained on surfaces of the test-assembly parts and the test enclosure.

22 Temperature Test – Gas-Vent Pipe Surfaces

22.1 The difference between inner and outer wall surface temperatures shall be not less than 10 percent of the flue-gas temperature rise above room temperature at the elevation specified in 22.2.

22.2 The plywood material used for walls in the test structure is to be removed. Means are to be provided for measuring flue-gas temperature at the vertical axis of the gas-vent pipe at an elevation 48 inches (1.22 m) above the first floor of the structure. Four thermocouples are to be secured to the outside surface of the pipe at 90 degrees around the circumference of the gas-vent pipe and at the same 48 inch elevation. Four additional thermocouples are to be secured to the inside surface of the gas-vent pipe around the circumference of the pipe at 90 degrees to each other and at 45 degrees to the outside thermocouples, and at the same 48 inch level.

22.3 The flue-gas generator is to be fired and adjustments made as for the Temperature Test – Structures, Section 21. The test is to be continued until equilibrium temperatures are attained on the gas-vent pipe surfaces at the location specified in 22.2. The difference between the average temperature indicated by the four thermocouples on the inside circumference and the average temperature indicated by the four thermocouples on the outside circumference is to be compared to the temperature rise above room temperature of the flue gas at the corresponding elevation to determine compliance with the requirements of 22.1.

23 Draft Loss and Wind Effects Test

23.1 A cap for direct attachment to a gas-vent pipe and a cap of a roof assembly or roof jack shall not impede the flow of flue gases in still air when tested as described in 23.2 and 23.3.

23.2 The cap is to be mounted on a continuous length of gas vent or on its roof assembly or roof jack mounted, in turn, on a continuous length of gas vent. The gas vent is to be sealed so that there is no flow. Static pressure within the gas vent is to be determined by a pitot tube, pressure tap, or piezometer ring located 12 inches (300 mm) below the point of cap attachment. Pressure readings are to be taken with an instrument capable of being read to the nearest 0.001 inch (0.025 mm) of water column (w.c.). The gas vent is to be the same nominal diameter as the cap under test. The cap manufacturer shall furnish a section of gas vent not over 12 inches long, having a typical joint connecting to the cap. This pipe section

is be left in place on the end of the vent for the test for wind effects where applicable. All joints in the test gas vent between the inlet end and the cap under test are to be sealed or taped against leakage for all tests.

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

23.4 A cap for direct attachment to a gas-vent pipe having an internal diameter of 12 inches (300 mm) or less shall not impede the flow of flue gases due to wind action at angles from 45 degrees below horizontal to 45 degrees above horizontal when tested as the test described in 23.5 and 23.6.

23.5 The gas-vent cap, mounted on a continuous length of gas vent as described in 23.2, is to be fixed in position at a wind generator outlet to obtain various elevation angles of wind approach. The wind generator is to be able to produce a uniform wind front of 20 miles per hour (32 km/h) velocity [29.3 feet per second (8.93 m/s); velocity pressure 0.192 inch (4.88 mm) w.c.] over an area described by a diameter not less than 12 inches (300 mm) greater than the maximum width of the cap under test. The velocity is determined to be uniform when the variation at any point does not exceed 5 percent of the specified velocity. The configuration of the gas vent and cap is to be such that the cap remains centered in the wind front during rotation about any axis.

23.6 With the cap in place on the vent and an upward air velocity of 10 feet per second (3.05 m/s) in the vent, a simulated wind front of 20 miles per hour (32 km/h) is to be directed at the cap at a series of elevation angles ranging from 45 degrees below horizontal to 45 degrees above the horizontal, in 15 degree intervals. The average of the static pressures in the gas vent shall be not more than 0.068 inch (1.73 mm) w.c. greater than the pressure measured in the uncapped vent as described in 23.3 when:

a) At a horizontal wind front and at the three angles below horizontal; and

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

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

23.8 A cap for direct attachment to a gas-vent pipe having an internal diameter of 12 inches (300 mm) or less shall induce the intended updraft effect when subjected to wind flow past the cap, as determined by the test methods described in 23.9 and 23.10.

23.9 The test arrangement described in 23.2 and 23.5 is to be employed. The cap is to be placed on the gas vent and centered in the wind front. The inlet to the gas vent is to be sealed so that there is no air flow through the vent. A 20 mile per hour (32 km/h) wind front is to be directed at the cap at a series of elevation angles ranging from 45 degrees below horizontal to 45 degrees above horizontal in 15 degree intervals. Caps that are nonsymmetrical and intended for mounting in any orientation about the vertical axis are to be rotated and tested at the position in azimuth that creates the minimum updraft capability.

23.10 At the angles of wind front elevation and azimuth described in 23.9, the average static pressure within the sealed test gas vent shall be equal to or less than 0.034 inch (0.86 mm) w.c. below atmospheric pressure. For winds approaching from below horizontal, the static pressure is to be the average of the pressures at horizontal and the three angles below horizontal. For winds approaching from above the horizontal, the static pressure is to be the average of the pressures at horizontal and the three angles above the horizontal. No individual pressure reading at any angle above or below horizontal shall indicate a pressure greater than atmospheric pressure.

24 Vertical Support Test

24.1 An assembly intended to support the gas vent shall not be damaged, nor shall the security of its attachment to the building structure be impaired, when tested as described in 24.2.

24.2 The support assembly is to be installed as described in the manufacturer's installation instructions in a framework simulating a typical installation. A section of the gas vent 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 gas-vent assembly that the support will be required to sustain in service. The load is to be applied for a minimum of 60 minutes.

25 Strength Test

25.1 General

25.1.1 A gas-vent section shall not open up, break apart, or become damaged to the extent that it is not capable of further use as a result of three impacts of a sand bag as described in 25.2.1 – 25.2.4.

25.1.2 Parts shall not open up, break apart, or become damaged to the extent that they are not capable of further use when subjected to a longitudinal force of 100 pounds (445 N) applied as described in 25.3.1 and 25.3.2.

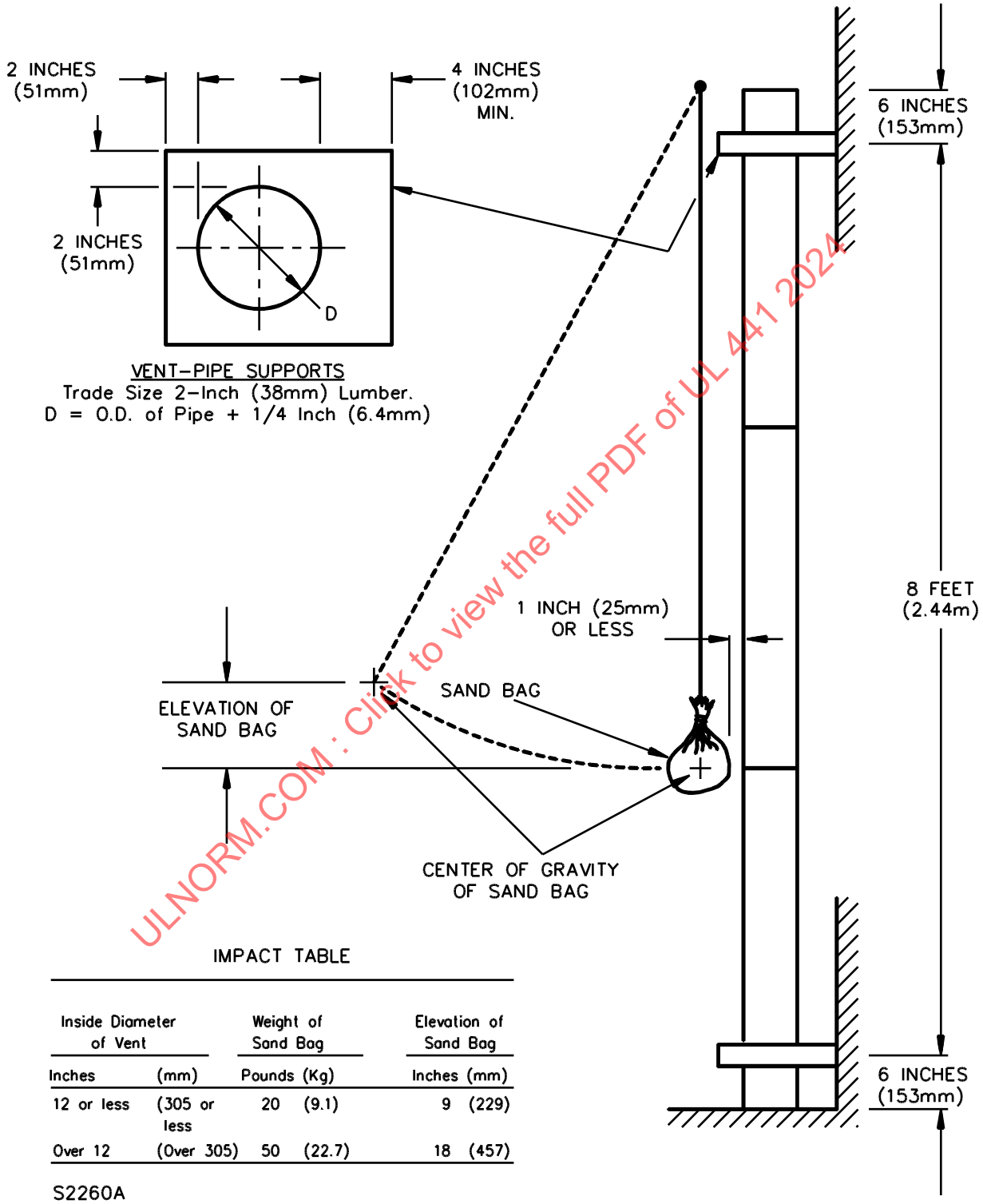
Exception: A double wall gas-vent connector for use with a Type B gas vent roof jack is not required to be subjected to the longitudinal force.

25.2 Impact test

25.2.1 With reference to the requirements in 25.1.1, the impact is to be applied to an unenclosed gas vent installed as shown in Figure 25.1. Tests are to be conducted on samples of each gas vent size. Each section is to be joined together as specified by the manufacturer. If cemented joints are included in an assembly, the cement is to dry before the test is conducted.

Figure 25.1

Strength test



IMPACT TABLE

Inside Diameter of Vent		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)

S2260A

25.2.2 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 25.1. 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 vent. 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 25.1 above the center of gravity of the bag at its at-rest position.

25.2.3 The length of the pendulum shall, for convenience, be varied.

25.2.4 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 90 degrees from the impact point in (b).

25.3 Longitudinal force test

25.3.1 With reference to the requirements in 25.1.2, the longitudinal force is to be applied on a number of vent 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 dry before the test is conducted.

25.3.2 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 by gripping one part as if to pull it from the part to which it is joined.

26 Wind Load Test

26.1 A roof assembly shall resist, without damage or opening of joints, a force 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 26.2 – 26.4.

26.2 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 in accordance with the manufacturer's installation instructions.

26.3 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 gas vent or roof jack.

26.4 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 cannot 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 surface. See Figure 26.1. The load is to be sustained for 60 minutes.