UL 1738

STANDARD FOR SAFETY

Venting Systems for Gas-Burning Appliances, Categories II, III, and IV

UL Standard for Safety for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV, UL 1738

Third Edition, Dated October 4, 2010

Summary of Topics

This revision of ANSI/UL 1738 dated March 25, 2021 includes temperature ratings and diameters of vents; 3.14 and Table 19.1

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated February 5, 2021.

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Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV

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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 venting systems intended for venting Category II, III, or IV gas-burning appliances as defined by the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47 and the National Fuel Gas Code, NFPA 54. Venting systems covered by these requirements are intended to be used with Category II, III, and IV appliances that have been installed in accordance with NFPA 54, and with codes such as the BOCA National Mechanical Code, the Standard Mechanical Code, the Uniform Mechanical Code, and local codes.

1.2 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 Units of Measurement

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

3 Glossary

3.1 For the purpose of these requirements, the following definitions apply.

3.2 APPLIANCE – A gas burning device constructed and installed in accordance with nationally recognized standards, as appropriate.

3.3 APPLIANCE ADAPTER – A special gas vent fitting which typically joins non-metallic vent systems to the outlet of a fuel gas-burning appliance.

3.4 CATEGORY II APPLIANCE – An appliance that operates with a nonpositive vent static pressure and with a flue loss less than 17 percent in accordance with the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47.

3.5 CATEGORY III APPLIANCE – An appliance that operates with a positive vent static pressure and with a flue loss not less than 17 percent in accordance with the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47.

3.6 CATEGORY IV APPLIANCE – An appliance that operates with a positive vent static pressure and with a flue loss less than 17 percent in accordance with the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47.

3.7 COMBUSTIBLE MATERIAL – Material made of or surfaced with wood, compressed paper, plant fibers, or other material that will ignite and burn, 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 considered as combustible even though flameproofed, fire-retardant treated, or plastered.

3.8 CONDENSING TYPE APPLIANCE – Any Category II or IV appliance.

3.9 FLEXIBLE VENTING SYSTEM – A venting system that is intended to be bent during the installation process to avoid obstacles or to change direction, and whose bending capability is inherent in the vent gas conduit.

3.10 NONCOMBUSTIBLE MATERIAL – For the purpose of this Standard, a material which is not capable of being ignited and burned, such as materials consisting entirely of, or a combination of, steel, iron, brick, tile, concrete, slate, asbestos, glass, and plaster.

3.11 OFFSET VENT – A venting system that incorporates elbows.

3.12 PRODUCT – The term "product" as used in these requirements refers to all venting systems or any part thereof covered by these requirements unless specifically noted otherwise.

3.13 RADIATION SHIELD – A panel or panels interposed between heating surfaces and jackets to reduce heat loss through radiation.

3.14 TEMPERATURE RATING – The maximum use temperature specified by the vent manufacturer for which the venting system is intended. The marked temperature rating is equal to the minimum vent input temperature selected from Table 19.1.

3.15 THIMBLE – The part of a venting system that is intended to provide a means for routing the venting system through a combustible wall in a horizontal installation.

3.16 VENT GAS CONDUIT – The part of a venting system that is directly exposed to vent gas products.

3.17 VENT GAS INPUT TEMPERATURE – The vent gas temperature at the location where the venting system attaches to an appliance.

3.18 VENT TERMINATION OR CAP – The fitting at the end of the vent pipe that directs the flue products into the outdoor atmosphere.

3.19 VENTING SYSTEM – The gas vent, chimney or single-wall metal pipe, and vent connector when used, assembled to form a continuous open passageway from the flue collar or draft hood outlet of a gas appliance to the outside atmosphere for the purpose of removing vent gases.

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 Components

5.1 Except as indicated in 5.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components used in the products covered by this standard.

5.2 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.

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

5.4 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.

CONSTRUCTION

6 Materials

6.1 A venting system shall be made of corrosion resistant materials, or have a corrosion resistant finish in areas subject to corrosion from the effects of condensate, and shall be made of materials acceptable for exposure to the temperatures anticipated during all operations of the appliance. Metals shall not be used in combinations such as to cause galvanic action at any location within the assembly.

6.2 The thickness of sheet metal, including any coatings, shall not be less than as specified in Table 6.1 unless otherwise specified in these requirements. The requirements in Table 6.1 do not preclude the use of other materials that provide for equivalent rigidity, corrosion resistance, thermal properties, and gas tightness.

Table 6.1
Minimum metal thickness

Metal	Inch	(mm)
Aluminum alloys (1100, 3003) inner pipe	0.012	(0.30)
Aluminum alloys (1100, 3003) other than for inner pipe	0.012	(0.30)
Steel coated	0.016	(0.41)
Galvanized steel (G90 coating class)	0.018	(0.46)
Aluminum-coated steel [40 ounces per square foot (0.12 kg/m^2)]	0.018	(0.46)
Stainless steel	0.012	(0.30)

6.3 A vent gas conduit of a venting system shall be of a material having the rigidity, durability, and resistance to heat necessary for the intended application. Stainless steel, porcelain coated steel, aluminum, cast or fired refractory, nonmetallic materials, and other vent gas conduit shall comply with the requirements for the applicable tests described in these requirements. See Performance, Sections 16 – 43.

6.4 Parts of a venting system subject to contact by vent gases at or beyond the terminus of the vent gas conduit shall be of a material equivalent to the vent gas conduit. See 6.3.

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

6.6 Metallic materials which are coated shall be free of sharp edges, burrs, or protrusions which could scratch mating parts in a manner so as to reduce the thickness of the coating.

6.7 Nonmetallic vent gas conduit materials shall be made of:

a) Class 12454-B or 12454-C PVC as specified in the Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds, ASTM D1784,

b) Class 23447-A or 23447-B CPVC as specified in ASTM D1784, or

c) Material having equivalent properties.

6.8 A nonmetallic venting system part shall be of material having sufficient strength and rigidity for the intended application, shall not soften or melt when exposed to the temperatures anticipated during appliance operation, or crack when exposed to outdoor or indoor temperatures, as applicable.

6.9 Polymeric venting system materials shall be resistant to the effects of acids contained in the vent gas products, and shall show no signs of aging after extended use that would increase the risk of injury when using the product. See Polymeric Materials – Conditioning for Physical Properties Tests, Section 40, High Acid Conditioning Test, Section 41, and Polymeric Materials – Physical Properties Tests, Section 42.

7 Assembly

7.1 A venting system shall consist of all the essential parts necessary for the intended installation. Each venting system part shall be constructed for assembly as intended without requiring alteration, cutting, threading, drilling, welding, or similar tasks.

Exception No. 1: An assembly or part intended to be cut to length or fitted by the installer may be provided if 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 venting system or specified in the manufacturer's installation instructions and be readily available.

Exception No. 2: Drilling is acceptable if:

a) The drilling operation does not weaken the assembly,

b) The size of the drill bit is specified and the instructions clearly describe the location or locations to be drilled,

c) The required fasteners are provided with the venting system, and

d) The drilling operation does not expose protected metal parts to corrosion.

7.2 Two or more parts of a venting system 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 need for 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 individual part, such as a pipe section, elbow, vent cap, firestop-spacer, coupling, tee, or the like shall be completely assembled by the manufacturer at the factory.

7.4 A venting system shall not void the firestopping required between spaces of a building when the assembly is installed in accordance with the manufacturer's installation instructions.

7.5 A venting system intended for use with a condensate neutralizer shall be provided with a means to direct overflow to a sanitary waste system should the neutralizer become blocked.

7.6 Thermal insulation that is not self-supporting shall be applied to solid surfaces so that the insulation does not sag.

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

7.8 A venting system shall not take air from an occupied space and exhaust such air to the outside of a building for cooling purposes.

8 Joints

8.1 Joints and seams in a venting system intended for use with Category III or IV appliances shall be gas-tight as determined by the Leakage Test, Section 33.

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

8.3 When cement, joining compounds, tape, screws, or similar means are required for sealing vent joints, they shall be provided or specified in the manufacturer's installation instructions and be readily available. Joint compounds and tape shall be resistant to deterioration due to aging and temperatures anticipated during use of the venting system. See Joint Sealing Compound Test, Section 34.

Exception: Solvent welding materials used as a secondary means of securing vent joints together are not required to be subjected to the Joint Sealing Compound Test, Section 34.

8.4 A joint shall not retain condensate or permit condensate to flow from the interior to the exterior of the vent gas conduit.

8.5 A joint shall not reduce the cross-sectional area of the vent gas conduit.

9 Firestop Spacers

9.1 A venting system intended for vertical installation within a trade size 2 by 4 inch [nominal 1-1/2 by 3-1/2 inch (38 by 89 mm)] or a trade size 2 by 6 inch [nominal 1-1/2 by 5-1/2 inch (38 by 140 mm)] stud space, with other than zero clearance, shall be provided with ceiling plate spacers constructed to locate the venting system centrally in the stud space.

9.2 A ceiling-plate spacer shall constitute a complete firestop.

9.3 A spacer shall have sufficient strength and bearing surface to maintain the required clearance from venting system parts to joists, ceiling and floor material, and the inner surface of walls.

9.4 A firestop shall provide complete firestopping when the assembly is installed in a framed joist opening, or through a stud space, that is 1/2 inch (13 mm) greater on each side than the opening for which the space is intended. A spacer shall provide for continuous interference around the perimeter of the construction for a height of not less than 1 inch (25 mm). The inside diameter of the firestop opening shall

not be more than 1/8 inch (3.2 mm) greater than the outside diameter of the venting system, either at the firestop or at the outside diameter of the venting system, excluding vent joints and raised projections.

9.5 Firestops for non-metallic venting systems shall be provided and designed to permit unrestricted longitudal or radial thermal expansion and contraction movement that occurs during pipe heating.

10 Thimbles

10.1 A venting system intended for horizontal installation shall be provided with a thimble constructed to enable the venting system to penetrate a vertical wall unless the venting system is tested at zero clearance to combustible construction.

10.2 A thimble shall have sufficient strength and bearing surface to maintain the required clearance from the venting system parts to the wall studs and inner surfaces of walls.

10.3 Thimbles for non-metallic venting systems shall be provided and designed to permit unrestricted longitudal or radial thermal expansion and contraction movement that occurs during pipe heating.

11 Support Assembly

11.1 A support assembly, if required, shall establish and maintain the minimum required clearance between a venting system and combustible construction. A support for installation in a joist area shall constitute a complete firestop when tested in accordance with these requirements.

11.2 A support assembly shall sustain a load equivalent to four times the weight imposed upon it by all the venting system parts it is intended to support. See Vertical Support Test, Section 21.

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

11.4 A venting system intended for exterior installation shall be provided with support assemblies.

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

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

11.7 Supports and hangers shall be specified and shall accommodate both longitudinal and lateral vent movement. Instructions for the maximum length of pipe between supports and hangers shall be specified in the manufacturer's installation instructions.

12 Radiation Shields

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

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

b) Provide a continuous barrier for a vertical distance, referenced to the ceiling or floor level, of not less than 10 inches (250 mm) for venting systems having an internal diameter of 12 inches (300 mm) or less, and not less than 12 inches for all other sizes. The assembly shall fit into a framed joist area not larger than the sum of:

1) 1/2 inch (13 mm) greater than the outside diameter of the venting system, and

2) Twice the dimension to be specified in the installation instructions for clearance between venting system sections and combustible enclosures.

12.2 Parts of a firestop-spacer or support assembly that are intended to shield combustible construction from radiation are not considered to be radiation shields.

12.3 A radiation shield provided for compliance with the maximum temperature limits of these requirements for roof structures shall not be employed in a roof or other terminating assembly that is intended to be altered in the field if such alteration would require the shifting or relocation of the shield.

13 Vent Termination or Caps

13.1 A vent termination or cap shall be provided to resist the entrance of debris and rain into the vent gas conduit and into any cooling air passage terminating exterior to the building. See Rain Test, Section 24.

13.2 A vent termination or cap shall be constructed so that snow, leaves, and debris falling or blown onto it are not retained so as to obstruct vent gas or cooling air passages.

14 Drain Fittings

14.1 Drain fittings, if provided, shall be permanently marked at or near the fitting as specified in 45.8. The marking shall advise the user to ascertain that the appliance is intended for use with a vent system that includes a drain fitting.

15 Appliance Adapters

15.1 Appliance adapters shall be provided as part of a non-metallic gas vent pipe system intended for category III appliances. The adapter shall be provided with identification of the intended uses of the adapter.

Exception: Vent adapters are not required to be provided for appliances provided with integral adapters for connection with non-metallic venting systems.

15.2 With respect to the identification of intended uses noted in 15.1, the identification shall include appliance identification, construction, or any other means which identifies the intended appliance flue outlet construction on which the adapter is to be used.

15.3 Metal used in an appliance adapter which is subject to contact by flue gases or flue-gas air mixtures shall comply with the requirements for the Resistance to Condensate-Exposure Corrosion Test for Metals described in Section 39. See 6.3 and 6.4.

Exception: Appliance adapters intended to be connected to an appliance that does not employ an internal condensate drain system are not required to comply with this requirement. See 15.5.

15.4 When attached to an appliance flue outlet, three samples of the appliance adapter/flue outlet joint shall be capable of sustaining:

a) A 100-pound (445-N) longitudinal force for 5 minutes without separation; and

b) A 24 foot-pound (34 N·m) torque for 5 minutes without separation.

Exception: An outlet designed to allow rotation without separation is not required to subjected to the torque test.

15.5 Appliance adapters intended to be connected to an appliance which does not employ an internal condensate system shall comply with the following:

a) Metals in contact with flue gases or flue gas-air mixtures shall consist of a material having durability and resistance to corrosion and heat equivalent to Type 1100 aluminum or Series 300 or Types 430 and 446 stainless steel;

b) The installation instructions shall specify a field-installed condensate drain as close as possible to the appliance adapter and downstream of the appliance adapter.

c) Each appliance adapter shall be marked in accordance with 45.9.

15.6 Metals shall not be used in combinations that cause galvanic action at any location within the connection.

PERFORMANCE

16 General

16.1 When a venting system is tested in accordance with these requirements, specified temperatures on combustible construction shall be maintained as specified in Section 19, Temperature Test – Structure.

16.2 After being subjected to the tests specified in Sections 19 – 43, as applicable, a venting system shall be acceptable for intended use.

16.3 With regard to the requirements of 16.2, acceptable for intended use includes the following:

a) No part of the venting system shall be damaged or permanently distorted to an extent that it or the assembly does not continue to function as intended.

b) The effectiveness of any required protective coating or finish shall not be impaired.

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

d) The reflectivity of a surface shall not be impaired if the reflectivity of such surface is utilized to reduce the risk of fire.

e) The effectiveness of insulating material shall not be reduced.

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

g) Nonmetallic parts shall not have softened, melted, distorted, creeped, or moved in relation to other components.

h) Sealing materials or tape at joints shall not be deteriorated.

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

a) The products resulting from the combustion or volatilization of any combustible binder shall be discharged to the vent termination 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.

16.5 Representative samples are to be selected and used for test purposes. If venting system sections are of uniform grade, thickness, and cross section, such as square or round, the samples are to be selected from the largest and the smallest sizes. Square or round sections, varying in grade and thickness with size, may also require samples in the intermediate size range. Rectangular sections are to be selected on the basis of grade, thickness, and size, as well as the largest ratio of width to depth produced by the manufacturer. Consideration is to be given to selecting sample shapes that will be the most vulnerable to damage under the conditions of test.

17 Test Installations

17.1 The test installation for a venting system is to be based on the following factors:

a) Size and shape (round, oval, or other).

b) Height of a vertical venting system and length of a horizontal venting system.

c) Minimum clearance to combustible construction.

d) Enclosure in stud space.

e) Single or multistory building or buildings.

17.2 The general form for a test structure for a venting system installed vertically is illustrated in Figure 17.2. Test structure details for various venting system features and designs are illustrated in Figure 17.1 – Figure 17.4.

Figure 17.1

Typical test structure – direct vent horizontal

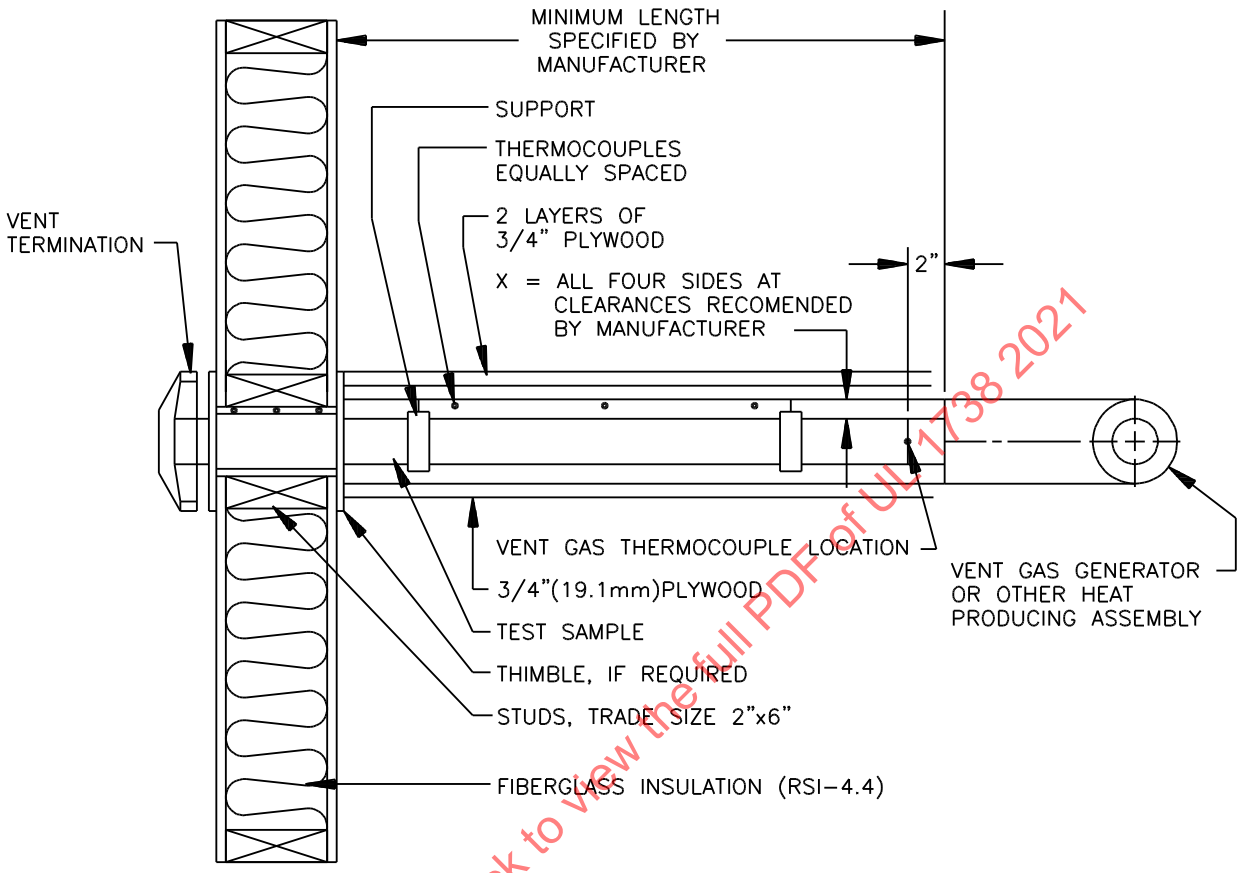


Figure 17.2

Typical test structure – vertical installation installation

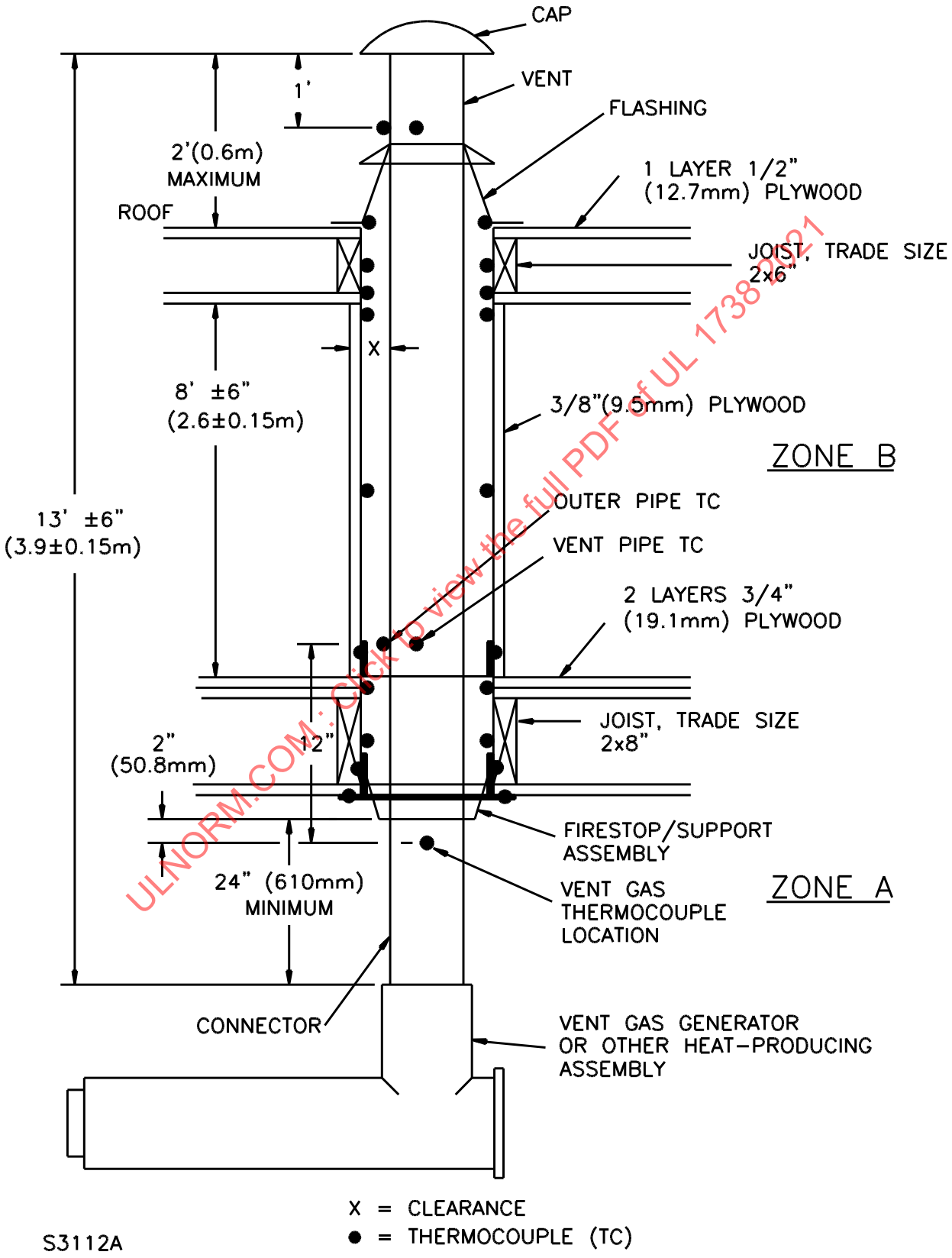


Figure 17.3

Typical test structure for oval vents

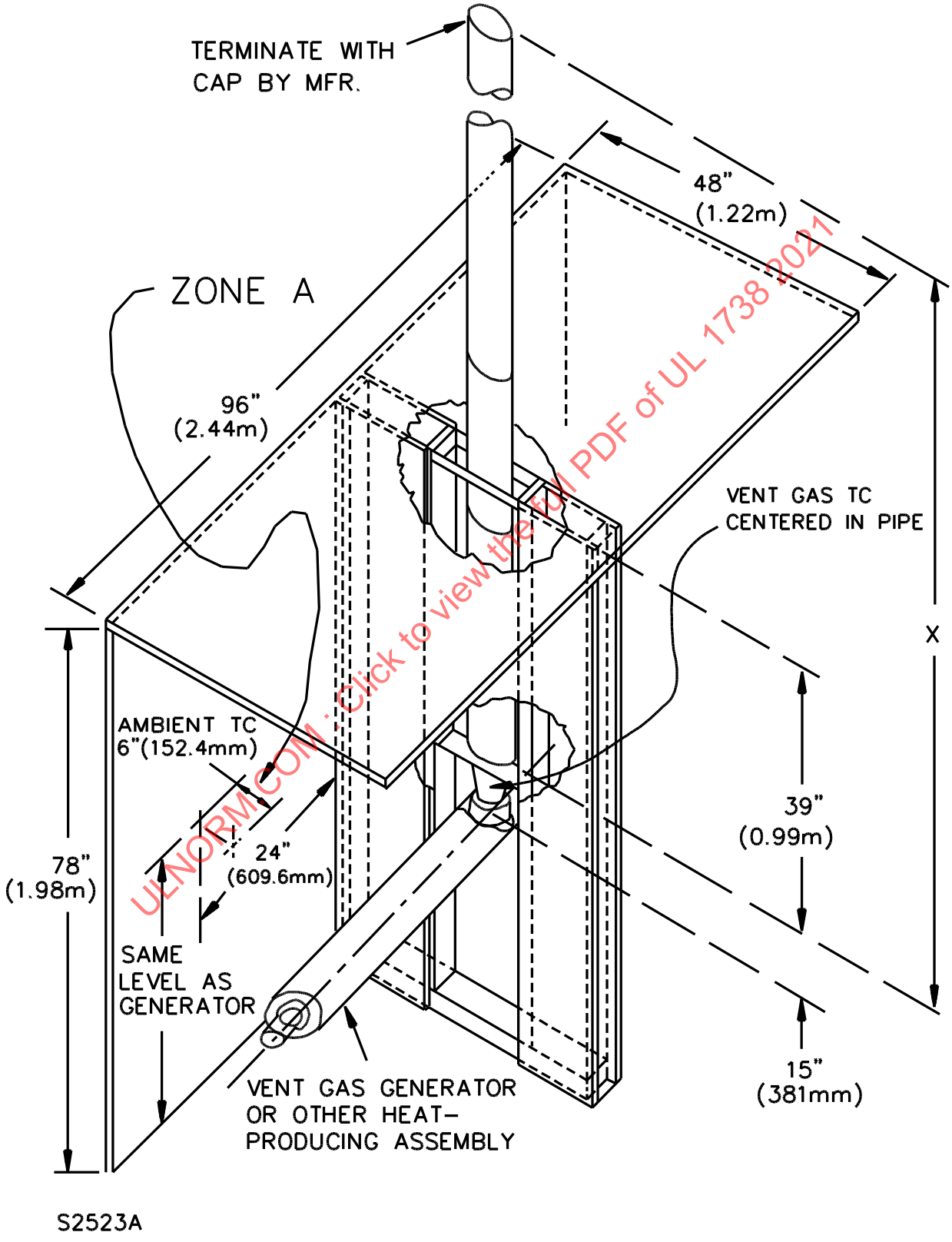
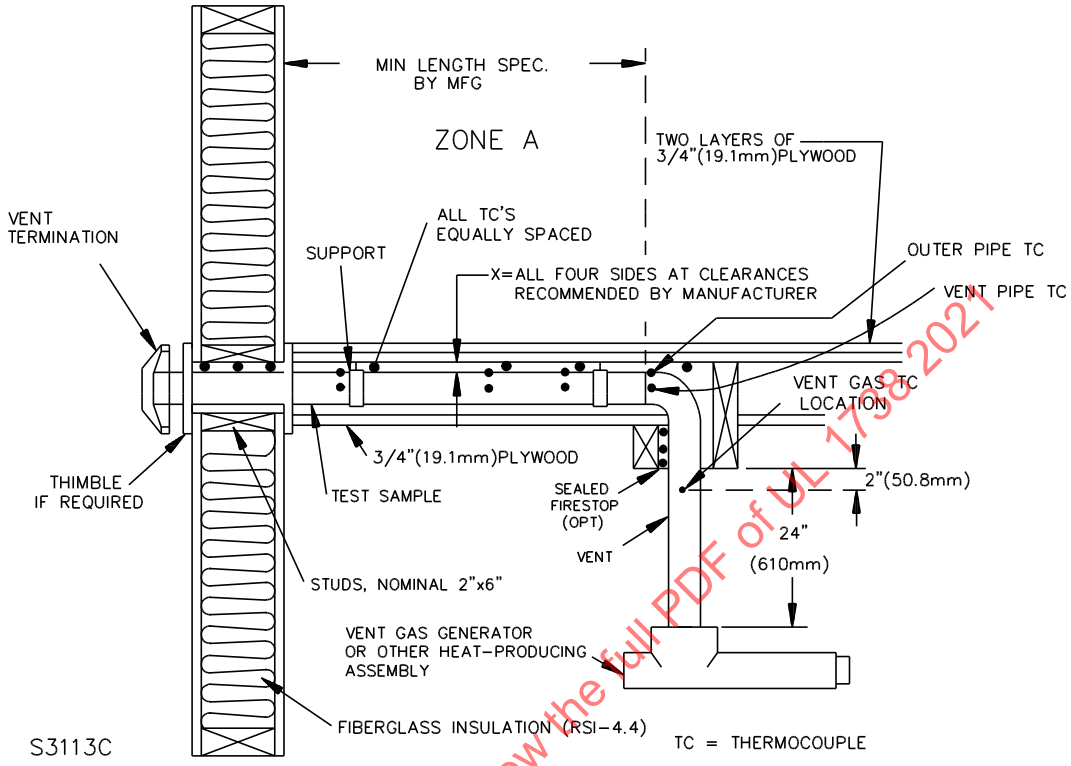


Figure 17.4

Typical test structure – horizontal installation



17.3 A venting system intended for installation through a wall is to be tested as illustrated in Figure 17.1 and Figure 17.4. The installation is to include all spacers, supports, flashings, and other components described in the installation instructions.

17.4 The test structure is to be erected within a room having ventilation capable of controlling the build-up of carbon monoxide to less than 50 parts per million (ppm) throughout the period of any test. The room is to be free of extraneous drafts and the vent is to exhaust into the same space or into a space freely communicating with the space from which the combustion air is taken. The room is to be such that during any one test the room temperature does not increase by more than 20° F (11° C) above the room temperature recorded at the beginning of the test.

17.5 If a venting system provides for taking air from the outside of a building to cool the venting system, the test arrangement is to provide means for maintaining the temperature of such air between 70 and 90°F (21 and 32°C).

17.6 A test venting system is to consist of an assembly composed of standard venting system sections and other furnished parts erected according to the installation instructions. The outlet of a test venting system is considered as terminating at the roof assembly and cap or wall outlet as specified by the installation instructions. Other functional parts of the venting system, such as a support or firestop-spacer, are to be used during a test. A venting system incorporating an elbow or elbows is to be additionally installed and tested in accordance with the most restrictive assembly specified in the installation instructions.

17.7 A vent gas generator as illustrated in Figure 17.6, or equivalent heat producing assembly such as that illustrated in Figure 17.7, is to be used to achieve the vent temperatures at 70°F (38.8°C) above the

temperature rating of the venting system. Dilution air is to be introduced into the test assembly as necessary to maintain the specified temperatures.

Figure 17.5

Test structure for firestop-spacer assembly

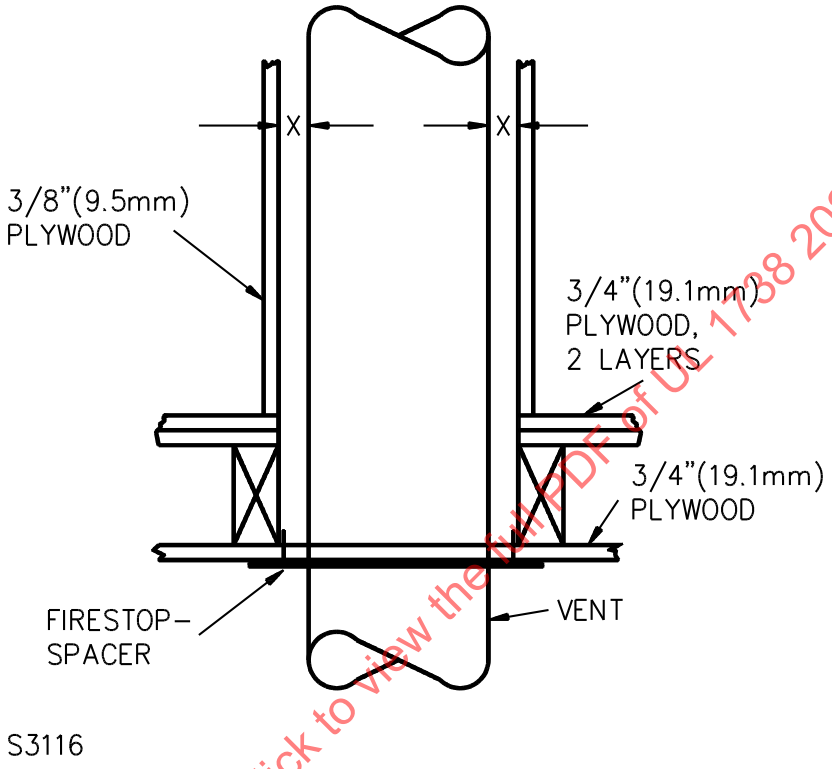


Figure 17.6

Vent gas generator

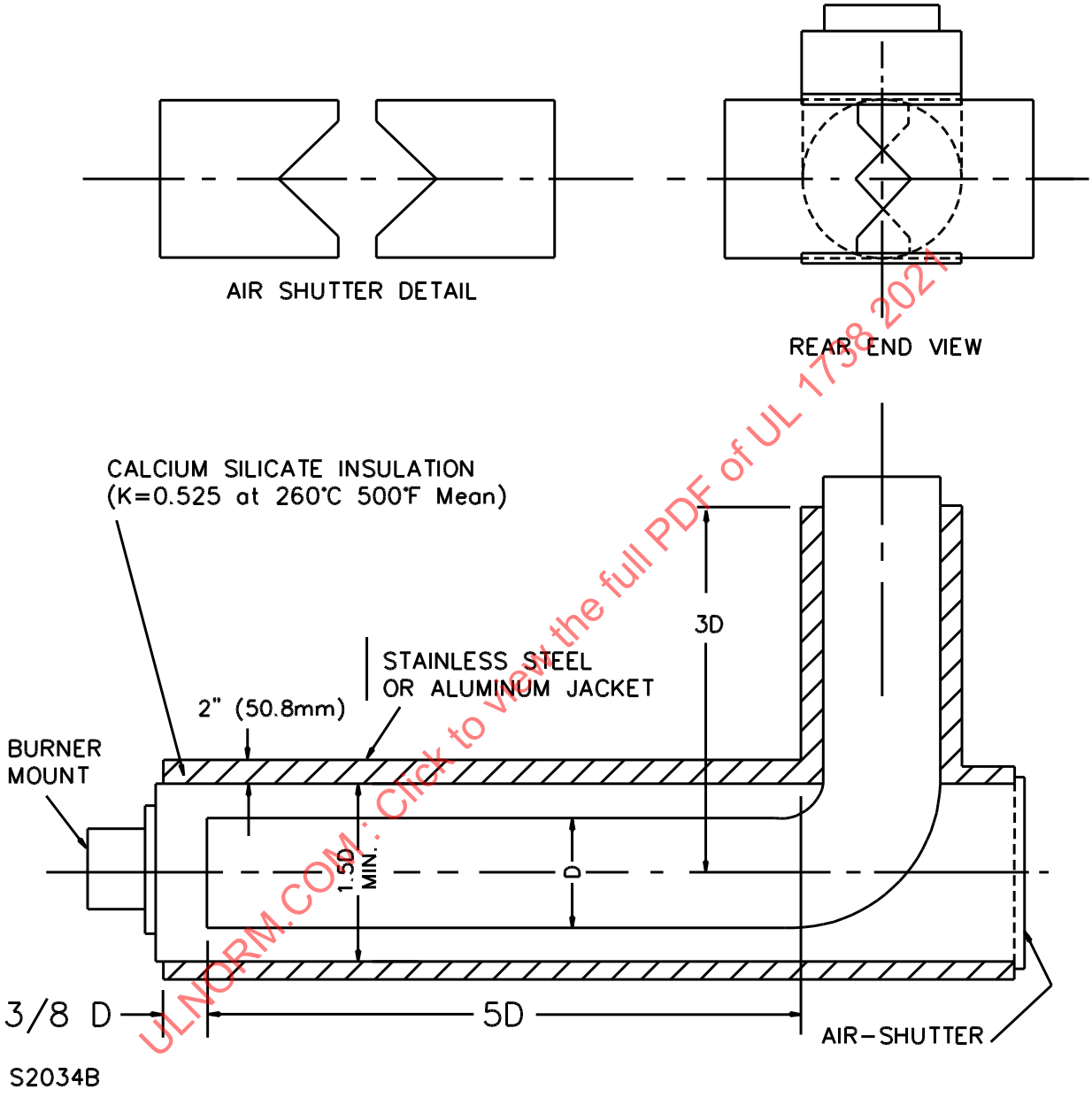
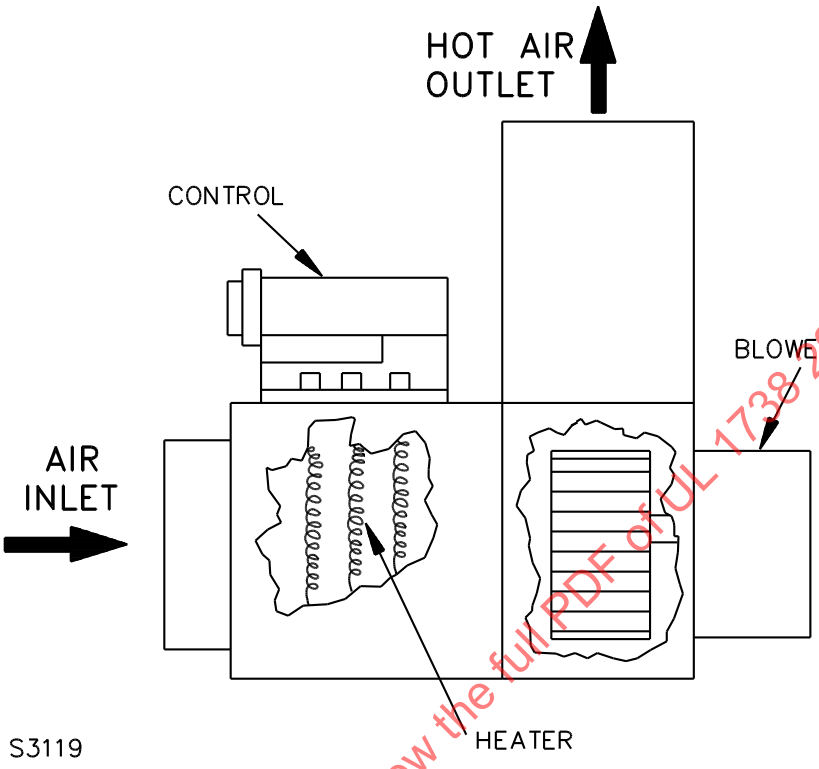


Figure 17.7

Hot air blower heat producing assembly



17.8 For a vent gas generator, a premix type burner assembly, such as an Eclipse brand, or the equivalent, capable of supplying a stoichiometric air-gas mixture is to be used. Combustion is to be complete within the horizontal straight length of the generator combustion chamber. The insulated generator outlet is to be connected directly to the inlet of the test venting system using the manufacturer's specified connector parts.

17.9 A vertically installed venting system is to be installed as shown in Figure 17.1, and totally encased for its full height within all stories and attic space, except for the level on which the generator is installed. Venting systems are to be tested on the basis of clearance from the enclosure as specified by the installation instructions and measured between the outer surface of the venting system sections and the interior surfaces of the enclosing material. These clearances are designated by the dimensions "X" in Figure 17.1 and Figure 17.5. The vent enclosure material is to be 3/8 inch (9.5 mm) thick plywood, and is to be closed at each floor-joist level by the installation of a manufacturer's firestop or firestop-spacer assembly. Such assemblies are to be placed at the ceiling line of each floor joist level, except that at the joist level serving the attic space the assembly may be placed on top of the attic space floor material.

17.10 The test enclosure material at each floor joist level is to be of trade size 2 by 8 inch [nominal 1-1/2 by 7-1/4 inches (38 by 140 mm)] lumber, forming a box placed at zero clearance to the vent sections or to a manufacturer's support or firestop-spacer assembly. The test enclosure material at the roof-joist level is to be of trade size 2 by 6 inch [nominal 1-1/2 by 5-1/2 inch (38 by 184 mm)] lumber forming a box placed at the clearance specified in the installation instructions for enclosures or at the lesser clearance required to provide support means for a roof assembly. See Figure 17.1. All ceiling, floor, and roof material is to be cut flush with the inside of all framed joist openings.

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

17.12 All joints and openings between a venting system pipe and factory furnished parts, between spacers or supports and the test enclosure, all joints in a test enclosure, and all joints intended to be sealed for field installation are to be sealed with plastic coated or film faced pressure sensitive tape lapping the joint by a minimum of 1 inch (25.4 mm) on each side. The peel adhesion characteristics of the tape on fibrous (wood) combustible enclosure materials are to comply with the Standard Test Method for Adhesion of Pressure-Sensitive Tape to Fiberboard at 90 Degree Angle and Constant Stress, ASTM D2860, at a temperature of 150°F (66°C).

18 Temperature Measurement

18.1 Thermocouples

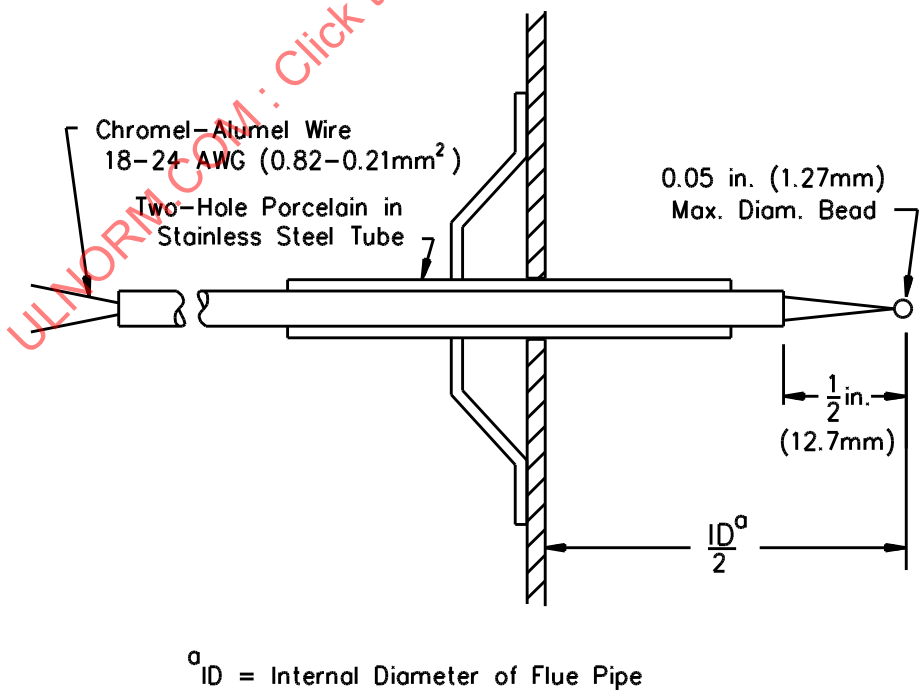
18.1.1 Temperatures are to be measured using either Type J (iron-constantan) or Type K (chromel-alumel) thermocouples of 18 – 24 AWG (0.82 – 0.21 mm^2) wire having an untwisted bare bead junction not more than 0.050 inch (1.27 mm) diameter.

18.2 Vent gas temperatures

18.2.1 Vent gas temperatures are to be determined for the Temperature Test – Structure, Section 19, by a thermocouple, see Figure 18.1, located as illustrated in Figure 17.1 – Figure 17.4.

Figure 18.1

Vent-gas thermocouple and support bracket



[a]ID = Internal Diameter of Flue Pipe

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18.2.2 The vent gas thermocouple is to be inserted into the center of the vent pipe.

18.2.3 The heat producing assembly then is to be operated as for the Temperature Test – Structure, Section 19, and the dilution air regulated so that the vent gas temperature specified in Table 19.1 is achieved as indicated by the thermocouple.

18.3 Other temperatures

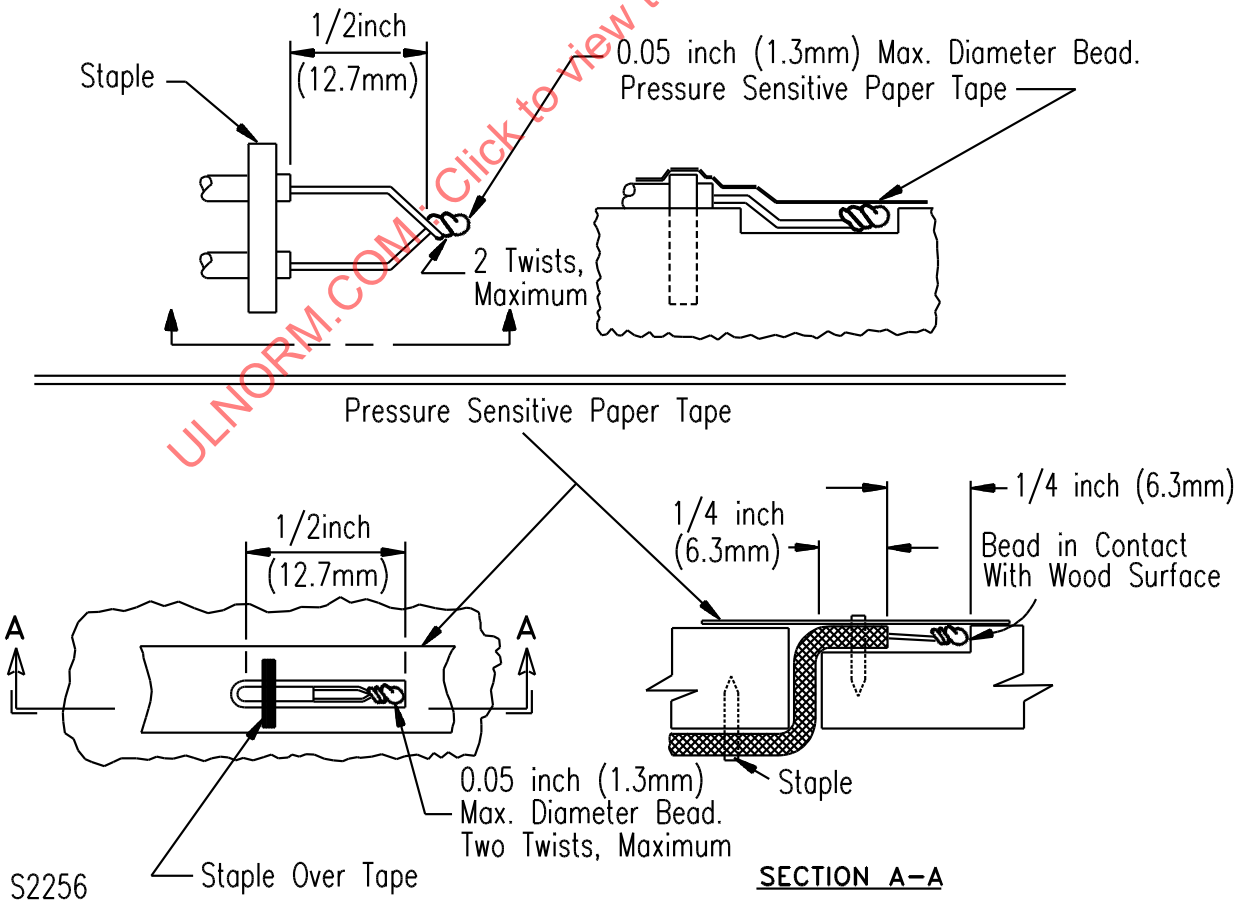
18.3.1 For test enclosure elements in contact with venting system parts, junctions of thermocouples are to be placed on the vent part surfaces, except that at a point or line contact of a spacer not over 1/8 inch (3.2 mm) diameter, or width, thermocouples are to be placed on the test enclosure at points 1/2 inch (12.7 mm) from the centerline of such point or line contact. Thermocouples are to be:

a) Attached to test enclosure elements having a surface adjacent to the venting system parts and onto ceilings or roof areas adjacent to the venting system so as to have 1/2 inch of wire exposed, and

b) Secured to wood surfaces by staples placed over the insulated portion of the wires. The thermocouple insulation and tip are to be depressed for a length of 1/2 inch into the wood so as to be flush with the wood surface at the point of measurement and held in thermal contact with the surface at that point by the use of flat black pressure sensitive paper tape. See Figure 18.2.

Figure 18.2

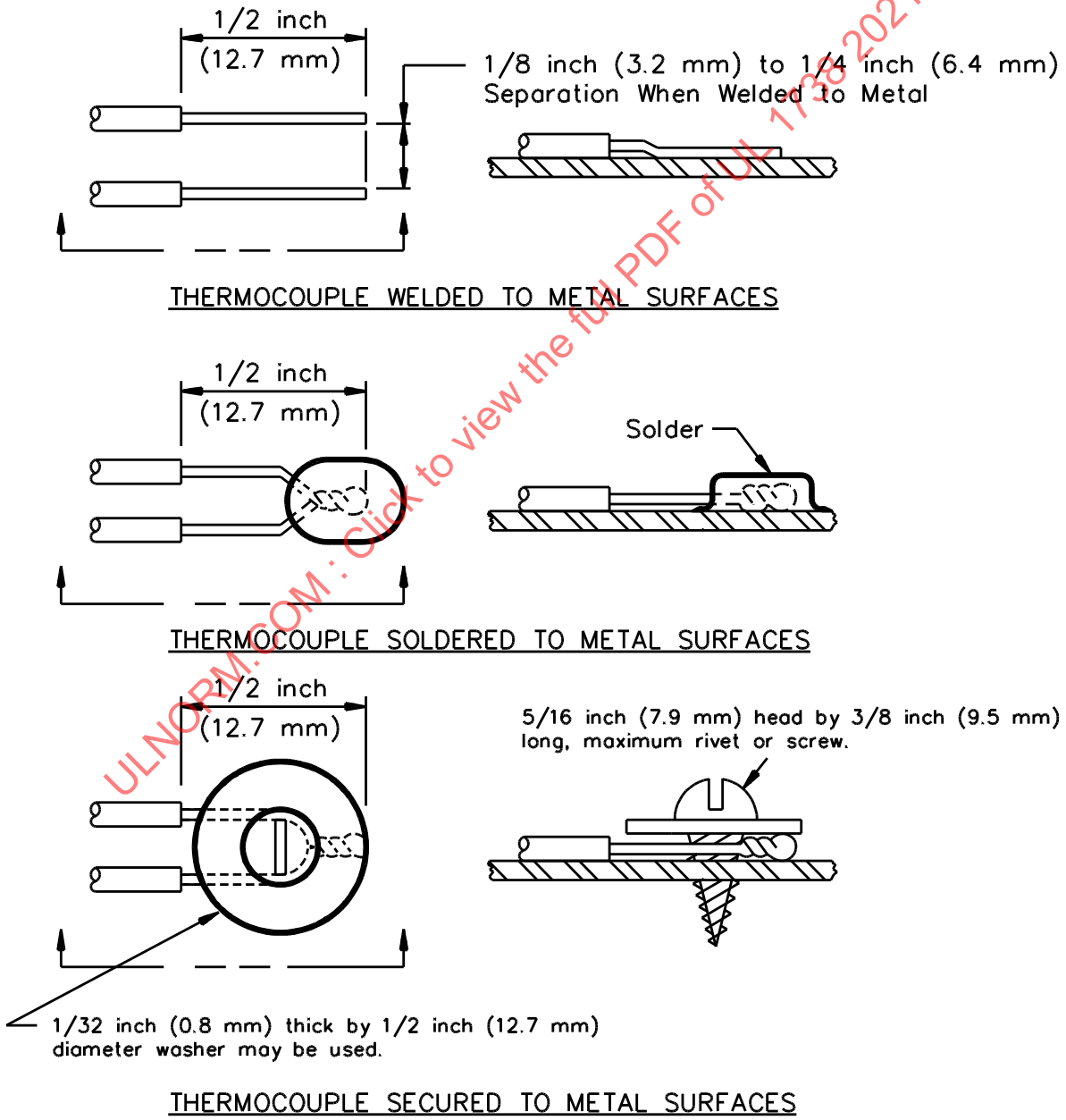
Thermocouple installation methods on wood surfaces



18.3.2 Temperatures attained by surfaces on parts of the vent are to be obtained by means of thermocouples applied to the parts. Thermocouples are to be attached to metal surfaces by screws, rivets, silver soldering, brazing, or welding of the tip to the metal surface. See Figure 18.3. Thermocouples to be attached to surfaces of nonmetallic or nonwood parts are to have junctions and at least 1 inch (25 mm) of the lead wires imbedded flush with the surface of the material. Furnace or epoxy 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 may be placed at other locations that are in contact with or subject to radiation from surfaces of the venting system.

Figure 18.3

Thermocouple installation methods on metal surfaces



18.3.3 Ambient temperatures of a zone are to be determined by a shielded thermocouple located centrally within a vertically oriented 6 inch (152 mm) length of aluminum painted 2 inch (50.8 mm) steel pipe open at both ends. Ambient temperatures are to be determined by shielded thermocouples located with reference to the various parts of the vent, test structure, and vent gas generator; and by placing the shield in a manner to avoid direct radiation to the thermocouple.

18.3.4 The ambient temperature in Zone A (see Figure 17.1 – Figure 17.4) is to be the ambient temperature at the level of the vent gas generator.

18.3.5 The ambient temperature in Zone B (see Figure 17.1) is to be determined by a thermocouple located 2 feet (0.6 m) away from the centerline of the enclosure and 4 feet (1.2 m) above the floor.

18.3.6 The ambient temperature in the space above a roof line is to be determined by a thermocouple located 2 feet (0.6 m) away from the centerline of the venting system or roof assembly and 1 foot (0.3 m) above the roof, and in an area so as to not be affected by the gases exiting the venting system.

18.3.7 For the purpose of determining temperature rises on venting system parts, on an enclosure, and on the test structure, the temperatures are to be referenced to ambient temperatures as determined in 18.1, 18.2, and 18.3.1 – 18.3.6. Temperatures of joists and rafters are to be referenced to the average of the ambient temperatures above and below the joist or rafter area. Temperatures of floor or roof material are to be referenced to the ambient temperatures above the floor or roof. Temperatures of ceiling material are to be referenced to the ambient temperature below the ceiling.

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

18.3.9 A minimum number of typical thermocouple locations on wood surfaces is shown in Figure 17.1, Figure 17.2, and Figure 17.4. Additional thermocouples are to be used if necessary because of the construction and method of installation.

19 Temperature Test – Structure

19.1 When a venting system is tested as described in 19.3, the maximum temperatures on surfaces of the test structure, such as ceilings, enclosures, floors, and joists, and on surfaces of vent parts at points of zero clearance to the test structure, shall be not more than:

a) 117°F (65°C) above ambient temperature on exposed surfaces of the test enclosure, and

b) 90°F (50°C) above ambient temperature on concealed surfaces of the test enclosure, such as within the vent enclosure.

19.2 The temperature measured on the inner and outer surface of any polymeric part shall not exceed the relative thermal index for the material employed, as specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

19.3 The temperature of the vent gases or heated air entering the test venting system is to be adjusted to 70°F (38.8°C) above the rated temperature at the minimum input specified in Table 19.1. If a gas burner is used, combustion of fuel gases is to be complete within the combustion chamber of the vent gas generator.

Table 19.1
Vent gas test temperatures and minimum vent input for vent sizes

Nominal diameter (or equivalent cross-section) of vent,		Rated temperature, and minimum vent input			
		210°F (99°C)[1,2,3]		300°F (149°C)[1,2]	
		Minimum vent-gas generator	Minimum heat producing assembly input	Minimum vent-gas generator input	Minimum heat producing assembly input
inches	(mm)	Btu/hr	kW	Btu/hr	kW
2	(51)	1,900	0.57	2,200	0.64
3	(76)	4,277	1.25	4,950	1.45
4	(102)	7,605	2.23	8,800	2.58
5	(127)	11,882	3.48	13,750	4.03
6	(152)	17,103	5.01	19,790	5.80
		330°F (177°C)[1,2]		400°F (204°C)[1,2]	
		Minimum vent-gas generator	Minimum heat producing assembly input	Minimum vent-gas generator input	Minimum heat producing assembly input
		Btu/Hr	kW	Btu/Hr	kW
2	(51)	2,320	0.68	2,513	0.74
3	(76)	5,190	1.52	5,655	1.66
4	(102)	9,320	2.73	10,056	2.95
5	(127)	14,340	4.20	15,712	4.60
6	(152)	21,170	6.20	22,616	6.63
		480°F (249°C)[1,2]		550°F (288°C)[1,2]	
		Minimum vent-gas generator–	Minimum heat producing assembly input –	Minimum vent-gas generator input –	Minimum heat producing assembly input –
		Btu/Hr	kW	Btu/Hr	kW
2	(51)	2,830	0.83	3,142	0.92
3	(76)	6,350	1.86	7,070	2.07
4	(102)	11,300	3.31	12,570	3.68
5	(127)	17,600	5.16	19,640	5.76
6	(152)	25,300	7.41	28,270	8.29

[1] The actual test temperature is the specified value plus 70°F (38.8°C) as noted in 19.3.

[2] For a vent with a diameter not specified in Table 19.1, the minimum vent-gas generator and minimum heat producing assembly input values for testing shall be determined by extrapolation of the values indicated in Table 19.1.

[3] The vent system manufacturer is allowed to specify a lower Rated Temperature than 99°C (210°F). In this case, the actual test temperature is the specified value plus 70°F (38.8°C), as noted in 19.3. The minimum vent gas generator and minimum heat producing assembly input values shall be determined by extrapolation of the values indicated in Table 19.1.

19.4 The vent gas or heated air input is to be continued until equilibrium temperatures are attained. Equilibrium temperatures are considered to have been attained when three successive readings taken at 15 minute intervals show no change or show a decrease.

19.5 Upon successful completion of test, the vent temperature rating shall be equal to the minimum rated temperature selected from Table 19.1.

20 Draft Loss, Wind Effects and Induced Updraft Tests

20.1 Draft loss test

20.1.1 A cap or vent termination for attachment to a venting system shall not significantly impede the flow of vent gases in still air when tested as described in 20.1.2 and 20.1.3.

Exception: A cap or vent termination that is intended for use on a venting system suitable for use only on Category III and IV appliances which incorporate a power draft blower or blowers need not be subjected to the draft loss test.

20.1.2 The cap or vent termination is to be mounted on:

a) A continuous length of vent pipe, or

b) On its roof assembly mounted, in turn, on a continuous length of vent pipe.

Static pressure within the venting system 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 accurate to the nearest 0.001 inch (0.025 mm) of water column. The venting system is to be the same nominal diameter as the cap under test. All joints in the venting system between the inlet end and the cap under test are to be sealed or taped against leakage for all tests.

20.1.3 With the cap or vent termination removed, air velocity of 10 feet (3.05 m) per second [velocity pressure 0.023 inch (0.60 mm) water column] is to be established in the venting system and the static pressure measured. The cap or vent termination is then to be placed on the venting system, a velocity of 10 feet per second established, and the static pressure measured. The difference between the static pressures shall not exceed 0.034 inch (0.86 mm) water column.

20.2 Wind effects tests

20.2.1 A cap or vent termination for attachment to a venting system shall not impede the flow of vent gases when tested under wind conditions as described in 20.2.2 and 20.2.3.

Exception: A cap or vent termination that is intended for use on a venting system suitable for use only on Category III and IV appliances which incorporate a power draft blower or blowers need not be subjected to the wind effects tests.

20.2.2 The cap or vent termination, mounted on a continuous length of venting system pipe as described in 20.1.2, 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 at 20 miles per hour (32 km/h) [29.3 feet per second (8.93 m/s)]; velocity pressure 0.192 inch (4.88 mm) water column over an area described by a diameter not less than 12 inches (305 mm) greater than the maximum width of the cap or vent termination under test. The velocity is to be considered uniform if the variation at any point does not exceed 5 percent of the specified velocity. The configuration of the venting system and cap or vent termination is to be such that the cap or vent termination remains centered in the wind front during rotation about any axis.

20.2.3 With a symmetrical vent cap or termination intended for vertical installation in place and an 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 or vent termination at a series of elevation angles ranging from 45 degrees below the horizontal to 45 degrees above the horizontal, in 15 degree intervals. The average of the static pressures in the venting system:

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

b) At a horizontal wind front and at the three angles above the horizontal shall be not more than 0.068 inch (1.73 mm) water column greater than the pressure measured in the uncapped vent as described in 20.1.3.

20.2.4 For symmetrical vent caps intended for horizontal installation and exit from the structure, and an outward 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 or vent termination at a series of projected angles ranging from 0 to 90 degrees perpendicular to the vent axis, in 15 degree intervals. The average of the static pressure measurements in the venting system at the seven angles of exposure shall be not more than 0.086 inch (2.18 mm) water column greater than the pressure measured in the uncapped vent as described in 20.1.3.

20.2.5 Caps or vent terminations that are nonsymmetrical and intended for mounting in any orientation about their axis are to be rotated and tested in any position in azimuth, including any position that imposes the greatest draft loss.

20.3 Induced updraft test

20.3.1 A vent cap or termination for direct attachment to a venting system shall induce an updraft effect when subjected to wind flow past the vent cap or termination, as determined by the test methods described in 20.3.2 and 20.3.3.

Exception: A vent cap or termination that is intended for use on a venting system suitable for use only on Category III and IV appliances which incorporate a power draft blower or blowers need not be subjected to the induced updraft test.

20.3.2 The test arrangement described in 20.1.2 and 20.2.2 is to be employed. The cap or vent termination is to be placed on the venting system and centered in the wind front. The inlet to the venting system is to be sealed so that there is no air flow through the venting system. A 20 mile per hour (32 km/h) wind front is to be directed at the cap or vent termination at a series of elevation angles ranging from 45 degrees below the horizontal to 45 degrees above the horizontal in 15 degree intervals for vertical venting systems, and at 0 to 90 degrees perpendicular to the venting system axis in 15 degree intervals for horizontal installations. A vent cap or termination that is nonsymmetrical and intended for mounting in any orientation about its axis is to be rotated and tested at any position in azimuth that creates the minimum updraft capability.

20.3.3 At the angles of wind front elevation and azimuth described in 20.3.2, the average static pressure within the sealed venting system shall be equal to or less than 0.034 inch (0.86 mm) water column below atmospheric pressure. For winds approaching from below horizontal, the static pressure is considered 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 considered 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.

21 Vertical Support Test

21.1 An assembly intended to support a vertical venting system shall not be damaged, nor shall the security of its attachment to the building structure be impaired when tested as described in 21.2.

21.2 The support assembly is to be installed as described in the manufacturer's installation instructions and in a framework simulating a typical installation. The venting system is to be placed on the support, and 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 assembly that the support will be required to sustain in service. The load is to be applied for a minimum of 60 minutes.

22 Strength Tests

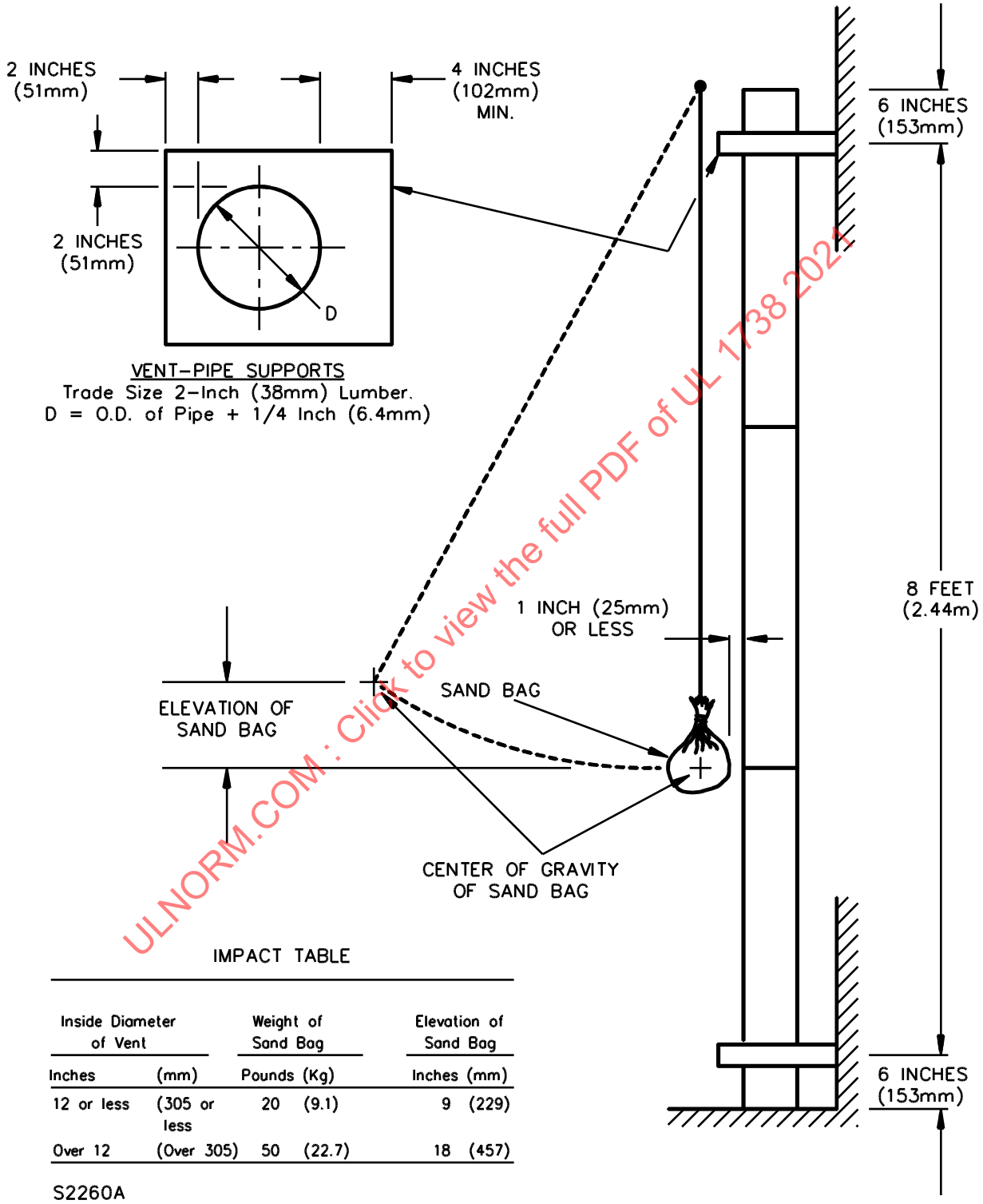
22.1 Impact test

22.1.1 A venting system or its parts shall not break, disassemble, or become damaged to the extent that they are unacceptable for further use as a result of three impacts of a sand bag applied as described in 22.1.2 – 22.1.5. In addition, the impact described in 22.1.5 (a) shall not be transmitted to the venting system or cause damage to the connection of the venting system at the appliance.

22.1.2 With reference to the requirements in 22.1.1, the impact is to be applied to a vertically installed venting system as shown in Figure 22.1, and to a horizontally installed venting system as shown in Figure 22.2. Tests are to be conducted on samples of each vent size. Each section is to be joined together as specified by the manufacturer. Any adhesives or cements are to be allowed to cure for at least 24 hours. Samples are not to be exposed to relative humidity greater than 70 percent during the 24-hour period prior to the test.

Figure 22.1

Vertical vent impact 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)

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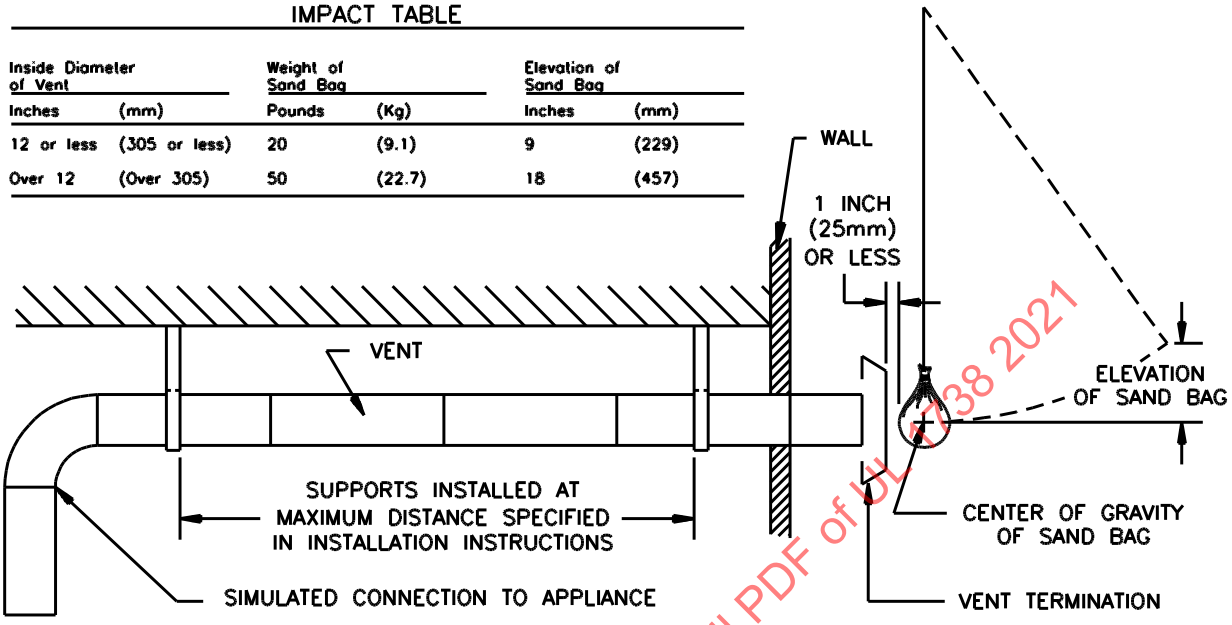
Figure 22.2

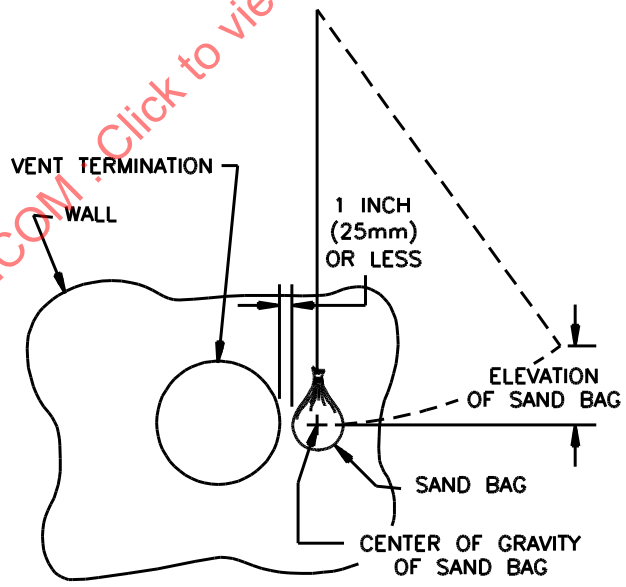
Horizontal vent impact test

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)



ONE IMPACT PERPENDICULAR TO THE TERMINATION



TWO IMPACTS – EACH PERPENDICULAR TO THE VENT PIPE BUT AT THE VENT TERMINATION & 180° APART FROM EACH OTHER

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22.1.3 The impact to the vertical or horizontal venting system 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 22.1. 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 22.1 and Figure 22.2 above the center of gravity of the bag at its at-rest position.

22.1.4 The length of the pendulum may vary, depending upon the intended point of impact.

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

a) For a horizontal venting system that terminates through a wall:

1) One impact perpendicular to the termination; and

2) Two impacts – each impact perpendicular to the vent pipe but at the vent termination and 180 degrees apart from each other.

b) For a vertical venting system:

1) One impact at the level of a joint,

2) One impact at the level halfway above the first joint tested and the next joint, and

3) One impact at the same level as in (1), but rotated around the axis of the venting system by 90 degrees from the impact in (1).

22.2 Longitudinal force test

22.2.1 Venting system parts shall not break, disassemble, or become damaged to the extent that they are unacceptable for further use when subjected to a longitudinal force of 100 pounds (445 N) applied as described in 22.2.2 and 22.2.3.

22.2.2 The longitudinal force is to be applied on assemblies of vent pipe sections, the number tested to represent each size of venting system parts intended to be field joined together. The force is to be exerted on the assembly in a direction tending to pull the assembly apart. If cemented joints are included in an assembly, the cement is to be allowed to dry for 24 hours before the test is conducted.

22.2.3 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 to the vent gas conduit and then, if provided, to the outer jacket or casing. The force is to be sustained for 5 minutes.

22.3 Load test for vent elbows

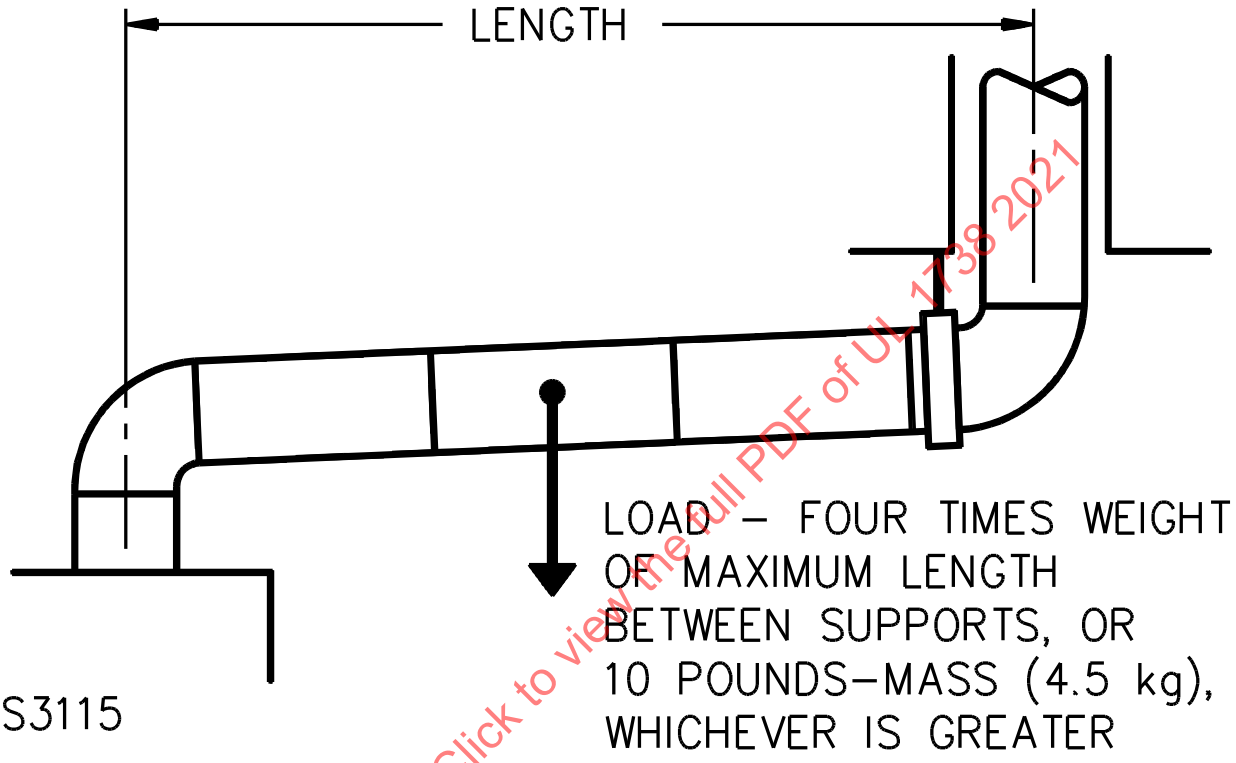
22.3.1 A support for an elbow shall not break, disassemble, or become damaged to the extent that it would be unacceptable for further use when subjected to a load equivalent to four times the weight of the longest venting system section between adjacent supports, but not less than 10 pounds-mass (4.5 kg), when the venting system is assembled and supported as described in the installation instructions. See 22.3.2.

22.3.2 The test is to be performed as illustrated in Figure 22.3. Elbows are to be tested using an elbow vent section having the greatest angle from the vertical specified by the manufacturer and installed directly on the vent section. A vertical load, equivalent to four times the weight of the longest supported section of

the venting system that is intended to be attached to the elbow, or a load of 10 pounds-mass (4.5 kg), whichever is greater, is to be applied through the center of gravity of the section. The load is to be sustained for 5 minutes.

Figure 22.3

Load test for vent elbows



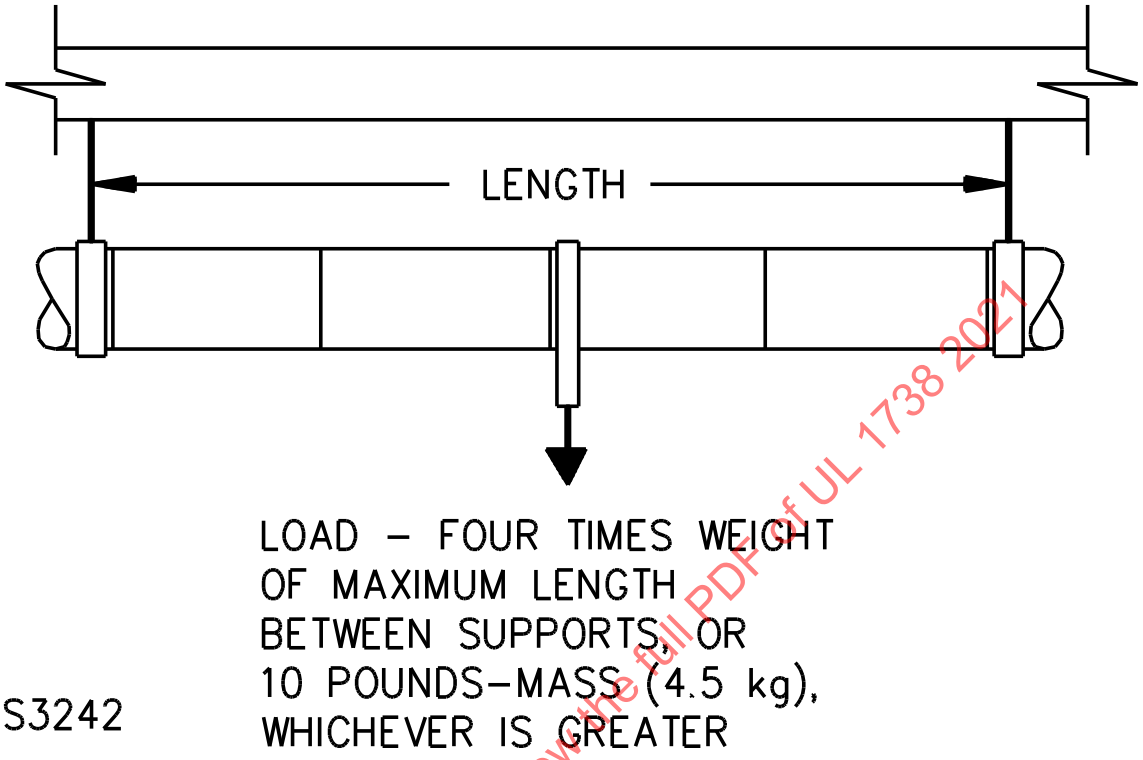
22.4 Vent joint load test

22.4.1 A vent joint of an offset vent shall not loosen, break, or disassemble when subjected to a load equivalent to four times the weight of the maximum length between the supports applied as described in 22.4.2, but not less than 10 pounds-mass (4.5 kg).

22.4.2 The test is to be performed as illustrated in Figure 22.4. The maximum inclined length of vent 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 offset vent between supports, or 10 pounds-mass (4.5 kg), whichever is greater, is to be applied at the joint located centrally between the supports. The load is to be sustained for 5 minutes.

Figure 22.4

Vent joint load test



23 Wind Load Test

23.1 Test on roof assemblies

23.1.1 A roof assembly shall withstand, 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 23.1.2 – 23.1.4.

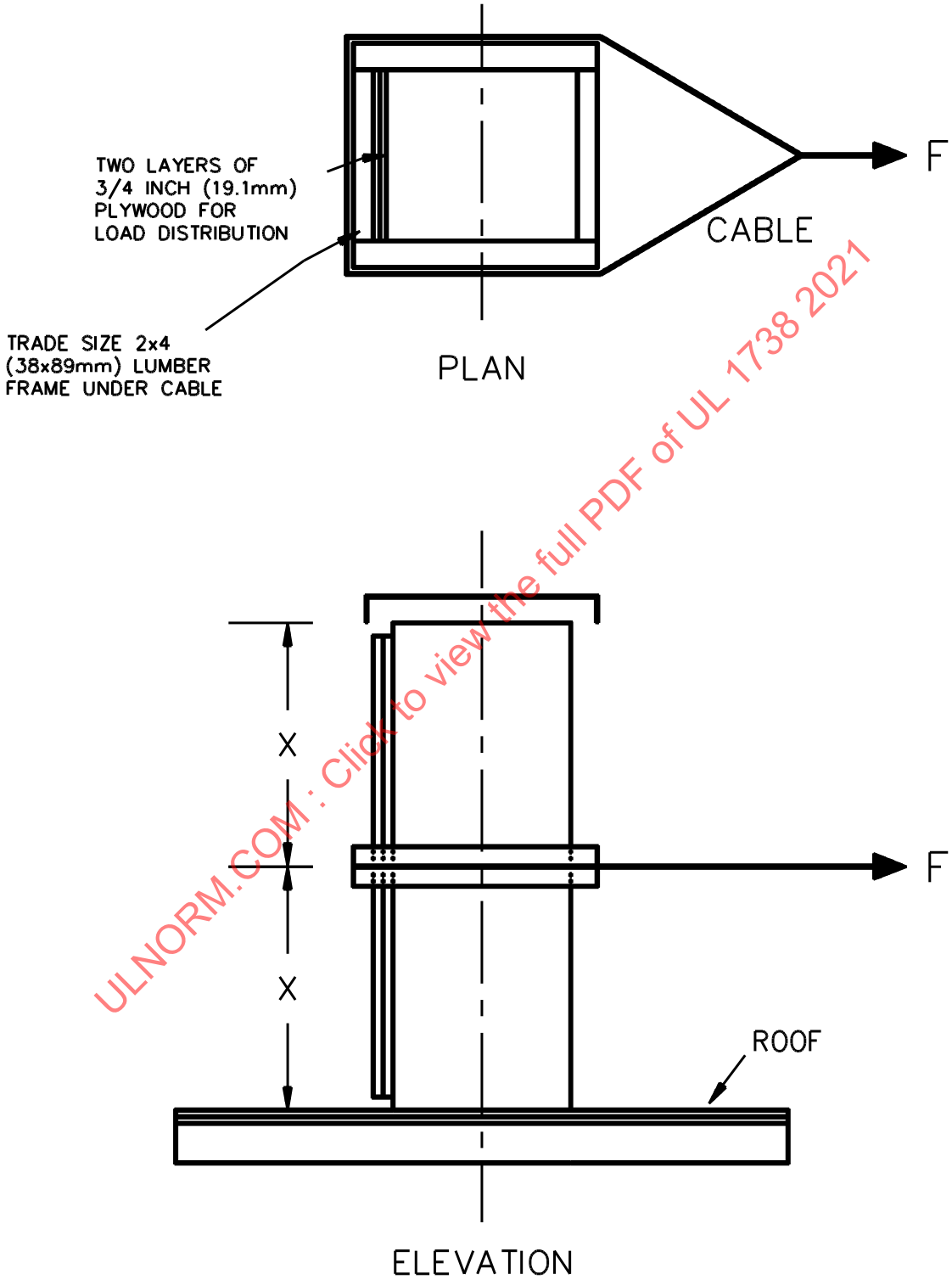
23.1.2 The test is to be conducted on the tallest roof assembly representative of each style furnished by the manufacturer. The assembly is to be installed in a flat roof deck as described in the manufacturer's installation instructions.

23.1.3 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 vent.

23.1.4 A load equivalent to the product of the projected area, expressed in square feet (m^2) multiplied by an assumed wind pressure of 30 pounds per square foot (146 kg/m^2) is to be applied to the surface of the assembly in a horizontal direction. If 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 as much of the surface as practical. See Figure 23.1. The load is to be sustained for 60 minutes.

Figure 23.1

Wind load test on roof assembly



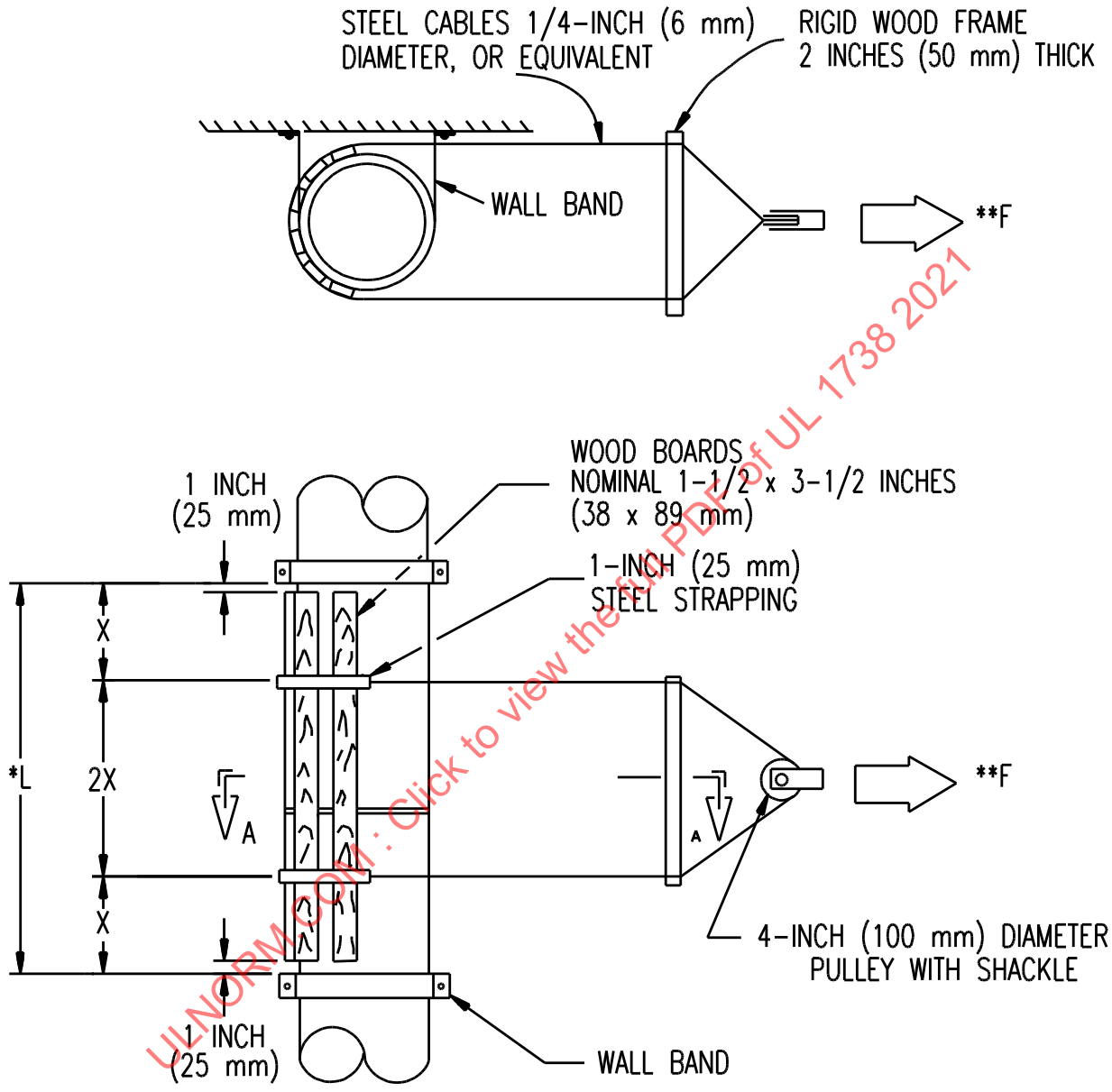
23.2 Test on lateral supports

23.2.1 A lateral support (such as a wall band) for exterior vent installations shall withstand, 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 23.2.2.

23.2.2 This test is to be conducted on an assembly consisting of one or more vent sections installed with two lateral supports spaced at the maximum distance specified by the manufacturer and mounted on a rigidly supported 3/4 inch (19 mm) thick plywood vertical surface. The projected area of the largest surface of the vent between the supports, and exposed to the wind, is to be calculated in square feet (m^2). A load equivalent to the product of the projected area, multiplied by 30 pounds per square foot (146 kg/m^2) and expressed in pounds-force; or 50 pounds-force (222 N), whichever is greater, is to be applied in a horizontal direction as illustrated in Figure 23.2. The load is to be sustained for 60 minutes.

Figure 23.2

Wind load test for vents intended for exposed exterior installation



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

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24 Rain Test

24.1 The quantity of water entering the vent gas conduit or any other individual passageway shall not exceed 2 percent of that which would enter the conduit or passageway if unprotected by a cap or other means when tested as described in 24.2 – 24.6.

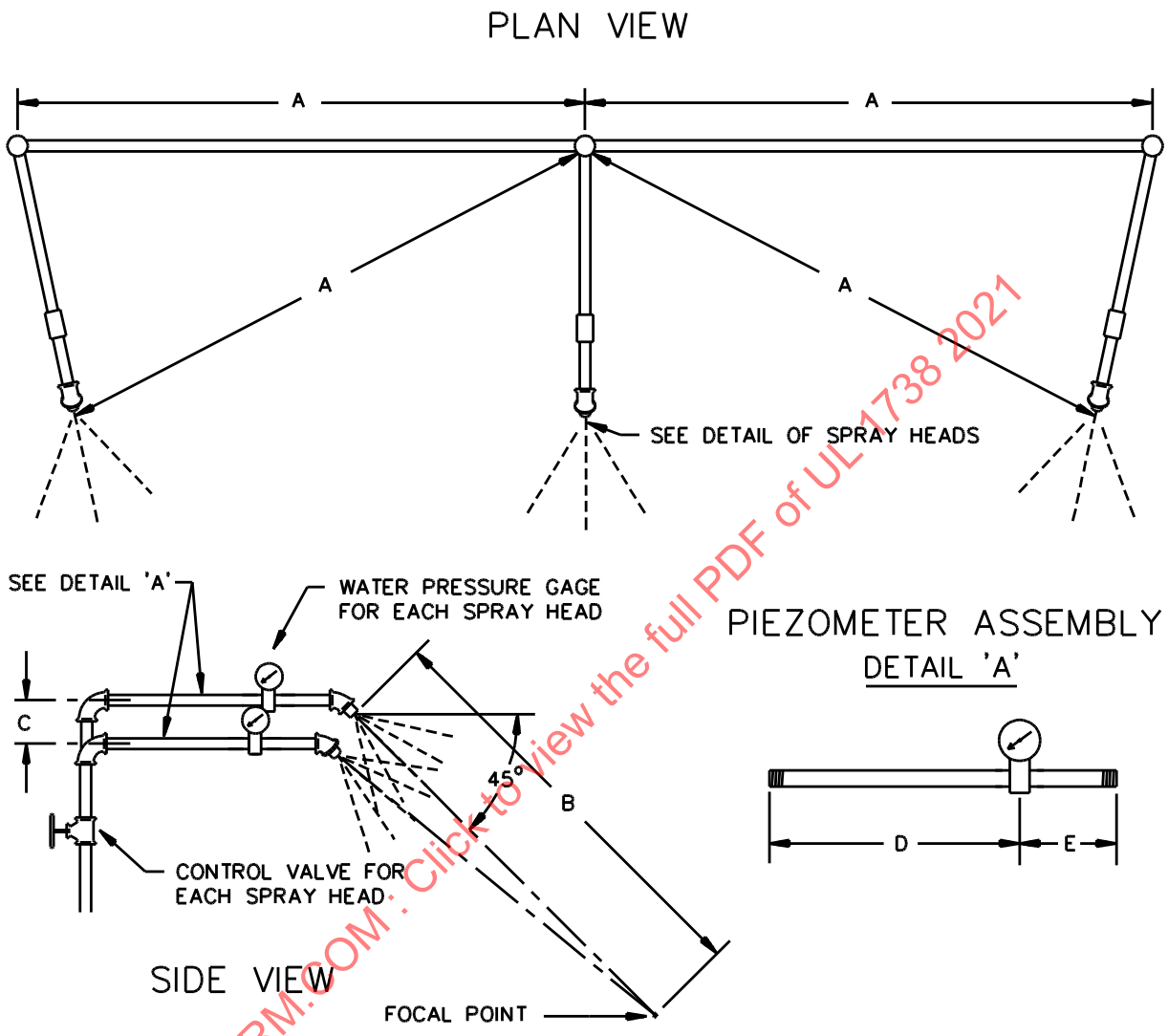
Exception: The Rain test is not required on a cap or vent termination that is intended for use only on a venting system designated for use with Category II and IV appliances and the installation instructions specify the use of adequate drainage in the system.

24.2 Representative sizes and styles of caps and roof assemblies are to be subjected to the tests described in 24.3 – 24.6. The roof assembly is to be sealed or flashed into a roof section of watertight material that will shed the water spray away from the underside of the test assembly. The arrangement is to permit any water entering the test assembly from above to be observed at the underside of the simulated roof and collected.

24.3 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as illustrated in Figure 24.1. Spray heads are to be constructed in accordance with the details illustrated in Figure 24.2. The water pressure for all tests is to be maintained at 5 psig (34.5 kPa) at each spray head. The spray is to be directed toward the top and side of the cap or roof assembly. The cap or roof assembly is to be centrally located within the spray pattern and the top of the cap or roof assembly under test is to be at least 3 feet (0.9 m) below the plane of the lower spray head outlet.

Figure 24.1

Rain test spray-head piping



Item	mm	inch
A	710	28
B	1400	55
C	55	2–1/4
D	230	9
E	75	3

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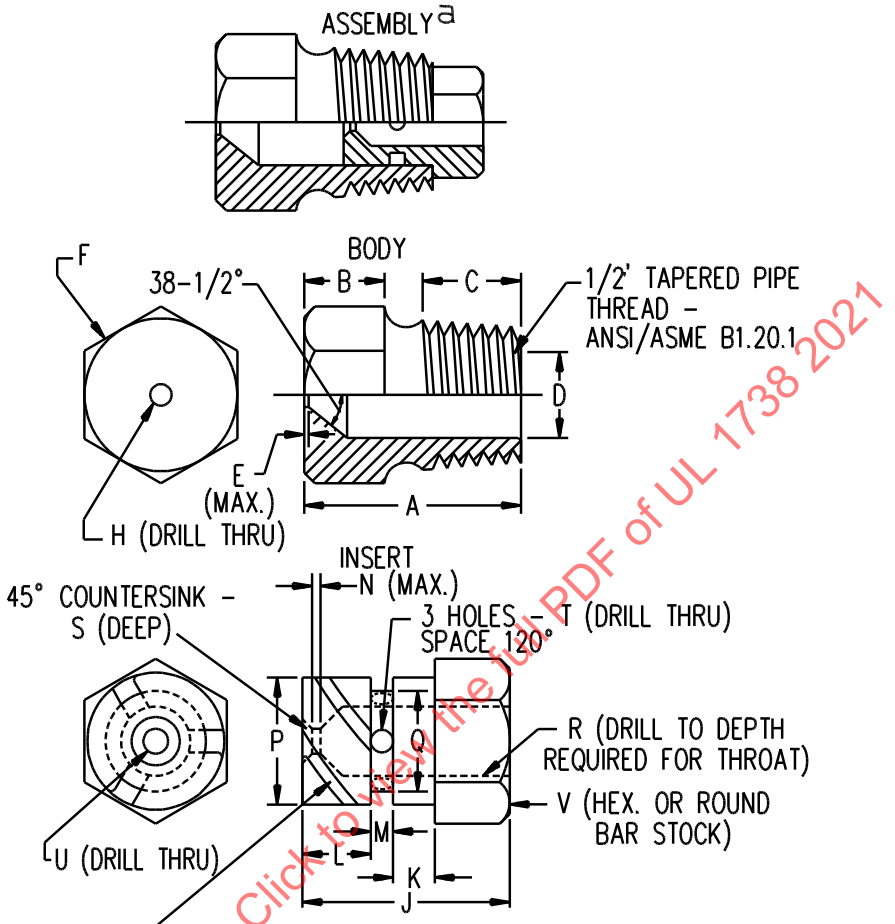
Figure 24.2

Rain test spray head



Item	mm	inch	Item	mm	inch
A	31.0	1-7/32	N	0.80	1/32
B	11.0	7/16	P	14.61	.575
C	14.0	9/16		14.63	.576
D	14.68	.578	Q	11.51	.453
	14.73	.580		11.53	.454
E	0.40	1/64	R	6.35	1/4
F	c	c	S	0.80	1/32
G	1.52	.06	T	2.80	(No. 35) [b]
H	5.0	(No.9) [b]	U	2.50	(No. 40) [b]
J	18.3	23/32	V	16.0	5/8
K	3.97	5/32	W	1.52	0.06
L	6.35	1/4			
M	2.38	3/32			

[a] Nylon Rain-Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional - To serve as a wrench grip.

RT100F

24.4 The average rate of simulated rainfall in inches per hour over an area 12 inches (305 mm) in diameter with the water pressure at 5 psig (34.5 kPa) is to be determined as follows. A 12 inch (305 mm) diameter cylindrical container, open at one end and approximately 20 inches (508 mm) deep, is to be used to collect the rainfall for 30 minutes. The center of the open end of the container is to be located at the same position as the center of the upper surface or plane of the cap, termination or roof assembly to be tested. The depth of rainfall collected in 30 minutes is to be multiplied by two to determine the rainfall per hour.

24.5 For the rain test of an assembly, arrangements are to be made for collecting, in separate containers, any water entering:

a) The vent gas conduit, and

b) Any ventilation air passageway of a given configuration.

The rain test is to cover a period of 1 hour.

24.6 The maximum amount of water collected in either the vent gas conduit or in any ventilation air passageway shall not exceed the value obtained by application of the formula:

$$Q \leq 0.02 \times R \times A$$

where:

Q = Volume of water actually collected, cubic inches per hour (mm^3/hour);

R = Rainfall, inches (mm) per hour; and

A = Area of conduit or passageway, square inches (mm^2).

25 Freezing and Thawing Test for Water-Absorptive Nonmetallic (Cementitious) Materials

25.1 Parts of nonmetallic (cementitious) materials that absorb water shall not show disintegration, cracking, spalling, or loss of weight of more than 5 percent of the initial dry weight after being subjected to the freezing and thawing treatment described in 25.2 – 25.6.

25.2 The samples of each material to be tested are to be free of observable cracks, and may contain laminations and fissures only to the extent that they are representative of the material from which the samples are taken.

25.3 The samples are to be dried to constant weight in a ventilated oven at a temperature of 108 ±3°C (226 ±5.4°F). The samples then are to be submerged for 24 hours in water at a temperature of 21 ±3°C (69.8 ±5.4°F). The water then is to be heated to boiling temperature, maintained at this temperature for 5 hours, and then allowed to cool to a temperature of 21 ±3°C. Each sample then is to be removed from the water, wiped dry with a cloth, and weighed immediately. The average water absorption by weight is to be calculated and recorded.

25.4 Representative samples of complete parts are to be selected to be free of observable cracks or shattered edges. The samples may contain laminations and fissures only to the extent that they are representative of the material from which the samples are taken.

25.5 The samples are to be dried to constant weight in a ventilated oven at a temperature of 108 ±3°C (226 ±5.4°F), and the weights recorded. The dried samples are to be immersed for 72 hours in water at a temperature of 21 ±3°C (69.8 ±5.4°F), removed from the water, and allowed to drain for 1 minute. The

superficial moisture is to be removed with a towel or blotting paper and the samples immediately subjected to ten conditioning cycles as specified in 25.6.

25.6 Each conditioning cycle is to consist of exposure to a temperature of minus 18°C (0°F) for 16 hours, followed by exposure to a temperature of 110°C (230°F) for 7 hours, and then followed by immersion in water for 1 hour. After each conditioning cycle the samples are to be drained and dried as specified in 25.5. These cycles are to be continued for 240 hours (exclusive of the drying time specified after each cycle), except that once during the test the samples are to remain at the temperature of minus 18°C for 64 consecutive hours. At the end of the test period, the samples are to be dried to constant weight as specified in 25.5, and the weight recorded.

26 Cemented Joint Test for Metallic Vent Gas Conduit

26.1 There shall be no evidence of softening or leaching of the cement used for joining sections of vent gas conduit following the tests described in 26.2 and 26.3.

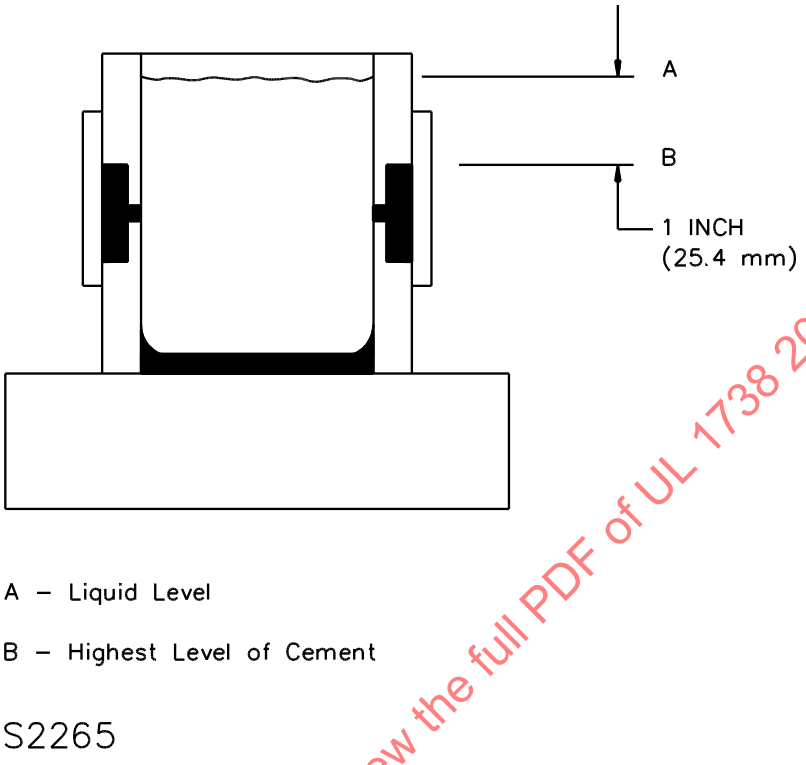
Exception: The requirement concerning softening or leaching does not apply to solvent welding materials which are used as a secondary means of securing vent joints together.

26.2 Four samples are to be prepared of each style of joint used between two sections of the vent gas conduit. The length of the test assembly need be no longer than required to include the complete joint. The joints are to be cemented and assembled as described in the installation instructions, and the cement is to be allowed to cure for at least the minimum time specified in the installation instructions.

26.3 The samples are to be dried to constant weight. Each sample then is to be placed in an ambient temperature between 21 and 32°C (70 and 90°F), and mounted with the axis of the assembly in a vertical position. The bottom of the assembly is to be sealed to retain liquid, and the assembly is to be filled with a solution of deionized water containing 100.0 ppm Cl^{1}, 15.0 ppm SO_4^{-2}, 30.0 ppm NO_3^{-1}, 5.0 ppm NO_2^{-1}, with a pH of 2.5 to a level 1 inch (25.4 mm) above any cemented portion of the joint. The solution is to be maintained at that level for 72 hours. See Figure 26.1.

Figure 26.1

Test of cemented joints



27 Condensate Exposure Test for Porcelain-Coated Steel Used for Vent Gas Conduit

27.1 The loss in weight of porcelain coated steel used for vent gas conduit shall be not greater than 0.30 percent following the tests described in 27.2 – 27.4.

27.2 Two samples are to be tested, each approximately 2 by 2 inches (50 by 50 mm) in face area. If seams are incorporated in the product, each sample is to include the conduit seam. The samples are to be weighed and the thickness of the base metal determined. The sample weights are to be adjusted to a base metal thickness of 0.026 inch (0.66 mm). The edges of the samples are to be coated with wax.

27.3 The samples are to be suspended completely immersed for 44 hours in a solution of deionized water containing 100.0 ppm Cl^{-1}, 15.0 ppm SO_4^{-2}, 30.0 ppm NO_3^{-1}, 5.0 ppm NO_2^{-1}, with a pH of 2.5. The solution temperature is to be between 21 and 32°C (70 and 90°F). After removal from the solution, the samples are to be cleaned, dried, and weighed; and the loss of weight is to be calculated and recorded as a percent of the original adjusted dry weight.

27.4 If the steel is coated with a ceramic material the solution specified in 27.3 shall also contain 4.0 ppm F^{-1}.

28 Vent Sag Test for Horizontal Installations

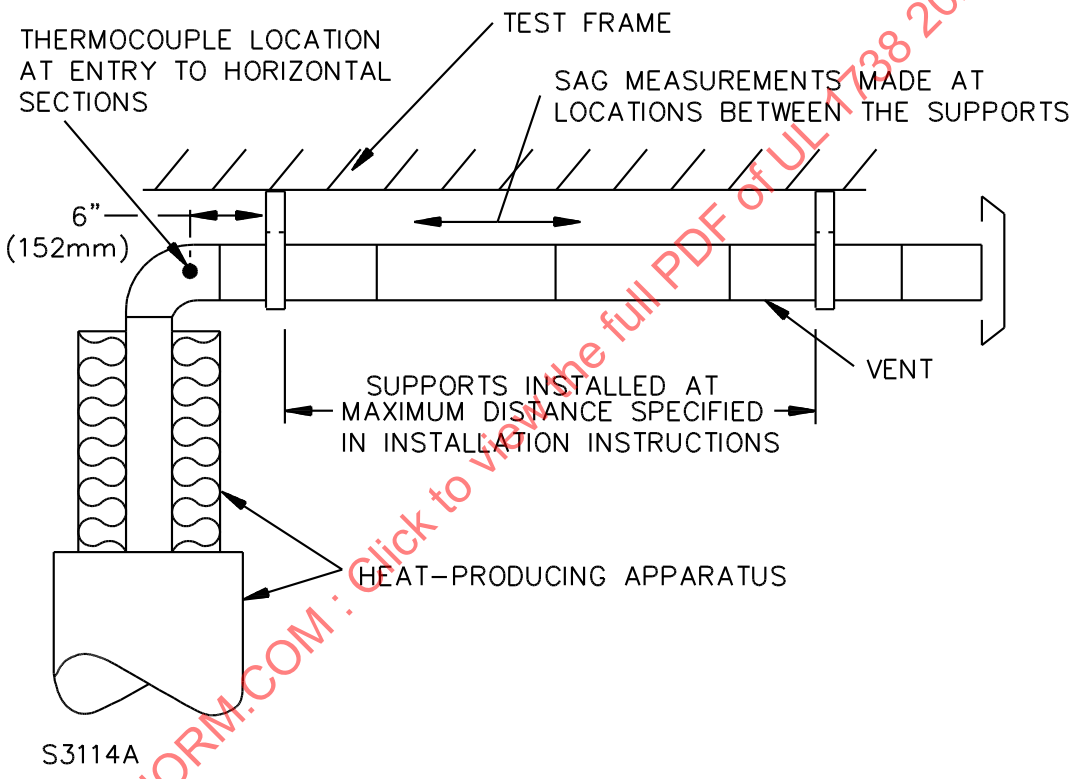
28.1 A venting system, or portion of a venting system, intended for horizontal installation shall not sag more than 6.25 percent of the diameter of the venting system at any location between supports when tested as described in 28.2 – 28.4. Additionally, materials used to support sections shall not cause wear or abrasion to the venting system, as determined by visual observation, when tested as described in 28.2 – 28.4.

28.2 The horizontal portion of the venting system, assembled in accordance with the installation instructions, is to be installed in a test frame that simulates typical residential construction. Manufacturer specified supports are to be installed at the maximum distance specified in the installation instructions. Unless otherwise prohibited in the installation instructions, the test installation shall include a joint located halfway between the supports. See Figure 28.1.

28.3 The heat producing assembly used in the Temperature Test – Structure, Section 19, is to be used to provide heated air or vent gases into the venting system to maintain the temperature at the thermocouple location specified in Figure 28.1 at 70°F (38.9°C) above the rated temperature.

Figure 28.1

Vent sag test assembly



28.4 The test is to be conducted for 3 hours or until equilibrium conditions are attained, whichever occurs last. Equilibrium temperatures are considered to be attained when the venting system shows no measurable sag during any 45 minute period.

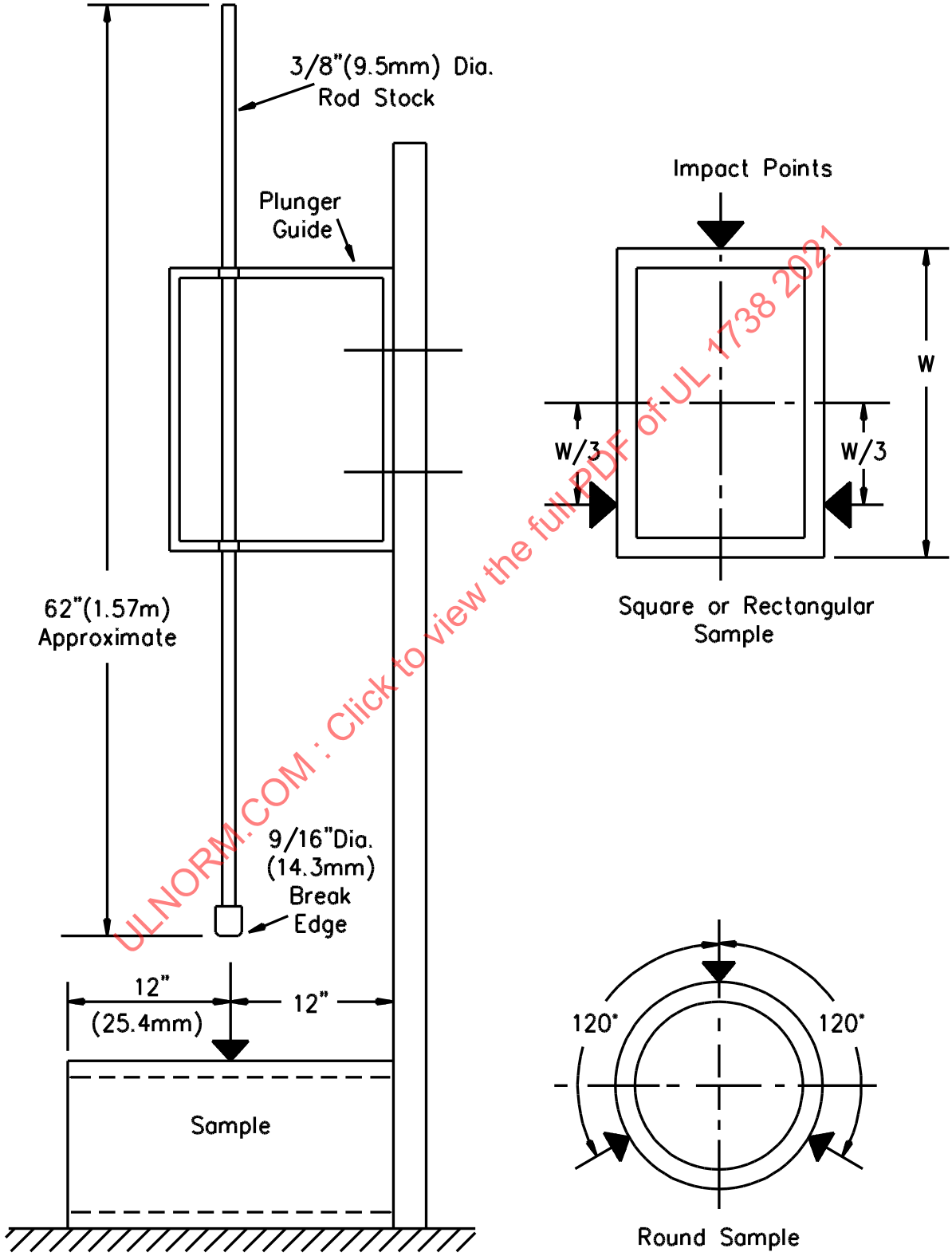
29 Puncture Test

29.1 A venting system shall not be punctured when tested as described in 29.2 – 29.6.

29.2 Test apparatus providing for a free fall of a plunger onto the surface of the sample is to be used for this test. The apparatus is to be as illustrated in Figure 29.1.

Figure 29.1

Puncture test



29.3 The plunger is to consist of a 3/8 inch (9.52 mm) diameter steel rod having a steel head, 9/16 inch (14.2 mm) diameter, attached to the impact end. The length of the plunger assembly is to be sufficient to provide a 2 pound (0.90 kg) weight. The surfaces of the rod and head are to be smooth. The impact end of the rod is to be formed as shown in Figure 29.1.

29.4 Guides arranged to allow for an essentially frictionless fall of the plunger and means for measuring the height of fall are to be provided.

29.5 Pieces 2 feet (0.6 m) long taken from vent sections previously subjected to the Vent Sag Test for Horizontal Installations, Section 28, and identical samples prepared from untested product, are to be subjected to this test. The samples are to be provided with a firm support below and throughout their length and width. At least three areas of each sample are to receive the impact of the plunger at the impact points shown in Figure 29.1.

29.6 The samples shall prevent the complete penetration of the plunger head through the vent gas conduit wall of the sample when the plunger falls through a distance of 20 inches (508 mm) as measured to the top surface of the sample.

30 Bending Test

30.1 Sections of flexible vent shall not be damaged when bent through a 180 degree arc over a mandrel having a diameter equal to the inside diameter of the venting system.

30.2 Observations are to be made during and following the test as specified in 30.3 – 30.6. The sample shall not rupture, break, tear, rip, or separate; any reduction in internal cross-sectional area shall not exceed 5 percent at any time during the test; any joining material shall remain intact; and there shall be no evidence of other damage to the sample that would cause it to be unacceptable for further use.

30.3 Previously untested 8 foot (2.44 m) long samples are to be used. If sections are of uniform grade, thickness, and cross section, such as square or round, the samples are to be selected from the largest and the smallest sizes. Square or round sections, varying in grade and thickness with size, may also require samples in the intermediate size range. Rectangular sections are to be selected on the basis of grade, thickness, and size, as well as the largest ratio of width to depth produced by the manufacturer. Consideration is to be given to selecting sample shapes which will be the most vulnerable to damage under the conditions of test.

30.4 Sections of venting systems are to be assembled to provide for a circumferential joint at the center of the sample. In assembling a sample, the material is to be extended to its full length. If the joint is reinforced to the extent that the section may be less vulnerable to being damaged than a section without the joint, additional samples of sections without the joint are to be tested; except that if the longest section obtainable from the material under test is less than 8 feet (2.44 m), additional pieces may be joined thereto to provide a sample 8 feet long, in which case the longest piece is to be in the middle of the test section. Any adhesives or cements are to be allowed to cure for at least 24 hours. Samples are not to be exposed to relative humidity greater than 70 percent for 24 hours prior to the test.

30.5 One end of the test sample is to be retained in place and the sample positioned adjacent to the test mandrel so that the center joint of the sample is not located in the area to be subjected to bending. The sample is to be bent through a 180 degree arc around the test mandrel. Steel collars, if necessary to provide vent rigidity for test purposes, are to be attached to each end of the test sample in accordance with the manufacturer's instructions.

30.6 The test is to be conducted five consecutive times. Before each test time the sample is to be extended to its full length.

31 Torsion Test

31.1 Sections of flexible vents and parts, and the joints between sections shall not be damaged when subjected to a torque of 25 foot-pounds (33.7 N·m) or a torque sufficient to produce an angular rotation of 180 degrees, whichever occurs first.

31.2 Observations are to be made during and following the application of the torque as specified in 31.3 and 31.4. The sample shall not rupture, break, tear, rip, collapse, or separate; any reduction in internal cross-sectional area shall not exceed 5 percent at any time during the test; any joining material shall remain intact to the extent that materials such as tapes do not become displaced more than a total, for both edges, of 1/8 inch (3.2 mm) from their initial position, disregarding movement due to slack or stretch that does not produce a separation of materials; and there shall be no evidence of other damage to the sample that would cause it to be unacceptable for further use.

31.3 Previously untested 8 foot (2.44 m) long samples selected in accordance with 30.3 are to be used. Sections of flexible vents are to be prepared in accordance with 28.4. One end collar then is to be secured to an overhead support so as to allow the sample to be suspended vertically. Means to apply a torque to the lower end collar are to be provided.

31.4 The test is to be conducted by first applying the test torque so as to rotate the bottom end clockwise, releasing the torque, and returning the end to its initial position; then applying the test torque to rotate the bottom end counterclockwise, releasing the torque, and returning the end to its initial position. This test series is to be conducted five times.

32 Pressure Test

32.1 Vent sections with joints, assembled in accordance with the manufacturer's instructions, shall withstand without rupture an internal air pressure of 2-1/2 times the manufacturer's rated positive pressure, but not less than 1-1/4 inch water column (311 Pa).

32.2 The air pressure in the test sample is to be maintained at the designated test pressure for 1 hour. The sample shall not rupture, as evidenced by breaks, tears, rips, or other openings greater than 1/8 inch (3.2 mm) in length; any joining material shall remain intact to the extent that materials such as tapes do not become displaced more than a total, for both edges, of 1/8 inch from their initial position, disregarding movement due to slack or stretch that does not produce a separation of materials; and there shall be no evidence of other damage that would cause the sample to become unusable.

32.3 Previously untested 8 foot (2.44 m) long samples selected in accordance with 32.3 are to be used. Vent sections are to be prepared in accordance with 30.4. Each end of the sample is to be sealed airtight by any means consistent with the use of the material under test. To permit a sample employing flexible material to be fully extended to its maximum length, the sample is to be pressurized to 0.25 inch water column (62.2 Pa). Each end of the flexible material is to be attached to a stationary fixture.

32.4 A pressure tap consisting of pipe or tubing is to be sealed into one end of the test sample and connected to a water manometer which may be read directly to 0.05 inch water column (12.4 Pa). The manometer is to be checked for zero reading at the beginning and at the end of each test.

32.5 An air supply tap consisting of pipe or tubing is to be sealed into the same or the other end of the sample and connected to a source of air pressure capable of maintaining the specified air pressure in the sample. The manufacturer's rated pressure is to be gradually attained in not less than 45 seconds nor more than 60 seconds from the initial application of the test pressure. This pressure is to be held for 1 minute. The pressure then is to be increased to 2-1/2 times the manufacturer's rated pressure, but to not less than 1-1/4 inch water column (311 Pa) in not less than 45 seconds nor more than 60 seconds.

33 Leakage Test

33.1 A venting system, assembled in accordance with the manufacturer's instructions, shall not leak when tested as specified in 33.2 – 33.5.

33.2 The samples individually subjected to the tests for loading, impact, bending, tension, and torque, as appropriate for the product under investigation, are to be subjected to this test. The arrangement for test and the instrumentation are to be as for the Pressure Test, Section 32, except the water manometer is to be accurate to 0.01 inch water column (2.5 Pa). Samples longer than 8 feet (2.44 m) are to be reduced in length to provide a test sample 8 feet long. Three joints (excluding the ends) are to be incorporated in the test assembly. The test is to be conducted in a room in which the ambient temperature does not change by more than 2°F (1°C) during the test period.

33.3 An air meter is to be placed in the air supply system between the supply source and the test sample to indicate the total volume of air supplied to the sample during the test. The meter is to be accurate within plus or minus 0.05 cubic feet (0.0046 m^3) under the conditions of the test.

33.4 The volume within the test sample is to be calculated, based upon inside measurements to the nearest 1/16 inch (1.6 mm).

33.5 An air pressure of 0.50 inch water column (124 Pa) is to be maintained in the test sample for 1 hour. The total volume of air recorded by the air meter, from the time beginning with the establishment of the test pressure in the sample to the end of the test period, is not to exceed 20 multiplied by the volume of the sample.

34 Joint Sealing Compound Test

34.1 A joint sealing compound used to seal or secure joints in a venting system shall not crack, soften, melt or show other evidence of deterioration when subjected to the temperature specified in Table 19.1 for the type of vent being tested.

34.2 Two straight sections of vent, each 3 feet (0.9 m) long and each having a 90 degree elbow at one end, are to be assembled in accordance with the installation instructions using the specified joint sealing compound. A vent for use with Category III or Category IV appliances is to be pressurized at 2-1/2 times its rated positive pressure or at 1-1/4 inch water column (311 Pa), whichever is greater. The pressure is to be achieved by capping the open end of each elbow and then providing the required pressure.

34.3 The vent assembly is then connected to a heat producing assembly as shown in Figure 17.6 or Figure 17.7. The assembly is to be heated to 70°F (38.8°C) above the rated temperature for 3 hours.

34.4 At the end of 3 hours, each joint is to be visually observed to determine compliance with the requirements in 34.1.

35 Joint Tightness Test

35.1 Venting system parts shall not separate, break apart, open up, or become damaged when subjected to a torque of 25 foot-pounds (33.9 N·m).

35.2 Observations are to be made during and following the application of the torque. The sample shall not rupture, break, tear, rip, collapse, or separate; any reduction in internal cross sectional area shall not exceed 5 percent at any time during the test; any joining material shall remain intact to the extent that materials such as tapes do not become displaced more than a total, for both edges, of 1/8 inch (3.2 mm) from their initial position, disregarding movement due to slack or stretch that does not produce a

separation of materials; and there shall be no evidence of other damage to the sample that would cause it to be unacceptable for further use.

35.3 Previously untested samples are to be tested. Tests are to be conducted on a sufficient number and sizes of venting system parts to include representative samples of each size part intended to be field joined together. Sections of the venting system are to be joined together in accordance with the installation instructions. Any adhesives or cements are to be allowed to cure for at least 24 hours. Samples are not to be exposed to relative humidity greater than 70 percent for 24 hours prior to the test.

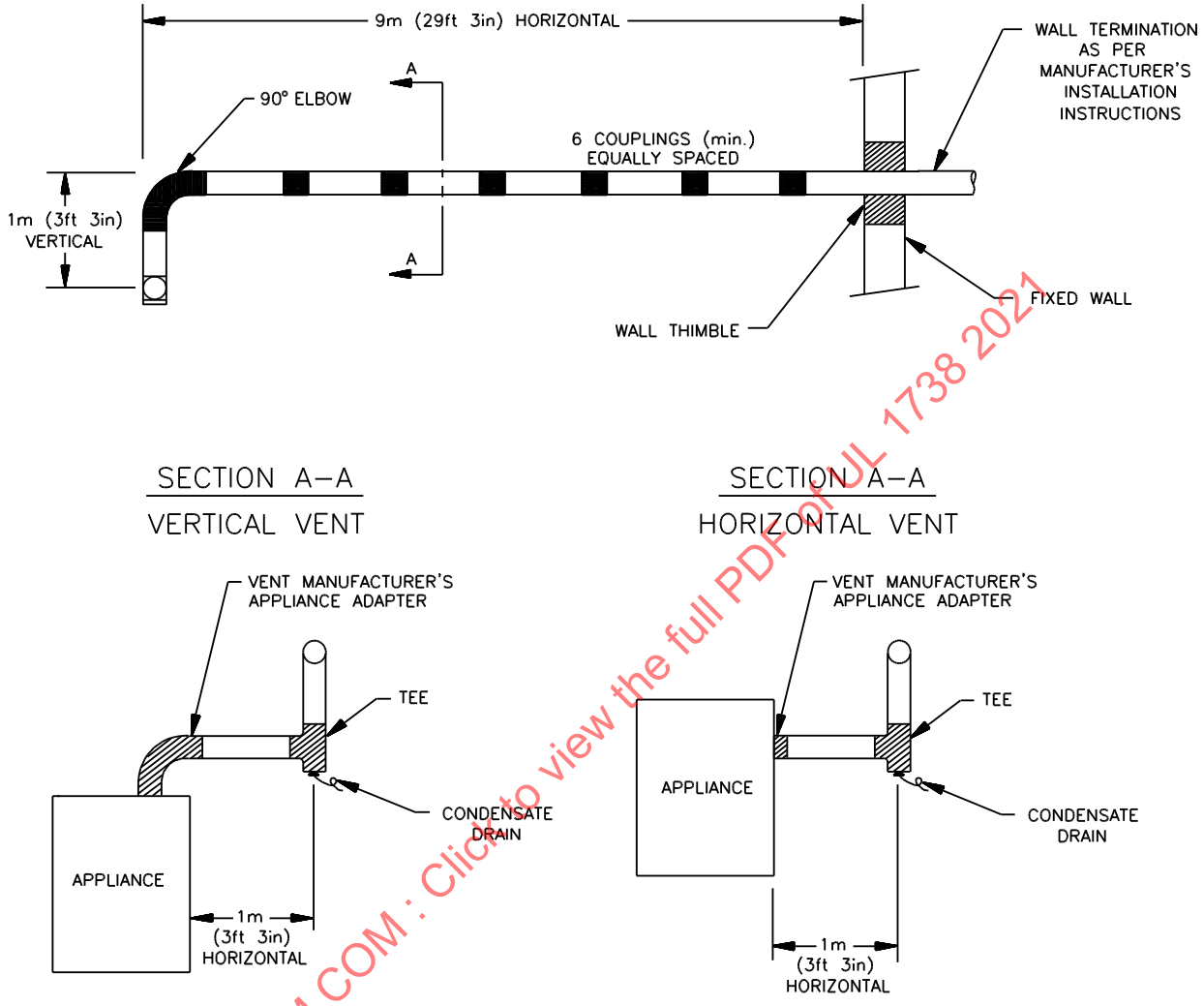
35.4 The test is to be conducted by applying the test torque to opposite ends of the assembled vent section in a clockwise direction and then in a counterclockwise direction.

36 Strength Test for Joining Non-Metallic Vent Systems

36.1 Representative sections of non-metallic vent piping employing a minimum of six straight couplings, an elbow, and a tee section, are to be assembled per manufacturer's instructions, and as shown in Figure 36.1. Supports, as recommended by the manufacturer, an appliance adapter, condensate drain, wall thimble, and a vent termination or cap shall be provided as part of the test assembly.

Figure 36.1

Strength test assembly



36.2 The appliance adapter inlet is to be connected to a flue-gas generator having a minimum carbon dioxide level of 6 percent. After the minimum pipe joint cure time has been achieved as specified in the manufacturer's installation instructions, the flue-gas generator or gas appliance is to be operated, starting from ambient temperature, to obtain a flue-gas temperature of 464 ±9°F (240 ±5°C) at the "on" cycle. The flue-gas generator is to be fired at the input specified in Table 36.1 and flue-gas temperature measurement is to be at the location designated in Figure 36.1. The flue-gas temperature is to be taken 150 mm from the appliance outlet. The flue-gas generator or gas appliance is to be operated to cycle for approximately 10 minutes "on" and 15 minutes "off" and the test shall run continuously for 12,000 cycles.

Exception No. 1: For a nominal 3-inch (75-mm) diameter vent pipe, a gas appliance rated a minimum of 40,000 Btu/hour (42,000 kJ/hour) input capacity with 81 ±2 percent steady-state efficiency (19 ±2 percent steady-state flue loss) and a minimum carbon dioxide level of 6 percent is not prohibited from being used instead of the flue gas generator.

Exception No. 2: PVC systems with solvent-weld joints and temperature ratings not exceeding 140°F (60°C) and CPVC systems with solvent-weld joints and temperature ratings not exceeding 280°F (138°C) are not required to be subjected to the heat cycling tests.

Table 36.1
Flue-gas generator inputs

Equivalent nominal diameter of test vent		Minimum input to flue-gas generator	
Inches	(mm)	Btu/Hr	Kilowatts
2	(51)	2830	0.83
3	(76)	6350	1.86
4	(102)	11300	3.31
5	(127)	17600	5.16
6	(152)	25300	7.41

36.3 Other gases recognized by NFPA 54, the National Fuel Gas Code, (other than propane) shall be tested separately.

36.4 No visual evidence of cracking, condensate leakage at the joints, or other damage which would render the non-metallic venting system unfit for its intended use, shall occur during the test or during cool down to ambient temperature prior to disassembly and testing.

36.5 Following the test of 36.1 – 36.4, the testing pipe assembly (inclusive of the appliance adapter, tee, and elbow) is to be cut into test specimens, including at least a 6-inch (152.4-mm) projection of the vent pipe from each end of each joint or fitting after the assembly has cooled.

36.6 Four coupling/straight joint test assemblies, the appliance adapter and the tee from the test assembly (Figure 36.1) are to be tested. The test assemblies are to be heated until the inside surface of the test assemblies are at the temperature obtained on the inside surface during the Temperature Test Structure Testing, Section 19, and maintained at the temperature for 15 minutes. While in the heated condition (or within 1 minute of removal from the oven), two samples of the coupling/straight joint assemblies, the appliance adapter assembly and one side of the tee test assembly are to be subjected to the Longitudinal Force Test described in 22.2.

36.7 Two coupling/straight joint test assemblies and the tee test assembly are to be cooled to a 32°F (0°C) inner and outer wall surface temperature for a minimum of 15 minutes. While in the low temperature condition (or within 1 minute of removal from the environmental chamber), one sample is to be subjected to a Longitudinal Force Test described in 22.2, and one sample is to be subjected to the Joint Tightness

Test described in Section 35. The untested side of the tee test assembly is also to be subjected to the Longitudinal Force Test.

36.8 Two coupling/straight joint test assemblies and the elbow test assembly are to be tested. The test assemblies are to be heated until the inside surface of the test assemblies are at the temperature obtained on the inside surface during the Temperature Test Structure Testing, Section 19, and maintained at that temperature for 15 minutes. While in the heated condition (or within 1 minute of removal from the oven), the test assemblies are to be subjected to the Joint Tightness Test as described in Section 35.

37 Low-Temperature Handling Test (Non-Metallic Venting Systems)

37.1 A non-metallic venting system shall not shatter, chip, crack, or otherwise be damaged when handled at low temperature as specified in 37.2.

37.2 One 30 inch (762 mm) long specimen is to be cut from sample lengths of each size of finished vent pipe. The ends of each specimen are to be smooth and perpendicular to the longitudinal axis of the vent pipe. The specimens are to be cooled in circulating air for 5 hours to a temperature of minus 20.0 ±1.0°C (minus 4.0 ±1.8°F). While still at the low temperature, each specimen is to be dropped onto a concrete floor twice in quick succession from a height of 60 inches (1.5 m). During the first drop, the specimen is to be at an angle of approximately 45 degrees with respect to the floor so that one end of it reaches the floor first. During the second drop, the specimen is to fall parallel to the floor. After the two drops each specimen is to be visually examined to determine compliance with the requirements in 37.1.

38 Water Absorption Test

38.1 When tested as specified in 38.2 and 38.3, a finished venting system shall not absorb water in excess of the following percentages of its own weight:

a) 0.50 percent if a laminated or coextruded polymer system, or

b) 1.50 percent if a mono-extruded or a single resin system.

38.2 Two specimens are to be preconditioned by drying in a full-draft circulating air oven at a temperature of 50.0 ±3.0°C (122.0 ±5.4°F) for 24 hours, after which they are to remain in still dry air at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) at a relative humidity of not greater than 50 percent for 24 hours.

38.3 Clean, dry specimens of finished vent pipe at least 150 mm (6 inches) long are to be preconditioned as indicated in 38.2, weighed (W_1) to within 5 mg of balance, and then immersed for 24 hours in distilled water that is at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F). The specimens are then to be removed from the water, dried quickly inside and out with a clean piece of soft lintless cloth, and immediately reweighed (W_2) to within 5 mg of balance. The material for the vent pipe is not acceptable if W_2/W_1 is larger than the following values.

a) 1.0050 if a laminated or coextruded polymer system, or

b) 1.0150 if a mono-extruded or a single resin system.

39 Resistance to Condensate-Exposure Corrosion Test for Metals

39.1 When tested as described in 39.2 – 39.5, metal in the minimum thickness intended for use in direct contact with vent gases shall:

a) Show no evidence of stress cracking, or pits with depths greater than 0.0004 inch (0.01 mm), and

b) Not demonstrate a corrosion rate exceeding 0.0001 inch (0.002 mm) per year.

39.2 Thirty specimens are to be tested; ten specimens of flat stock, ten specimens with welded seams, if provided, and ten specimens formed with a U-bend having a radius of 0.5 inch (12.7 mm). The flat and welded specimens are to be 1-1/2 by 2 inches (38.1 by 50.8 mm); the U-bend specimens are to be 2-1/2 by 2 inches (63.5 by 50.8 mm) with the bend in the 2-1/2 inch dimension.

39.3 The specimens are to be weighed and visually examined for pitting or stress cracking.

39.4 Each specimen is then to be suspended at an angle between 15 and 30 degrees from the vertical and exposed to 10,000 cycles of wetting and drying in an exposure chamber as described in the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117. Each cycle is to consist of 5 minutes of wetting and 15 minutes of drying. The wetting solution is to be of deionized water containing 100.0 ppm Cl^{-1}, 15.0 ppm SO_4^{-2}, 30.0 ppm NO_3^{-1}, and 5.0 ppm NO_2^{-1} with a pH of 2.5. During the exposure, the chamber temperature is to be 120°F (49°C). Heated air at 250°F (121°C) is to be used for the drying portion of each cycle.

39.5 If the metal is coated with a ceramic material, the solution specified in 39.4 shall also contain 4.0 ppm F^{-1}.

39.6 Following the exposures, the specimens are to be weighed and examined visually for pitting and stress cracking using an adequate power magnification to determine compliance with the requirements specified in 39.1.

40 Polymeric Materials – Conditioning for Physical Properties Tests

40.1 General

40.1.1 Polymeric materials used in venting systems are to be conditioned as specified in 40.2 – 40.4 for use in conducting the Polymeric Materials – Physical Properties Tests, Section 42.

40.2 Elevated temperature conditioning

40.2.1 Plaque or injection molded samples in the minimum vent pipe wall thickness manufactured, sized 7 by 7 inches (178 by 178 mm), or larger, and 30 inch (762 mm) lengths of the maximum diameter vent pipe, fittings, and joined samples are to be placed in full draft recirculating air ovens maintained at the use temperature as indicated in 19.2. As used herein, the term "full draft" refers to an oven having inlet and outlet vents open and an air vent damper control set to provide 250 to 350 air changes per hour.

40.2.2 The samples are to be supported in an oven that has been preheated at full draft. The samples are not to touch one another or the sides of the oven.

40.2.3 Plaque and injection molded samples are to be removed after 30, 60, 90, and 180 days and tested as described in 42.2 and 42.3. Plaque and injection molded samples are also to be removed after 90 and 180 days and subjected to the flammability test specified in 42.5.2. Pipe, fitting, and joined samples are to be removed after 90 and 180 days and tested as described in 42.2.1 – 42.2.4 and 42.4 and 42.4.1. Separate samples are to be used for each test.

40.3 Light and water conditioning

40.3.1 Plaque or injection molded samples in the minimum vent pipe wall thickness manufactured, sized 7 by 7 inches (178 by 178 mm) or larger, are to be conditioned using a Xenon-arc lamp apparatus in accordance with the Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices