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Underwriters Laboratories Inc.®

A not-for-profit organization dedicated to public safety
and committed to quality service

April 15, 1996

Revision pages for

Standard for

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

UL 1738, Second Edition

Attached to this transmittal notice is a revision of the Second edition of UL 1738.

A CHANGE ON A PAGE DATED APRIL 15, 1996 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT EXCEPT FOR THOSE PARAGRAPHS, SECTIONS, TABLES, AND FIGURES HAVING FUTURE EFFECTIVE DATES AS INDICATED IN THE SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM. TO RETAIN THE REQUIREMENTS IN EFFECT UNTIL THESE FUTURE EFFECTIVE DATES, DO NOT DISCARD THE PAGES REPLACED BY THOSE HAVING FUTURE EFFECTIVE DATES UNTIL THOSE DATES.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this standard unless the applicant specifically requests that the product be judged under the current requirements. However, should the applicant elect this option, it should be noted that compliance with all the requirements in this standard will be required as a condition of continued Listing, Recognition and Follow-Up Services after the effective date and understanding of this should be signified in writing.

The new and revised requirements are substantially in accordance with UL's bulletins on this subject dated February 7, 1995, April 18, 1995, and December 27, 1995. These bulletins are now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

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UL 1738

Standard for

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

First Edition – November, 1990

Second Edition

December 15, 1993

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

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FOREWORD

- A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.
- B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.
- C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.
- D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.
- E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.
- F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

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 in use when the Standard was developed, and that involves a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this Standard.

2 Units of Measurement

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

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.

3.2.1 **APPLIANCE ADAPTER** — A special gas vent fitting which joins the vent to the outlet of a fuel gas-burning appliance.

3.2.1 added April 15, 1996

3.3 **CATEGORY II APPLIANCE** — An appliance that operates with a nonpositive vent pressure and with a vent gas temperature less than 140°F (78°C) above the dewpoint temperature in accordance with the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47.

3.4 **CATEGORY III APPLIANCE** — An appliance that operates with a positive vent pressure and with a vent gas temperature of 140°F (78°C) or higher above the dewpoint temperature in accordance with the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47.

3.5 **CATEGORY IV APPLIANCE** — An appliance that operates with a positive vent pressure and with a vent gas temperature less than 140°F (78°C) above the dewpoint temperature in accordance with the Standard for Gas-Fired Central Furnaces (except Direct-Vent Central Furnaces), ANSI Z21.47.

3.6 **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.

3.7 **CONDENSING TYPE APPLIANCE** – Any Category II or IV appliance.

3.8 **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.

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

3.10 **OFFSET VENT** – A venting system that incorporates elbows.

3.11 **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.

3.12 **RADIATION SHIELD** – An integral part of a firestop-spacer or support assembly intended to limit the temperature rise of combustible construction.

3.13 **TEMPERATURE RATING** – The maximum use temperature specified by the vent manufacturer for which the venting system is intended.

3.14 **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.

3.15 **VENT GAS CONDUIT** – The part of a venting system that is directly exposed to vent gas products, and is a continuous conveyer of the gases from the appliance outlet to the outside atmosphere.

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

3.17 **VENT TERMINATION OR CAP** – The part of a venting system that terminates exterior to the building and is intended to resist the entrance of debris and rain into the vent gas conduit.

3.18 **VENTING SYSTEM** – A complete assembly, external of an appliance, comprised of all field-installed component parts necessary to convey vent gas products from an appliance to the outside atmosphere.

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

4.2 A component need not comply with a specific requirement that:

a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

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

CONSTRUCTION

5 Materials

5.1 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.

5.2 The thickness of sheet metal, including any coatings, shall not be less than as specified in Table 5.1 unless otherwise specified in these requirements. The requirements in Table 5.1 do not preclude the use of other materials that provide for equivalent rigidity, corrosion resistance, thermal properties, and gas tightness.

Table 5.1
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)

5.3 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 14 – 39.

5.4 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 5.3.

5.5 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 Table 1 of the Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, ASTM A525-86, with not less than 40 percent of the zinc on any side, based on the minimum single spot test in ASTM A525-86. The weight of zinc coating shall be established in accordance with the Standard Test Methods for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ANSI/ASTM A90-81. Aluminum coated steel shall be of Type T1-40 (regular) [0.40 ounce per square foot (0.12 kg/m²)].

5.6 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.

5.7 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 D1784-81,
- b) Class 23447-A or 23447-B CPVC as specified in ASTM D1784-81, or
- c) Material having equivalent properties.

5.8 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.

5.9 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 37, and Polymeric Materials – Physical Properties Tests, Section 38, High Acid Conditioning Test, Section 37A.

5.9 revised April 15, 1996

5.10 **Deleted April 15, 1996**

6 Assembly

6.1 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.*

6.2 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.

6.3 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.

6.4 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.

6.5 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.

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

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

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

7 Joints

7.1 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 31.

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

7.3 If cement, joining compounds, tape, screws, or the like 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 32.

Exception: Solvent welding materials need not be resistant to aging and temperatures anticipated during use of the product.

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

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

8 Firestop Spacers

8.1 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.

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

8.3 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.

8.4 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.

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

8.5 added April 15, 1996

9 Thimbles

9.1 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.

9.2 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.

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

9.3 added April 15, 1996

10 Support Assembly

10.1 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.

10.2 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 19.

10.3 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.

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

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

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

10.7 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.

10.7 added April 15, 1996

11 Radiation Shields

11.1 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.

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

11.3 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.

12 Vent Termination or Caps

12.1 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 22.

12.2 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.

13 Drain Fittings

13.1 Drain fittings, if provided, shall be permanently marked at or near the fitting as specified in 40.8. The marking shall advise the user to ascertain that the appliance is intended for use with a vent system that includes a drain fitting.

13A Appliance Adapters

13A.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.

Added 13A.1 effective October 15, 1996

13A.2 With respect to the identification of intended uses noted in 13A.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.

Added 13A.2 effective October 15, 1996

13A.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 36. See 5.3 and 5.4.

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 13A.5.

Added 13A.3 effective October 15, 1996

13A.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 be subjected to the torque test.

Added 13A.4 effective October 15, 1996

13A.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 40.9.

Added 13A.5 effective October 15, 1996

13A.6 Metals shall not be used in combinations that cause galvanic action at any location within the connection.

Added 13A.6 effective October 15, 1996

PERFORMANCE

14 General

14.1 When a venting system is tested in accordance with these requirements, specified temperatures on combustible construction shall be maintained as specified in Section 17, Temperature Test – Structure.

14.2 After being subjected to the tests specified in Sections 17 – 39, as applicable, a venting system shall be acceptable for intended use.

14.3 With regard to the requirements of 14.2, 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, crept, or moved in relation to other components.
- h) Sealing materials or tape at joints shall not be deteriorated.

14.4 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.

14.5 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.

15 Test Installations

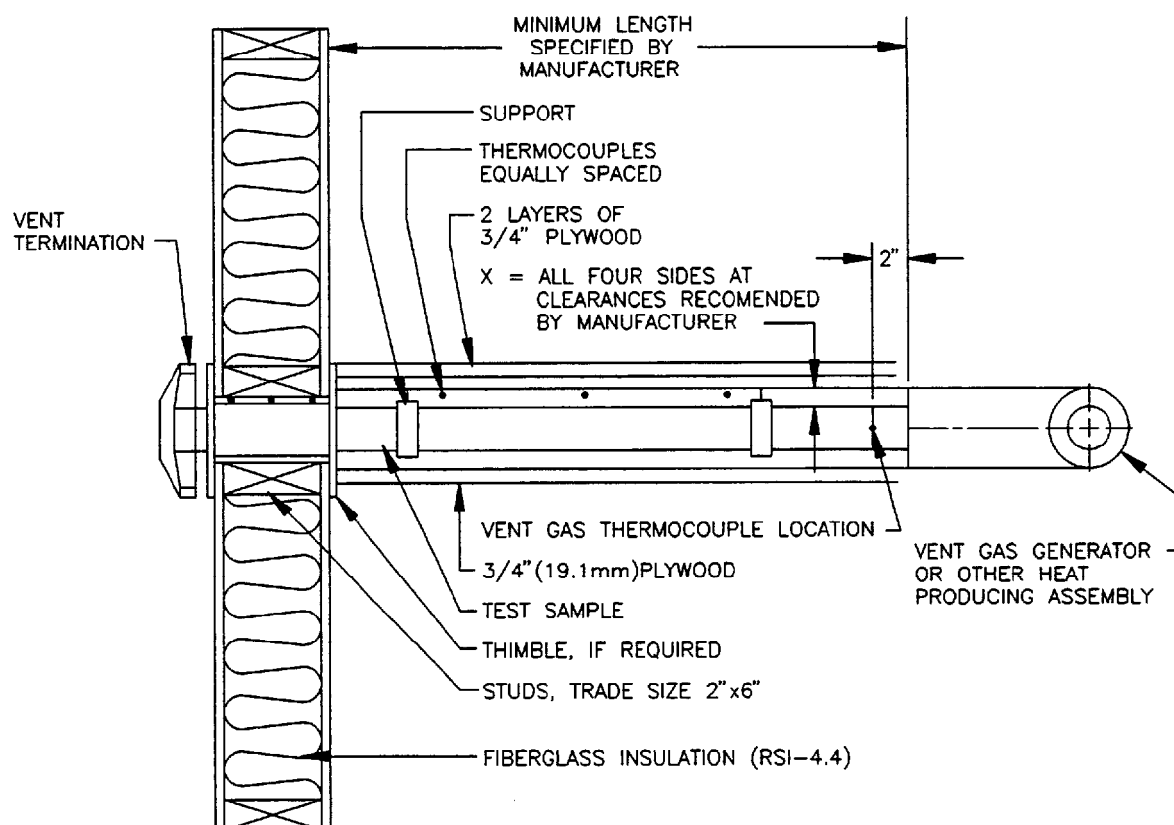
15.1 The test installation for a venting system is to be based on the following factors:

- 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.

15.2 The general form for a test structure for a venting system installed vertically is illustrated in Figure 15.1. Test structure details for various venting system features and designs are illustrated in Figures 15.1 – 15.4.

Figure 15.1
Typical test structure – direct vent horizontal



S3392

Figure 15.1 revised April 15, 1996

Figure 15.2
Typical test structure – vertical installation
installation

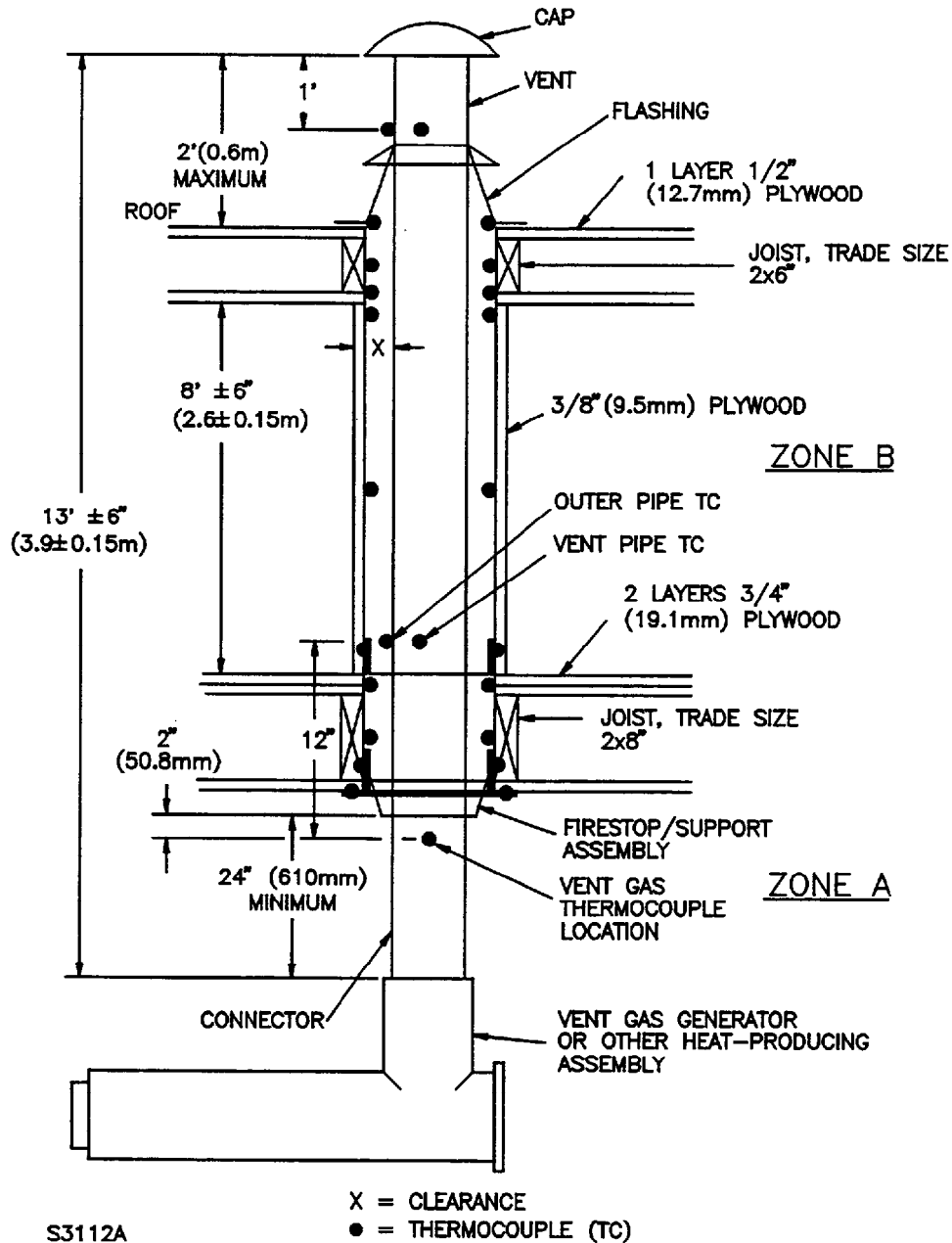


Figure 15.2 revised April 15, 1996

22.4 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.

22.5 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.

22.6 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 (mm³/hour);

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

A = Area of conduit or passageway, square inches (mm²).

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

23.1 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 23.2 – 23.6.

23.2 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.

23.3 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.

23.4 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.

23.5 The samples are to be dried to constant weight in a ventilated oven at a temperature of $108 \pm 3^\circ\text{C}$ ($226 \pm 5.4^\circ\text{F}$), and the weights recorded. The dried samples are to be immersed for 72 hours in water at a temperature of $21 \pm 3^\circ\text{C}$ ($69.8 \pm 5.4^\circ\text{F}$), 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 23.6.

23.6 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 23.5. 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 23.5, and the weight recorded.

24 Cemented Joint Test for Metal IC Vent Gas Conduit

24.1 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 24.2 and 24.3.

Exception: The requirement concerning softening or leaching does not apply to solvent welding materials.

24.1 revised April 15, 1996

24.2 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.

24.3 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^- , 15.0 ppm SO_4^{2-} , 30.0 ppm NO_3^- , 5.0 ppm NO_2^- , 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 24.1.

33A Strength Test for Joining Non-Metallic Vent Systems

33A.1 Representative sections of 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 33A.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.

Added 33A.1 effective October 15, 1996

33A.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 $464 \pm 9^\circ\text{F}$ ($240 \pm 5^\circ\text{C}$) at the "on" cycle. The flue-gas generator is to be fired at the input specified in Table 33A.1 and flue-gas temperature measurement is to be at the location designated in Figure 33A.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: 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.

Added 33A.2 effective October 15, 1996

Table 33A.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

Added Table 33A.1 effective October 15, 1996

33A.3 Other gases recognized by NFPA 54, the National Fuel Gas Code, (other than propane) shall be tested separately.

Added 33A.3 effective October 15, 1996

33A.4 No visual evidence of cracking, condensate leakage at the joints, or other damage which would render the venting system unfit for its intended use, shall occur during the test or during cool down to ambient temperature prior to disassembly and testing.

Added 33A.4 effective October 15, 1996

33A.5 Following the test of 33A.1 – 33A.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.

Added 33A.5 effective October 15, 1996F

33A.6 Four coupling/straight joint test assemblies, the appliance adapter and the tee from the test assembly (Figure 33A.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 17, 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 20.2.

Added 33A.6 effective October 15, 1996

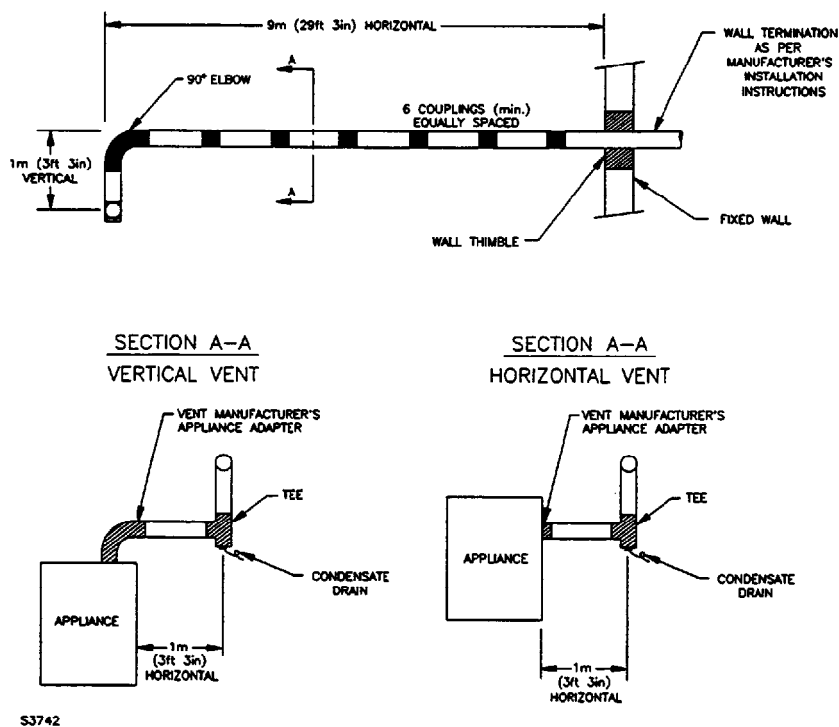
33A.7 (R) Two coupling/straight joint test assemblies and the tee test assembly are to be cooled to a 32°F (0°C) inner and outer wall surface temperature for a minimum of 15 minutes. While in the low temperature condition (or within 1 minute of removal from the environmental chamber), one sample is to be subjected to a Longitudinal Force Test described in 20.2, and one sample is to be subjected to the Joint Tightness Test described in Section 33. The untested side of the tee test assembly is also to be subjected to the Longitudinal Force Test.

Added 33A.7 effective October 15, 1996

33A.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 17, 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 33.

Added 33A.8 effective October 15, 1996

Figure 33A.1
Strength test assembly



Added Figure 33A.1 effective October 15, 1996

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

34.1 A venting system shall not shatter, chip, crack, or otherwise be damaged when handled at low temperature as specified in 34.2.

34.1 revised April 15, 1996

34.2 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 $-20.0 \pm 1.0^{\circ}\text{C}$ ($-4.0 \pm 1.8^{\circ}\text{F}$). 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 34.1.

35 Water Absorption Test

35.1 When tested as specified in 35.2 and 35.3, 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.

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

35.3 Clean, dry specimens of finished vent pipe at least 150 mm (6 inches) long are to be preconditioned as indicated in 35.2, weighed (W_1) to within 5 mg of balance, and then immersed for 24 hours in distilled water that is at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). 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.

36 Resistance to Condensate-Exposure Corrosion Test for Metals

36.1 When tested as described in 36.2 – 36.5, 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.

36.2 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.

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

36.4 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 Method of Salt Spray (Fog) Testing, ASTM B117-85. 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^- , 15.0 ppm SO_4^{2-} , 30.0 ppm NO_3^- , and 5.0 ppm NO_2^- 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.

36.5 If the metal is coated with a ceramic material, the solution specified in 36.4 shall also contain 4.0 ppm F^- .

36.6 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 36.1.

37 Polymeric Materials – Conditioning for Physical Properties Tests

37.1 General

37.1.1 Polymeric materials used in venting systems are to be conditioned as specified in 37.2 – 37.4 for use in conducting the Polymeric Materials – Physical Properties Tests, Section 38.

37.2 Elevated temperature conditioning

37.2.1 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 17.2. 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.

37.2.2 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.

37.2.3 Plaque and injection molded samples are to be removed after 30, 60, 90, and 180 days and tested as described in 38.2 and 38.3. Plaque and injection molded samples are also to be removed after 90 and 180 days and subjected to the flammability test specified in 38.5.2. Pipe, fitting, and joined samples are to be removed after 90 and 180 days and tested as described in 38.2.1 – 38.2.4 and 38.4 and 38.4.1. Separate samples are to be used for each test.

37.3 Light and water conditioning

37.3.1 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 in accordance with Method 1, using a Type D or DH apparatus, as specified in the Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials, ASTM G23-81.

37.3.2 The samples are to be supported vertically on the inside of a drum revolving at one revolution per minute. The exposure cycle is to consist of 102 minutes of light followed by 18 minutes of light and water spray.

37.3.3 Plaque and injection molded samples are to be removed after 360 hours and tested as described in 38.2, 38.3 and 38.5.2. Separate samples are to be used for each test.

37.4 Condensate conditioning

37.4.1 Test specimens of the material in the minimum vent pipe wall or fitting thickness manufactured, are to be immersed in the solutions specified in 37.4.2 at a solution temperature of $185 \pm 9^\circ\text{F}$ ($85 \pm 5^\circ\text{C}$). Additionally, pipe samples in the maximum vent diameter manufactured, 3 inches (76 mm) minimum, are to be similarly immersed.

37.4.1 revised April 15, 1996

37.4.1.1 For each test at each duration specified in Table 37.1, three specimens are to be used. Individual specimens or a sufficient number of plaques to allow for preparation of needed specimens shall be employed.

37.4.1.1 added April 15, 1996

Table 37.1
Test specimens and conditions

Test	Test specimens and conditions		
	Test specimens		Pipe samples 30, 60, 90 and 180 days
	30 and 60 days	90 and 180 days	
Tensile strength (38.2)	X ^a	X ^a	X ^a
Impact (38.3)	X	X	
Pipe deflection (38.4)			X
Flammability (38.5)		X	
^a Tensile strength tests are able to be conducted on individual test specimens or specimens cut from pipe samples.			

Added Table 37.1 effective October 15, 1996

37.4.2 The solution is to be deionized water containing 100.0 ppm HCl, 550 ppm H₂SO₄, 850 ppm HNO₃ with a pH of 1.8 ± 0.2 .

Revised 37.4.2 effective October 15, 1996

37.4.3 Test specimens and pipe samples are to be removed from the solution after 30, 60, 90, and 180 days.

Revised 37.4.3 effective October 15, 1996

37A High Acid Conditioning Test

37A.1 Three nominal 1-inch (25.4-mm) long rings are to be cut from straight vent pipe using a sharp hack saw with a minimum of 24 teeth per inch (1 tooth per mm) blade. Each ring is then to be cut once longitudinally. The ends of the longitudinal edges are to be spread a sufficient amount to create an internal stress of 3000 ± 150 psi using the following formula:

$$\text{Stress} = 0.2338 \left(\frac{E \cdot T \cdot \Delta X}{r^2} \right)^{0.90} (\text{psi})$$

in which:

ΔX = end deflection with the edge free to rotate,

E = tensile modulus of the plastic (lb/in^2) ($350,000 \leq E \leq 420,000$),

T = pipe thickness (in) ($0.05 \leq T \leq 0.10$), and

r = nominal (unstressed) pipe radius (in) ($1.25 \leq r \leq 2.25$).

The rings are then to be immersed in a solution of 15 percent H_2SO_4 and conditioned at a temperature of $185 \pm 9^\circ\text{F}$ ($85 \pm 5^\circ\text{C}$) for 30 days. Upon completion of the above conditioning there shall be no evidence of cracking or breaking of the rings.

Added 37A.1 effective October 15, 1996

38 Polymeric Materials – Physical Properties Tests**38.1 General**

38.1.1 Polymeric materials used in venting systems, conditioned as specified in Polymeric Materials – Conditioning for Physical Properties Tests, Section 37, are to be used for this test.

38.2 Tensile strength

38.2.1 Polymeric material shall retain at least 70 percent of its original tensile breaking strength after being subjected to each of the elevated temperature conditioning periods specified in 37.2.

38.2.2 Polymeric material shall retain at least 70 percent of its original tensile breaking strength after being subjected to the light and water conditioning specified in 37.3.

38.2.3 Polymeric material shall retain at least 50 percent of its original tensile breaking strength after being subjected to the condensate conditioning specified in 37.4.

Exception: After condensate conditioning, the polymeric material may retain less than 50 percent of its original tensile breaking strength, but not less than 25 percent, if:

- a) The final tensile breaking strength of specimens conditioned for 180 days is no less than 80 percent of the tensile breaking strength of specimens conditioned for 90 days;*
- b) Conditioned samples of the pipe subjected to the longitudinal force test, sub-section 20.2, withstand a longitudinal force of 150 lb (667 N) longitudinal force for 5 minutes without damage; and*
- c) Samples of the pipe withstand a torque of 50 foot-pounds (68 N·m) for 5 minutes without damage.*

Revised 38.2.3 effective October 15, 1996

38.2.4 Original tensile strength tests are to be conducted on injection molded specimens or specimens cut from plaques or pipe samples in accordance with the Standard Test Method for Tensile Properties of Plastics, ASTM D638-84. Type I specimens are to be used.

38.2.4 revised April 15, 1996

38.3 Impact

38.3.1 Polymeric material shall retain at least 70 percent of its original impact resistance after being subjected to each of the elevated temperature conditionings specified in 37.2.

38.3.2 Polymeric material shall retain at least 70 percent of its original impact resistance after being subjected to the light and water conditioning specified in 37.3.

38.3.3 Polymeric material shall retain at least 50 percent of its original impact resistance after being subjected to the condensate conditioning specified in 37.4.

38.3.4 Impact resistance is to be determined either in accordance with Method G, geometry GB, as specified in the Standard Test Methods for Impact Resistance of Flat Rigid Plastic Specimens by Means of a Tup (Falling Weight), ASTM D3029-93, or in accordance with the Standard Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials, ASTM D1822-93.

Revised 38.3.4 effective October 15, 1996

38.4 Pipe deflection (crush) resistance and stiffness

38.4.1 Polymeric material shall retain at least 70 percent of its original pipe deflection (crush) resistance and stiffness after being subjected to each of the elevated temperature conditioning periods specified in 37.2.

38.4.2 Polymeric material shall retain at least 50 percent of its original pipe deflection (crush) resistance and stiffness after being subjected to the conditioning specified in 37.4.

38.4.3 Original pipe deflection (crush) resistance and stiffness testing is to be conducted on specimens cut from pipe samples and determined in accordance with the Test Method for External Loading Properties of Plastic Pipe by Parallel-Plate Loading, ASTM D2412-87. Specimens 6 inches (152 mm) long are to be used.

38.5 Flammability

38.5.1 Polymeric materials for use in venting systems rated for use at 140°F (60°C) or less shall comply with the requirements for a Class 94V-0 material, as specified in the Standard for Tests for Flammability of Plastic Material for Parts in Devices and Appliances, UL 94.

38.5.2 Polymeric material for use in venting systems rated for use at greater than 140°F (60°C) shall comply with the requirements for Class 94-5VA or Class 94-5VB material as specified in UL 94.

39 Deflection Temperature of Polymeric Materials Under Load Test

39.1 The deflection temperature of polymeric materials used in a venting system shall be at least 10°C (18°F) higher than the use temperature as indicated in 17.2 but not less than 70°C (158°F) when tested as described in the Standard Test Method for Deflection Temperature of Plastics Under Flexural Load, ASTM D648-86. The polymeric material is to be tested at fiber stresses of 455 and 1820 kPa (66 and 264 psi).

39A Internal Stress Test

39A.1 The average calculated internal residual stress for a straight section of polymeric pipe used in a venting system, shall be less than 300 psi and shall be a positive (+) number.

Added 39A.1 effective October 15, 1996

39A.2 In determining the internal stress levels, five ring samples as described in 39A.3 are to be randomly selected from different areas of a pipe sample from each of two different production runs. No individual sample is to exceed 600 psi nor be less than 0 psi and the average of all then is not to exceed 300 psi.

Added 39A.2 effective October 15, 1996

39A.3 Each test sample shall be nominally a 1-inch (25.4-mm) long ring cut from a straight vent pipe using a sharp hack saw with a minimum of 24 teeth per inch (1 tooth per mm) blade. A ring is to be cut from the end of a pipe section. The ring itself is then to be cut once longitudinally. If there is a residual stress from the extrusion operation, the ends of the cut ring will overlap or spread apart. The amount of the overlap or spread can be used to calculate residual stress on the inside of the pipe by the following formula:

$$\text{Stress} = 0.2338 \left(\frac{E \cdot T \cdot \Delta X}{r^2} \right)^{0.90} (\text{psi})$$

In which:

ΔX = end deflection with edge free to rotate (including saw blade thickness),

E = tensile modulus of the plastic (lb/in²) (350,000 ≤ E ≤ 420,000),

T = pipe thickness (inch) (0.05 ≤ T ≤ 0.10), and

r = nominal pipe radius before cutting (inch) (1.25 ≤ r ≤ 2.25)

Added 39A.3 effective October 15, 1996

MARKING

40 General

40.1 Each individual assembly or part, such as a vent pipe section, a vent pipe fitting, cap, support, or roof jack, shall be permanently marked with the manufacturer's or private labeler's name or identifying symbol, temperature rating, and appliance category. In addition, a specific catalog designation shall be permanently marked on each pipe section, connector, ceiling plate spacer, firestop spacer, baseplate, and separate roof flashing and storm collar, if provided.

40.1.1 The exterior surface of each straight vent pipe section of 10 feet (3.05 m) or less in length shall be permanently marked in minimum 1/4-inch (6.4-mm) high white letters on an orange background with the word "WARNING" and the safety alert symbol located next to the wording as shown below. Pipe sections longer than 10 feet (3.05 m) shall be marked at least once per each 10 feet (3.05 m) of length.



WARNING

The following statement shall also be included on the same marking label or stamping in letters at least 1/8 inch (3.2 mm) high: "Risk of Carbon Monoxide (CO) Poisoning and Risk of Fire If Improperly Installed. Follow All Cautions, Warnings, and Instructions, Regarding Installation of Vent Pipe System."

Added 40.1.1 effective October 15, 1996

40.2 The exterior surface of each vent pipe section shall be permanently marked with the statement "MINIMUM CLEARANCE - _____ INCH AIR SPACE TO COMBUSTIBLE MATERIALS AND BUILDING INSULATION," or equivalent. In the blank is to be entered the manufacturer's specified minimum clearance.

40.3 Each vent pipe section shall be permanently marked with an arrow, with the word "up," "out," "flow," or equivalent next to an arrow pointing in the direction of the intended flow.

Exception: This marking need not be provided if the orientation of the venting system does not affect the flow of the vent gases.

40.4 If a manufacturer produces vent parts at more than one factory, each individual part shall have a distinctive permanent marking to identify it as the product of a particular factory.

40.5 Each material furnished separately for use in fabrication of a venting system, such as tape, cement, adhesive, and the like shall be marked with sufficient identification (such as name and catalog designation of the venting system) to associate it with the marking on the venting system and the manufacturer's or vendor's installation instructions.

Exception: The marking need not be provided on the material if a marking specifying the use of the required material is provided on the venting system.

40.6 All required markings shall be grouped and, for vent pipe sections, located at intervals not exceeding once every 10 feet (3.0 m).

40.7 The exterior surface of each venting system section shall be marked with its date of manufacture (at least by quarter and year) which may be in an established or otherwise traceable code.