

1990

Mor-Flo Industries, Inc. and Polaris Water Heaters/ Arlington Place v. Industrial Commission of Utah : Amicus Brief

Utah Court of Appeals

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Recommended Citation

Legal Brief, *Mor-Flo Industries, Inc. v. Industrial Commission of Utah*, No. 900510 (Utah Court of Appeals, 1990).
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UTAH COURT OF APPEALS
BRIEF

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DOCKET NO.

900510-CA

IN THE UTAH COURT OF APPEALS

MOR-FLO INDUSTRIES, INC. and
POLARIS WATER HEATERS/ARLINGTON
PLACE

Petitioners,

v.

INDUSTRIAL COMMISSION OF UTAH,

Respondent.

: Appellate Court No.
: 900510-CA
:
:
: APPEAL FROM ORDER OF
: INDUSTRIAL COMMISSION
: OF UTAH AFFIRMING
: DECISION OF JUDGE
: JANET L. MOFFITT
:
: PRIORITY NO. 7

BRIEF OF STATE INDUSTRIES, INC., AMICUS CURIAE

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FILED

FEB 14 1991

FILED

APR 15 1991

IN THE UTAH COURT OF APPEALS

Mary T. Noonan

Mary T. Noonan
Justice of the Court
Utah Court of Appeals

MOR-FLO INDUSTRIES, INC. and
POLARIS WATER HEATERS/ARLINGTON
PLACE

Petitioners,

v.

INDUSTRIAL COMMISSION OF UTAH,

Respondent.

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ORDER

Appellate Court No.
900510-CA

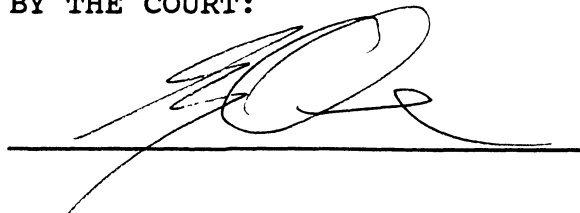
Based upon the motion of First Co., Inc. and the Gas
Appliance Manufacturers Association, it is hereby ORDERED:

1) This Court's Order of February 13, 1991 is amended to
grant permission to First Co., Inc. and the Gas Appliance
Manufacturers Association to file joinders in the amicus curiae
brief of State Industries, Inc.

2) This Court's Order of February 13, 1991 is amended to
grant the motions for admission pro hac vice of counsel for First
Co., Inc. and the Gas Appliance Manufacturers Association.

DATED this 12th day of April, 1991.

BY THE COURT:



IN THE UTAH COURT OF APPEALS

MOR-FLO INDUSTRIES, INC. and	:	Appellate Court No.
POLARIS WATER HEATERS/ARLINGTON	:	900510-CA
PLACE	:	
	:	
Petitioners,	:	APPEAL FROM ORDER OF
	:	INDUSTRIAL COMMISSION
v.	:	OF UTAH AFFIRMING
	:	DECISION OF JUDGE
INDUSTRIAL COMMISSION OF UTAH,	:	JANET L. MOFFITT
	:	
Respondent.	:	PRIORITY NO. 7

BRIEF OF STATE INDUSTRIES, INC., AMICUS CURIAE

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AMICUS CURIAE PARTIES

In addition to the parties below, the following have appeared as Amicus Curiae parties in the above-captioned appeal:

State Industries, Inc.

American Gas Association

First Co., Inc.

The Gas Manufacturers Association

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I. INTRODUCTION

State Industries, Inc. ("State Industries") is the successor to a business begun in 1946. State Industries manufactures and sells water heaters for residential and commercial use. State Industries is the largest water heater manufacturer in the United States, and makes its products in Tennessee and North Carolina. Water heaters made by State Industries are sold primarily in the United States, but also exported to Canada and the United Kingdom.

State Industries manufactures a water heater called by them the "Apollo." The Apollo provides not only potable hot water, but space heat as well. Like the Polaris water heater, the use of which is challenged by the Industrial Commission, the Apollo is a "Combination System", or a water heater which uses a recirculating loop and a fan to provide space heat.

The Industrial Commission of Utah has decided that water heaters, such as the Apollo, are subject to boiler construction requirements if used to provide both potable hot water and space heat. The appeal of that decision is now before this Court. The appeal presents a case of first impression; its outcome will affect manufacturers and users of water heaters nationwide.

The law here leaves no doubt: in subjecting Combination Systems to rules governing boilers, the Industrial Commission of Utah has strayed into error. This error comes at a high cost, for its effect is to foreclose the use of Combination Systems by Utah consumers, and force, for no good reason, the use of boilers

for home heating. Unless undone by this Court, the decision of the Industrial Commission to regulate Combination Systems as though they were boilers will work pointless economic hardship.¹ We urge the Court to reverse the decision below.

II. BASIS OF APPELLATE JURISDICTION

This Court has jurisdiction over this appeal pursuant to Utah Code Ann. §§63-46b-16(1) and 78-2a-3(2)(a).

III. STATEMENT OF ISSUES PRESENTED

A. Did the Industrial Commission of Utah (the "Industrial Commission" or "Commission") err in determining that it had authority to regulate the Polaris Combination System?

B. If it otherwise had authority to regulate the Polaris Combination System, did the Industrial Commission err in determining that the Polaris Combination System, while incapable of boiling water, and otherwise meeting all the criteria of a water heater, is nonetheless a hot water heating boiler because used for space heating?

IV. STANDARD OF REVIEW

The first issue above asks whether the Industrial Commission correctly interpreted the scope of its powers.² This is a

¹In section E of the argument of this brief, we discuss in detail the economic effects of the Commission's decision.

²Because this action was instituted after January 1, 1988, its resolution is governed by the Utah Administrative Procedure Act ("UAPA"). See Utah Code Ann. §63-46b-22(1) (UAPA applies "to all agency adjudicative proceedings commenced by or before an agency on and after January 1, 1988.") Concerning the standard of review of agency action, Section 63-46b-16(4)(d) of the UAPA provides:

question of law; the applicable standard of review is that of "correction of error". Under this standard, the Commission's exercise of authority over the Polaris Combination System must be reversed if the Commission misinterpreted the law in determining that it had such authority. In applying the correction of error standard, the appellate court treats the question before it as one of law. See Bevans v. Industrial Commission of Utah, 790 P.2d 573, 576 (Utah App. 1990) (agency's interpretation of its statutorily granted powers reviewed as matter of law, with no deference given to agency's view of law).

The second issue above presumes Commission authority, and raises a "mixed question" of fact and law: (1) what is the Polaris Combination System? (fact), and (2) what Commission rules are applicable to the Polaris System, and were those rules correctly applied by the Commission? (law).

The "intermediate" standard of review applies to mixed questions. Under this standard, the Court of Appeals

The appellate court shall grant relief only if, on the basis of the agency's record, it determines that a person seeking judicial review has been substantially prejudiced by any of the following:

.

(d) the agency has erroneously interpreted or applied the law.

.

This appeal challenges both interpretation and application of law by the Industrial Commission.

will not disturb the Board's application of its factual findings to the law unless its determination exceeds the bounds of reasonableness and rationality.

Pro-Benefit Staffing, Inc. v. Board of Review of the Industrial Commission of Utah, 775 P.2d 439, 442 (Utah. App. 1989).³

V. STATEMENT OF THE CASE

This case presents the question of whether the Industrial Commission of Utah has authority to regulate water heaters when used to heat space, and, if so, whether the Commission correctly determined that such water heaters are "hot water heating boilers" and thus subject to rules governing boilers.

The Commission determined that a water heater becomes a hot water heating boiler when used for space heating. The admini-

³The Court in Pro-Benefit determined that the intermediate standard of review set forth in Utah Department of Administrative Services v. Public Services Commission, 658 P.2d 601 (Utah 1983) for questions of mixed law and fact remained applicable under the UAPA. Concerning that standard, the Public Services court stated the following:

When the decision being reviewed represents the agency's weighing of competing values to select a particular goal, its interpretation of a special law, or its application of its findings of fact to a finding or conclusion on the 'ultimate facts' in the case, judicial review necessarily involves an independent judgment of the reasonableness of the agency decision. In these circumstances, reasonableness is measured against a specific standard: 'The reasonableness of the Commission's order must be determined in light of the statutory setting in which it operates.' Milne Truck Lines, Inc. v. Public Service Commission, 13 Utah 2d 72, 368 P.2d 590, 592 (1962). Thus, reasonableness must be determined with reference to the specific terms of the underlying legislation, interpreted in light of its evident purpose as revealed in the legislative history and in light of the public policy to be served.

Id. at 611.

strative law judge agreed with the Commission. The Board of Review of the Industrial Commission upheld the decision of the administrative law judge.

VI. STATEMENT OF FACTS

Upon being told that the "Polaris Combination System" had been installed at the Arlington Place Condominiums in Salt Lake City, Utah, James C. Parsell, an inspector with the Industrial Commission, visited Arlington Place to view the Polaris System.⁴ Mr. Parsell determined that because it was used both to provide potable hot water and space heat, the Polaris System was a "hot water heating boiler" within the meaning of the Industrial Commission's Boiler and Pressure Vessel Regulations.⁵

Because Mr. Parsell believed the Polaris was a hot water heating boiler, he decided the Polaris required a stamp by the American Society of Mechanical Engineers ("ASME") certifying its construction according to the standards of that association for boilers.⁶ Since the Polaris did not bear an ASME "H" stamp for boilers, Mr. Parsell ordered its removal from Arlington Place for failure to comply with Utah law and regulations governing boilers.⁷

⁴Reporter's Transcript of March 22, 1990 hearing ("R.T."), p. 10, lns. 10-16.

⁵R.T., p. 10, lns 19-25; p. 11, lns. 5-10; 12-16; 25; p. 12, lns. 1-23; p. 17, lns. 12-14; p. 18, lns 13-15; p. 24, lns 13-14, 25; p. 25, ln. 1.

⁶R.T., p. 11, lns. 5-10, 12-16, 25; p. 12, lns. 1-8; p. 18, lns. 3-7, 22-24; p. 28, lns 4-9.

⁷R.T., p. 13, lns. 18-21.

In deciding that the Polaris Combination System violated standards he believed applicable, Mr. Parsell did not consider whether the Polaris was unsafe, and was in fact unaware of any safety risks posed by the unit.⁸ Mr. Parsell also knew that the Utah Department of Health had no safety worries about the Polaris.⁹ Finally, Mr. Parsell knew nothing about the design of the Polaris Combination System when he made his decision that the Polaris was not up to code.¹⁰

The administrative law judge agreed with Mr. Parsell. In a decision dated May 4, 1990, the court found the Polaris Combination Unit to be a "functional hybrid," and therefore subject to the standards required of both a water heater and a hot water heating boiler. Because the Polaris met only the requirements for the former, the administrative law judge found the Polaris did not comply with Utah law.

On August 22, 1990, the Industrial Commission Board of Review upheld the decision of the administrative law judge. The Board of Review found that because the Polaris was used for space heating, it was a hot water heating boiler, and had to meet the ASME requirements for such.

⁸R.T., p. 10, lns. 22-25; p. 25, lns. 8-25; p. 25, lns. 1-3.

⁹R.T., p. 10, lns. 22-25; p. 25, lns. 8-11.

¹⁰R.T., p. 25, lns. 1-3.

VII. SUMMARY OF ARGUMENT

1. The design and construction of the Polaris Combination System, and of Combination Systems in general,¹¹ is governed by the Uniform Plumbing Code, adopted in Utah as part of the Utah Uniform Building Act, and administered by the Division of Occupational and Professional Licensing. The Industrial Commission misinterpreted the law in determining that it had authority over Combination Systems.

2. Even if the Industrial Commission otherwise had authority over Combination Systems, because Combination Systems are not boilers, they are explicitly exempt from boiler regulations.

3. The enabling legislation permitting the Industrial Commission to regulate boilers is plain: the purpose of boiler regulation is to protect the public against the risk of unsafe boilers. Combination Systems, like all water heaters, are built according to strict safety standards. Combination Systems are not built to the standards of a boiler for one simple reason: they are not boilers. Because they pose none of the risks of a boiler, the Commission's attempt to regulate Combination Systems as if they were boilers poaches beyond the scope of the Commission's power, and fails to serve the purpose of its enabling legislation.

¹¹Because this brief is meant to cover issues raised by all Combination Systems, and not simply the Polaris system, we will in the main refer simply to "Combination Systems."

We do not for a second denigrate the important function of the Industrial Commission in protecting public safety, nor the Commission's right to carry out its legislative mandate in a reasonable manner. However, in this case, the Industrial Commission has misconstrued the scope of its power, and rendered a decision which exceeds the bounds of reasonableness and rationality. The Industrial Commission's decision should be reversed.

VIII. ARGUMENT

A. Even when Providing Space Heat, Combination Systems Remain Water Heaters.

Water heaters normally remain idle for all but two to three hours each day, yet, while idle, remain able to generate space heat. Combination Systems use this capacity of the water heater to provide space heat, in addition to potable hot water.¹²

The basic Combination System consists of a specially designed heat exchanger coil which is attached by means of approved piping to a gas residential-size water heater.¹³ When space heating is required, the flow control module sends heated water (at a temperature of approximately 140°F) from the water heater through the coil. The fan in the heat exchanger then blows air across the hot water coil, forcing heated air

¹²Combination Systems have been used in the marketplace since approximately 1974. Industry sources estimate approximately 500,000 Combination Systems have been installed nationwide. (R.T., p. 49, lns. 9-14).

¹³The design of the Apollo Combination System is shown in Exhibit A to this brief.

throughout the ductwork into the home. The water from the coil loses approximately 10-20°F in this process before recirculating back into the water heater for reheating. The same water used to generate space heat is withdrawn for cooking, bathing or other purposes.

The only source of heat in the Combination System is the water heater. The heat exchanger coil does no more than allow a fan to blow air over the pipes warmed by the heated water produced by the water heater. The Combination System does not increase the water temperature within the water heater or any part of the plumbing system. The water heater in this system continues to provide safe, potable hot water for domestic, culinary, sanitary and related purposes, while also providing hot water for space heating. Combination Systems are water heaters.¹⁴

¹⁴The State of Utah Boiler and Pressure Vessel Rules and Regulations, Part I, Section 6(m) (1988) defines "water heater" as follows:

WATER HEATER means a closed vessel in which water is heated by the combustion of fuels, electricity or any other sources and withdrawn for use external to the system at pressures not exceeding 160 psig and shall included all controls and devices necessary to prevent water temperatures from exceeding 210 degrees F.

As we show later in this brief, Combination Systems meet each of these requirements.

B. Combination Systems are Regulated by the Uniform Plumbing Code, adopted in Utah by the Utah Uniform Building Standards Act, and Administered by the Division of Occupational and Professional Licensing. The Industrial Commission has no Authority to Regulate Combination Systems.

1. ANSI Standards, Adopted by the Uniform Plumbing Code, Govern Water Heaters.

Utah has adopted the Utah Uniform Building Standards Act.¹⁵ Section 58-56-4(1)(c) of that Act requires the State and each of its political subdivisions to adhere in regulation of building construction to the Uniform Plumbing Code as adopted by the International Association of Plumbing and Mechanical Officials ("IAPMO").¹⁶ Pursuant to authorization granted it by section

¹⁵Utah Code Ann. §§58-56-1--58-56-11.

¹⁶Section 58-56-4 states in its entirety:

Adoption of building codes -- Amendments.

(1) Except as provided in Section 58-56-10 and subject to the provisions of Subsection (3), the following are adopted as the construction standards to which the state and each political subdivision of this state shall adhere in building construction, alteration, remodeling and repair, and in the regulation of building construction, alteration, remodeling and repair:

(a) the Uniform Building Code as promulgated by the ICBO;

(b) the National Electrical Code as promulgated by the ICBO and IAPMO.

(c) The Uniform Plumbing Code as adopted by IAPMO; and

(d) the Uniform Mechanical Code as promulgated by the ICBO and IAPMO.

(2) The division, in collaboration with the commission, shall adopt by rule the specific edition of the NEC, UBC, UMC, and UPC to be used as the standard and may adopt by rule successor editions of any adopted code.

58-56-4(1) of The Building Standards Act, the Division of Occupational and Professional Licensing has adopted the 1988 edition of the Uniform Plumbing Code as the law in Utah.¹⁷

The Uniform Plumbing Code governs the construction, location and installation of water heaters.¹⁸ Pursuant to the Code, water heaters must be constructed according to accepted standards.¹⁹ The Uniform Plumbing Code, and thus Utah, has adopted the standards of the American National Standards Institute ("ANSI") as acceptable for the construction of water

(3) The division, in collaboration with the commission, may adopt amendments to the NEC, UBC, UMC, and UPC to be applicable to the entire state or within a political subdivision only in accordance with Section 58-56-7.

¹⁷Utah Uniform Building Standard Rules, Rule 153-56-4:

Specific Editions of Uniform Building Standards.

The following Uniform Building Standards are adopted as the building standard editions to be applied to construction in the state:

(1) the 1988 edition of the Uniform Building Code (UBC) promulgated by the International Conference of Building Officials;

(2) the 1990 edition of the National Electrical Code (NEC) promulgated by the National Fire Protection Association;

3) the 1988 edition of the Uniform Plumbing Code promulgated by the International Association of Plumbing and Mechanical Officials; and

(4) the 1988 edition of the Uniform Mechanical Code promulgated by the International Conference of Building Officials and the International Association of Plumbing and Mechanical Officials.

¹⁸Uniform Plumbing Code, §1301. A copy of all pertinent matter from the 1988 edition of the Uniform Plumbing Code is attached as Exhibit B.

¹⁹Id.

heaters.²⁰ All water heaters are built to ANSI Z-21 Standards.²¹

²⁰Uniform Plumbing Code, §§201(c), 1301. A copy of the ANSI Z-21 standards for gas water heaters is attached as Exhibit C.

²¹Those commercial water heaters which exceed 200,000 BTU input per hour or the other parameters set forth in ASME Section HLW-101 must also be built to the requirements of Part HLW of the ASME Boiler and Pressure Vessel Code. A copy of pertinent sections of Part HLW of the ASME Code is attached as Exhibit D.

The Accredited Standards Committee Z-21 on performance and installation of gas water heating appliances and related accessories is known as the "Z-21 Committee." The Z-21 Committee is accredited as a standards making body by the American National Standards Institute. The primary function of this Committee is to develop and maintain safety standards for the operation and construction of gas appliances and their accessories.

Attached as Exhibit E is information on the Z-21 Accredited Standards Committee entitled General Procedures for Creating and Revising Standards. Page 1 of this Publication indicates the broad spectrum of representatives who serve as members of the Committee. Members are drawn in proper balance from gas utilities and suppliers, gas appliance and accessory manufacturers, regional building and plumbing code writing bodies, electrical associations, insurance underwriter companies, independent testing agencies, federal, state and local government agencies and independent interest groups.

Specifically, the Committee has members from the Consumer Products Safety Commission, the Federal General Services Administration, the National Fire Protection Association, the National Electrical Manufacturers Association, the National Institute of Standards and Technology, United States Department of the Navy, Underwriters Laboratories, Inc., United States Department of Energy, United States Department of Health and Human Services, United States Department of Housing and Other Development, and other entities.

The membership of the Z-21 Committee is listed on pages iv and v of Exhibit C.

The Z-21 American National Standards Institute Standards for Gas Waters Heaters reflect over sixty years of continual refinement since these water heater standards were originally adopted in July 1927.

ANSI standards emphasize safety, and are developed in a public, non-partisan process. Numerous federal agencies are required to comply with ANSI standards, as is the Consumer Product Safety Commission.²² Each ANSI regulation is a result of a stringent, detailed, multi-tiered draft and review process involving input from government agencies, consumers and industries.

Part I of the ANSI Z-21 Standards provides construction requirements for everything used within the water heater, from the vessel itself to the burner, controls, and all else down to the bolts and screws.

Part II of the ANSI Standards contains a series of safety and performance standards that each water heater must meet.²³

²²Formerly, Federal agencies were free to develop their own standards. In 1981, however, OMB Circular A-119 was promulgated which mandates that no federal agency will adopt its own standards unless it first determines that there is no private standard which may fulfill its standards needs. Indeed, when the issue of regulation of combination space and water heating appliances was addressed only recently in the State of Delaware, the State of Delaware determined that the most appropriate regulation was to incorporate the Z-21 standards. The Delaware announcements are attached as Exhibit F.

²³For example, ANSI Z-21 standards, Volume 1, section 2.30, requires all water heaters to withstand in a hydrostatic test twice their intended and indicated working Pressure:

"[S]torage vessel shall withstand a hydrostatic test pressure two times the manufacturers rates maximum working pressure, but not less than 300 psi (207 MPa) without developing leakage or permanent deformation."

Nearly every home, apartment, and commercial building in the United States has at least one water heater. It is estimated that between 70 and 80 million water heaters are presently operating in the United States. These water heaters operate hour after hour, day by day, week by week, month by month, year after

Part III of the ANSI Standards outlines the manufacturing and production tests that must be performed by the manufacturer. The gas water heater's conformance to ANSI Standards is evaluated by a nationally recognized certification agency such as the American Gas Association testing laboratory. The AGA laboratory subjects each sample water heater to the prescribed rigorous tests and either certifies that the water heater complies with the ANSI Standards or denies certification if it determines that compliance has not been met.

ANSI standards prevent the water in a water heater from boiling: Section 1.21.1 provides that "[e]ach water heater shall be provided with an automatic gas shutoff system actuated by high water temperature as an integral part of the appliance." Section 2.15.4 provides that "[a]n automatic gas shutoff system shall operate to shut off the gas to all burners, including the pilot burners, before the stored water temperature in the top 6 inches (152 mm) of the tank exceeds 210F. . . ." ²⁴

The safety record of Combination Systems is impeccable. These systems have a maximum working pressure of 160 psi and a maximum fluid temperature of 210°F, below the boiling point.

year. And yet, injuries to persons or property from water heaters are infrequent. There is no record of any explosion of a water heater equipped with a functioning energy cutoff device and temperature-pressure relief device.

²⁴Combination Systems are thus safer than boilers. A water heater relief valve will open either before the water temperature exceeds 210°F. or before the pressure exceeds the intended and indicated working pressure of the vessel. A boiler relief valve, on the other hand, only opens when the pressure is excessive, not when the temperature rises above 210°F.

There is no danger of explosion from a Combination System because the water heater in a Combination System cannot boil.

2. ANSI Standards Govern Combination Systems.

The design and construction of Combination Systems is now explicitly governed by ANSI Z-21.10 standards for Gas Water Heaters: these standards were revised in 1988 to incorporate specific requirements for water heaters used for providing both potable water and space heating.²⁵ These requirements mandate that all piping connections be suitable for use with potable water, that toxic chemicals not be introduced into the potable water used for space heating, that the water not be connected to any components used with a non-potable water heating appliance, and that some means be installed to temper the water for those uses where reduction of scald hazard potential is needed.

The ANSI is not alone in recognizing the use of Combination Systems: the Plumbing Research Committee of the IAPMO, the very creator of the Uniform Plumbing Code, has now recommended the Combination System manufactured by State Industries as meeting the requirements of the Code.²⁶ The recommendation of the IAPMO is persuasive: in interpreting statutes based on model acts, Utah courts look for assistance to statements made by the drafter of

²⁵See Exhibit C, p. 30, Section 1.30.6.

²⁶A copy of the recommendation of the plumbing research committee is attached as Exhibit G.

the act.²⁷ The conclusion of the drafter of the Uniform Plumbing Code could not be clearer: the State Industries Combination System meets the requirements of the Code.

Water heaters, and Combination Systems, are regulated by the Uniform Plumbing Code. The Uniform Plumbing Code is the law of Utah, and is administered by the Division of Occupational and Professional Licensing. The Industrial Commission erred when it determined it had authority to regulate Combination Systems.

C. Even if Otherwise Subject to the Jurisdiction of the Industrial Commission, Combination Systems are Explicitly Exempt from Boiler Regulations.

Because the Uniform Plumbing Code regulates Combination Systems, the Industrial Commission may not. Even if Combination Systems otherwise fall within the category of devices subject to Commission regulation, Combination Systems are exempt by the Utah Boiler Inspection Law and the Commission's own rules from regulation by these same statutes and rules.

The Boiler Inspection Law of the Utah Code does not apply to "[b]oilers and pressure vessels which are excluded from the Boiler and Pressure Vessel Code published by the American Society

²⁷See, e.g., State v. Bishop, 753 P.2d 439, 469 (Utah 1988) (citing American Law Institute's statements about Model Penal Code); Grace Drilling v. Board of Review of the Industrial Commission of Utah, 776 P.2d 63, 66, n. 1 (Utah App. 1989) (noting that Utah Administrative Procedure Act is "substantially similar" to Uniform Model State Administrative Procedure Act); Pro-Benefit Staffing v. Board of Review of the Industrial Commission of Utah, supra, 775 P.2d 439, 442 (Utah App. 1989) (citing comments to Uniform Model State Administrative Procedure Act in adopting standard of review).

of Mechanical Engineers".²⁸ Residential size water heaters are expressly exempted from ASME construction requirements by Section IV, Part HLW-101 of the ASME Code:²⁹

"The rules of Part HLW are restricted to potable water heaters and water storage tanks for operation at pressures not exceeding 160 psi and water temperatures not in excess of 210°F., except that water heaters are exempted when none of the following limitations is exceeded:

- a. heat input of 200,000 Btu/hr;

²⁸Utah Code Ann. §35-7-5(d).

²⁹Part HG of the ASME Code provides rules for the safe construction of boilers of various types. The rules cover hot water supply boilers and hot water heating boilers. A copy of pertinent sections of section HG of the ASME Code is attached as Exhibit H.

Specifically, the ASME Boiler and Pressure Vessel Code provides rules for the construction of steam heating boilers, hot water supply boilers, hot water heating boilers and their appurtenances in its Part HG. The ASME Code states that "Part HG is not intended to apply to potable water heaters except as provided for in Part HLW." See Section IV, Section HG-100 of ASME Code.

The Introduction to Section IV, Part HLW of the ASME Code, see Exhibit D of this brief, clarifies the substantial difference between a water heater and a hot water heating boiler:

(a) In a water heater, the temperature of the water is limited to a maximum of 210°F.

(b) A water heater is provided with a corrosion resistant lining or constructed with corrosion resistant materials.

(c) A water heater is intended to supply potable hot water with 100% makeup from a potable water supply system. Therefore, certain controls and indicating instruments, such as a water level indicator, low and high water cut-offs, and pressure and altitude gages, are not necessary on a water heater. Vessels built under the rules of Part HLW may be used for storage of potable water. (emphasis added).

- b. water temperature of 210°F;
- c. nominal water-containing capacity of 120 gal, except that they shall be equipped with safety devices in accordance with the requirements of HLW-800. (emphasis added).

HLW-800 provides the requirements for an officially rated pressure temperature relief valve.

In a February 16, 1990 letter to Ernest Wenczl of State Industries, the ASME stated that the use of a recirculating loop connected to a water heater does not subject an otherwise exempt heater to ASME boiler regulation.³⁰ Figure HLW-809.2 on page 175 of the ASME Code, reproduced as Exhibit J to this brief, is helpful here. This drawing depicts acceptable piping installation for a water heater using an optional recirculating line. Water heaters using this recirculating system are not required to be H-stamped.³¹ Under the interpretation of its own rules by the ASME, the use of a recirculating line does not turn a water heater into a boiler.³²

Residential size water heaters are also exempt from the Boiler and Pressure Vessel Rules and Regulations promulgated by the Industrial Commission. Part II, Section 16 of those rules governs such exemptions. In a rule nearly identical to that of

³⁰A copy of the ASME letter to Mr. Wenczl is attached as Exhibit I.

³¹Only boilers are required to carry an "H" stamp under Section HG-530.1(a) of the ASME Code.

³²In a letter dated May 31, 1990, the ASME told Ernest Wenczl that no provision of Part HLW was intended to limit the use of heated potable water. A copy of this letter is attached as Exhibit K.

the ASME, the Commission exempts the following from boiler regulations:

(i) **HOT WATER SUPPLY BOILERS, WATER HEATERS, INCLUDING LINED POTABLE WATER HEATER** when none of the following limitations are exceeded:

- (1) a heat input of 200,000 BTU/hr.
- (2) a water temperature of 210°F.
- (3) a water-containing capacity of 120 gallons.

Boiler and Pressure Vessel Rules and Regulations, Part II, Section 16(i). The Combination System meets each of these requirements.

In the face of clear and contrary language of both statute and rule, the Industrial Commission has decided that a water heater used to provide space heat as well as potable hot water becomes a "hot water heating boiler." The Commission is mistaken.

Under the Commission's rules, a hot water heating boiler is defined as follows:

HOT WATER HEATING BOILER means a boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at a pressure not exceeding 160 psig and/or at temperatures of 250 degrees F. at or near the boiler outlet.

Boiler and Pressure Vessel Rules and Regulations, Part I, section 6(j).

Unlike a "hot water heating boiler", which is permitted under the Commission's rules to boil water, the Combination System cannot boil water, and contains devices to keep water

temperature from exceeding 210°F.³³ When used to provide space heat, the Combination System does not heat water to a temperature above that to which it heats water for other uses. Instead, the system circulates hot water which has been heated to its normal temperature through a coil.

A hot water heating boiler has the capacity by design, regardless of whether so used, to heat water above the boiling point; i.e., up to and including 250°F.³⁴ A Combination System can do no such thing.

A Combination System is a water heater, and meets all requirements set forth in the boiler statutes and rules for an exemption from those rules. Combination Systems are exempt from statutes and rules governing boilers.

³³Water heaters, including Combination Systems, are equipped with a thermostat, an automatic gas shutoff valve, and a temperature-pressure relief valve, all of which are intended to maintain the water temperature below the boiling point.

³⁴The need for regulation of a true boiler is obvious: superheated water, i.e., water heated to temperatures well in excess of 210°F, poses a clear explosion hazard unless a boiler is properly constructed. The transformation of water in liquid form to gas form is accompanied by a rapid expansion in volume. This transformation from liquid to gas only occurs at water temperatures in excess of 212°F and where the liquid is contained under pressure in a closed vessel, as in a boiler. This is not the case with a water heater, even when used to provide space heat. A water heater is not a boiler, and poses none of the risks of a boiler.

D. The Purpose of the Boiler Regulations, and of the Grant of Power to the Industrial Commission to Regulate Boilers, is to Protect the Public from the Risks of Boilers. Because Combination Systems Pose None of the Risks of Boilers, the Commission's Attempt to Subject Combination Systems to Boiler Regulations Exceeds the Scope of the Commission's Powers.

An administrative agency has only that power granted by the Utah Legislature.³⁵ In fulfilling its task, the agency must always be aware of, and cannot exceed, its legislative mandate.³⁶

³⁵Utah Dep't of Corrections v. Sucher, 796 P.2d 721, 722 (Utah App. 1990) (personnel review board); Bevans v. Industrial Comm'n of Utah, 790 P.2d 573, 576 (Utah App. 1990) (Industrial Commission).

³⁶Crowther v. Nationwide Mutual Insurance Co., 762 P.2d 1119 (Utah App. 1988):

An administrative agency's authority to promulgate regulations is limited to those regulations which are consonant with the statutory framework, and neither contrary to the statute nor beyond its scope. Administrative regulations 'may not conflict with the design of an Act, and when they do the court has a duty to invalidate them. . . . Furthermore, when an administrative official misconstrues a statute and issues a regulation beyond the scope of a statute, it is in excess of administrative authority granted.' It is the prerogative and responsibility of the legislature to set policy and that responsibility may not be constitutionally delegated to an agency under its rule-making authority. Agency regulations may not 'abridge, enlarge, extend or modify the statute creating the right of imposing the duty.' Id. at 1122 (citations omitted).

See also West Jordan v. Department of Employment Security, 656 P.2d 411, 414 (Utah 1982), disavowed in part on other grounds, Bayle v. Board of Review of Industrial Commission, 700 P.2d 1135 (Utah 1985) (agency ruling inconsistent with governing legislation and therefore invalid); Northwest Carriers, Inc. v. Industrial Commission of Utah Second Injury Fund, 639 P.2d 138, 141-42 (Utah 1981), disavowed in part on other grounds, Rex E. Lantham Co. v. Industrial Commission of Utah, 717 P.2d 255 (Utah 1986) (agency action inconsistent with purpose of remedial legislation); Silver Beehive Telephone Co. v. Public Service Commission, 512 P.2d 1327, 1328 (Utah 1973) (court will intervene

While agency expertise should be recognized, agency determinations must be grounded in fact.

Although it is a 'universally recognized rule' that this court must 'take some cognizance of the expertise of the agency in its particular field and accordingly to give some deference to its determination,' the agency's decision must rest upon some sound evidentiary basis, not a creation of fiat.

First National Bank of Boston v. County Board of Equalization of Salt Lake County, 799 P.2d 1163, 1166 (Utah 1990).

In the case at bar, the legislative mandate to the Commission, and the Commission's violation of the same, is plain.

Utah Code Ann. Sections 35-7-5--35-7-9 govern boiler inspections by the Industrial Commission. Section 35-7-5 defines the scope of the law:

Except as otherwise provided in this section, this chapter applies to all boilers and pressure vessels used in industrial or manufacturing establishments, business establishments, sawmills, construction jobs, and every place where workers or the public may be exposed to risks from the operation of boilers or pressure vessels. (emphasis added)

The intent of the statute is clear: boilers are to be

when agency's actions are "so clearly inconsistent" with agency's purpose "that they transgress the tolerable limits of reason." (footnotes omitted); Lorenc v. Call, 789 P.2d 46, 49 (Utah App.), cert. denied, 795 P.2d 1138 (1990) (school district policy invalid because narrower than rule adopted by Utah State Board of Education and in conflict with statutory purpose).

inspected to ensure that the public is protected from their risk.³⁷ Combination Systems are not boilers, pose none of the risks of boilers, and should not be regulated like boilers.³⁸

In a myopic parsing of the law and its own regulations, the Industrial Commission has nonetheless determined that because the

³⁷In its Boiler and Pressure Vessel Rules and Regulations, the Industrial Commission cites sections 35-7-5--35-7-89 as enabling the Commission to promulgate those regulations. The Commission's own regulations parrot the enabling legislation:

All boilers and pressure vessels used in industrial or manufacturing establishments, business establishments, construction job and every place where workmen or the public may be exposed to the risks thereof shall be designed, constructed, inspected, stamped and installed in accordance with the applicable sections of the ASME Boiler and Pressure Vessel Code and the latest Addenda thereto, in effect, and these Rules and Regulations.

Boiler and Pressure Vessel Rules and Regulations, Part II, Section 1(a).

³⁸New Jersey has faced this issue, and resolved it in favor of Combination Systems. Although the New Jersey inspector agreed that installations of Combination Systems in dwellings of less than six family units was permitted by statute in a letter dated October 19, 1989, the inspector later proposed new boiler rules mandating construction of these Combination Systems to the ASME Code.

After public comment, the New Jersey Register of Tuesday, January 16, 1990 at page 235, reproduced as Exhibit L to this brief, contained the following response:

"Several commenters suggested that the Department delete the amendments to N.J.A.C. . . concerning dual purpose vessels, as they would effectively prohibit the use of water heaters to provide both potable hot water and space heat in combination by making their construction, installation, registration and repair subject to excessive boiler regulation without furthering any legitimate safety concern. . . The Department agrees with the several commenters' suggestions, and has deleted the suggested language from the adoption." (emphasis added).

Polaris System heats both space and water, the Polaris is a "hot water heating boiler".³⁹ In its determination, the Commission has ignored the very purpose of both the enabling legislation and its own rules, and committed error in the process.

James Parsell determined that the Polaris Combination System was a hot water heating boiler because it was used to provide space heat. In so doing, Mr. Parsell ignored the design of the Combination System, and looked solely to its function. Indeed, Mr. Parsell did not bother to familiarize himself with the workings of the Polaris; and did not know whether the Polaris could heat water above 210°F or not.⁴⁰ Mr. Allison, a witness for the Commission and an employee of the National Board of Boiler and Pressure Vessel Inspectors, similarly testified that he did not know how the Polaris system worked,⁴¹ and that he had no idea whether the Polaris met the criteria of a water heater.⁴² Although he was ignorant of the design of the Polaris System, Mr. Allison nonetheless testified that the system was a

³⁹In its Order Denying Motion for Review, the Industrial Commission found that, because the Polaris Combination System circulates hot water "for heating purposes", the Polaris was a hot water heating boiler. Order, p. 2.

⁴⁰R.T., p. 20, lns. 12-15.

⁴¹R.T., p. 32.

⁴²R.T., p. 33, lns. 1-8.

hot water heating boiler and would require ASME boiler certification.⁴³

The question of safety should have been foremost in Mr. Parsell's mind, yet was not. Mr. Parsell found no health risks associated with Combination Systems,⁴⁴ and understood that the Department of Health had reached the same conclusion.⁴⁵ Instead of finding its ground in the purpose of the rules he sought to apply, Parsell's decision rested only on semantics: because the

⁴³R.T., p. 31, lns. 4-5, 15-18.

Neither the National Board of Boiler and Pressure Vessel Inspectors nor the ASME is completely independent from boiler industry influence. The United States has sued both these entities in an attempt to enjoin them from conspiring to exclude from sale in the United States qualified boilers and pressure vessels of foreign manufacture and to monopolize trade and commerce in boilers and pressure vessels. See United States of America v. The American Society of Mechanical Engineers, Inc. and the National Board of Boiler and Pressure Vessel Inspectors, United States District Court for the Southern District of New York, Civil Action No. 70-C.V.-3141 and the resulting consent decree reported in 1972 Trade Cases ¶74,028.

The United States Supreme Court has also voiced concern over the role the ASME plays in boiler regulation. See American Society of Mechanical Engineers v. Hydrolevel Corp., 456 U.S. 556, 72 C.Ed.2d 330, 102 S.Ct. 1935 (1982):

The facts of this case dramatically illustrate the power of ASME's agents to restrain competition. . . Furthermore, a standard-setting organization like ASME can be rife with opportunities for anti-competitive activity. Many of ASME's officials are associated with members of the industries regulated by ASME's codes. . . . some may well view their positions with ASME, at least in part, as an opportunity to benefit their employers. 102 S.Ct. at 1945.

⁴⁴R.T., pp. 25-26, lns. 14-25; p. 26, lns. 1-3.

⁴⁵R.T., p. 25, lns. 8-11.

Polaris supplied space heat as well as hot water, it was a boiler.⁴⁶

An agency decision must be reasonable. In turn, whether an agency decision is reasonable must be evaluated with reference to the legislation underlying the agency, interpreted in light of its evident purpose and the public policy to be served.⁴⁷

Measured against this standard, the decision of the Industrial Commission challenged here falls wide of the mark. The task of the Industrial Commission, as evidenced by its underlying legislation, is to keep the public safe from the risks of boilers. Combination Systems pose none of the risks of a boiler. Parsell could identify no risks from Combination Systems. The safety of Combination Systems is fully regulated by the Uniform Plumbing Code and ANSI standards.

The Commission's decision to subject Combination Systems to boiler regulations finds a basis neither in reason nor in legislative purpose, but only in a mercilessly contorted reading of rules. When held up to scrutiny, the Commission's decision cannot stand the strain.

⁴⁶R.T., pp. 18, lns. 1-6; p. 24, lns. 13-14, 25; p. 25, ln. 1.

Despite his decision that the use of a fan and coil turned the Polaris into a boiler, Parsell testified that nothing in the Utah Code prevented a water heater from being used for space heating, R.T., p. 19, lns. 19-24; p. 20, ln. 1, and that water heaters with a capacity of less than 200,000 BTUs did not require an ASME stamp and remained outside his jurisdiction. R.T., p. 26, lns. 11-15.

⁴⁷Utah Dept. of Administrative Services v. Public Services Commission, supra, 658 P.2d 601 at 611 (Utah 1983).

E. The Economic Effect of the Commission's Decision: When Imposed on Water Heaters, Rules Governing the Design and Construction of Boilers become Burdensome and Unnecessary.

We have shown above the error of the Commission's ways viewed in light of the law. We complete our brief with a discussion of the costs to be imposed by the Commission's decision.

Subjecting water heaters used in Combination Systems to section HG of the ASME Code will result in a host of new requirements:

1. That each device not otherwise exempt be installed in strict conformance with the ASME Code, National Board Inspection Code, and the Commission's Rules and Regulations;
2. That there be a certificate of inspection for each and every one of these devices installed in the State of Utah which are not otherwise exempt;
3. That an inspection and/or certificate fee⁴⁸ be paid for these devices when installed in the State of Utah and not otherwise exempt;
4. That the State of Utah or one of its commissioned boiler inspectors be notified before any major repair or alteration can be made to one of these devices installed within the State of Utah; and

⁴⁸Boiler manufacturers must register each boiler with the National Board of Boiler and Pressure Vessel Inspectors. Boiler and Pressure Vessel Rules and Regulations, Part II, Section 1(b). The registration fee is "by far the prime source of [the board's] income." Information Booklet, The National Board of Boiler and Pressure Vessel Inspectors, N.B.-21, Revision 4. Declining boiler sales would have an obvious impact on the National Board.

See also note 43, supra (ASME antitrust issues).

5. That these devices be designed, constructed, inspected, stamped and installed in accordance with the current applicable section of the ASME Boiler and Pressure Vessel Code, National Board Inspection Code, and the appropriate rules and regulations of the State of Utah.

In the case of a Combination System, these regulations serve no purpose at all, except to favor the use of true boilers for home heating. The economic effect of the Commission's decision is to artificially inflate the ultimate cost of space and water heating to the consumer. If the water heater in a Combination System must now be built to the requirements of Part HG of the ASME Code, then these water heaters must be construed under the design criteria of Part HG, be built with ASME certified materials, be welded by ASME certified welders, be inspected by an inspector holding a National Board of Boiler and Pressure Vessel Inspectors commission, and be registered with the Board or the National Board of Boiler and Pressure Vessel Inspectors. Each of these requirements adds tremendous cost to each system. Additionally, the consumer will pay more in installation costs because of the inherent complexity of boilers constructed under Part HG. (Part HG requirements also mandate use of low-water cutoffs, redundant controls, and high-limit devices.)⁴⁹

⁴⁹In addition, if a Combination System must now be constructed to the requirements of Part HG of the ASME Boiler and Pressure Vessel Code, whether the system will utilize fuel as efficiently as an ordinary water heater is open to question. The trade press has reported that small boilers constructed to Part HG requirements will not meet the minimum efficiency regulations promulgated by the Commission of Energy under the National Appliance Energy Conservation Act of 1987. Subjecting water heaters used in Combination Systems to Part HG construction requirements (if technically feasible at all) may reduce their

The water heater in Combination Systems, if governed by the ASME Code, must be also repaired by a shop holding a certificate from the National Board of Boiler and Pressure Vessel Inspectors. Permission to make the repair must be obtained from an authorized inspector.

If the Commission's decision remains, consumers will pay artificially increased costs to purchase heating equipment, to install heating equipment, to operate heating equipment and to repair heating equipment. These consumers will include homeowners, persons occupying apartments and condominium units as well as small businessmen occupying smaller commercial buildings such as laundry facilities, retail shops, restaurants, and the like. The Commission's decision prevents, for no good reason at all, these individuals and entities from enjoying the economic savings inherent in Combination Systems.⁵⁰

fuel efficiency.

⁵⁰Combination Systems save several costs. First, these units save space because less floor space is required for their installation than for competing appliances. Second, they are easily installed and less mechanically complex than competing appliances. Third, they operate with considerable fuel efficiency. Fourth, very little maintenance is required to maintain these systems' safe, efficient operation.

Alternative Technology of Raleigh, North Carolina has prepared a cost comparison of a Combination System and a boiler system as if each were installed in an identical building with a 30,000 Btu/design heat loss in Salt Lake City, Utah. The end user is estimated to save more than \$6,570 over 15 years by installing a Combination System rather than a boiler system. If only 500 Utah consumers installed a combination system rather than a boiler system, the cost savings are estimated at more than three million dollars.

IX. CONCLUSION

The Utah State Industrial Commission has decided that Combination Systems are boilers. To withstand appellate scrutiny, the Commission's decision must first be based on a correct interpretation by the Commission of the powers granted it. The Commission's decision must then be grounded in reason. The decision challenged here meets neither of these tests. The Industrial Commission's decision should be reversed.

Dated this 5th day of February, 1991.

LeBOEUF, LAMB, LEIBY & MacRAE


By: Ronald L. Rencher

BOULT, CUMMINGS, CONNERS & BERRY

 by 
By: A. J. Sharenberger, III

Counsel for State Industries, Inc.

A copy of this cost comparison is attached as Exhibit M.

CERTIFICATE OF SERVICE

I hereby certify that on the 5th day of February, 1991, a true and correct copy of the foregoing Amicus Curiae Brief of State Industries, Inc. was mailed, postage prepaid, to the following:

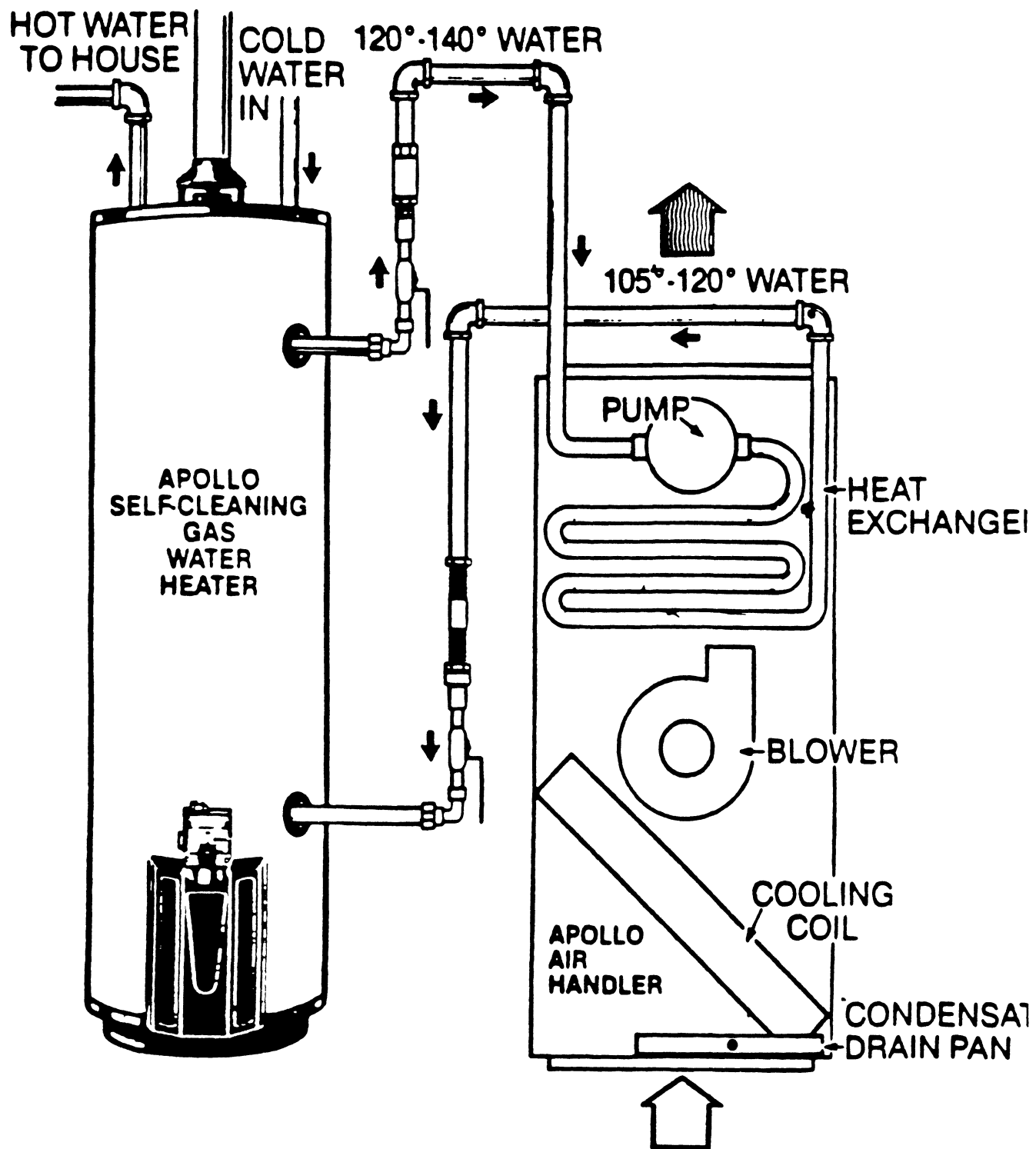
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Tab A



VERTICAL AIRFLOW

Tab B

**International Association of
Plumbing and Mechanical Officials**

**UNIFORM
PLUMBING
CODE**

**1988
EDITION**

Adopted at the Fifty-Seventh Annual Conference

SEPTEMBER, 1986

**INTERNATIONAL ASSOCIATION OF PLUMBING
AND MECHANICAL OFFICIALS**

(A Non-Profit Organization)

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of
Plumbing and Mechanical Officials**
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Eighteenth Edition
First Printing, January 1988
Second Printing, October 1988
Third Printing, August 1989
Fourth Printing, March 1990

Library of Congress Catalog Card Number 78-073977

Note:

When adopting the Uniform Plumbing Code in whole, in part, or by reference, please notify IAPMO Hqs. at 20001 Walnut Drive South, Walnut, California 91789-2825.

This information will enable us to keep records on how many jurisdictions are using the UPC.

Thank You.

FOREWORD

The advantages of a uniform plumbing code, acceptable in the various jurisdictions, have long been recognized. Increasing confusion resulting from widely divergent practices, dictated by a multitude of conflicting codes, induced the Western Plumbing Officials Association (now International Association of Plumbing and Mechanical Officials) to form a committee dedicated to the creation of a basic plumbing document.

After many months of concerted endeavor, this committee, composed of Plumbing Inspectors, Master and Journeyman Plumbers, Sanitary and Mechanical Engineers, assisted by the Public Utility Companies and the Western Plumbing Industry, successfully compiled the first edition of the "Uniform Plumbing Code" which was officially adopted by the International Association of Plumbing and Mechanical Officials in October, 1945. Amendments adopted by the membership and published in revised form every third year have kept this basic standard abreast of technological developments, and the widespread acceptance and use of the document is indicative of its merit.

In presenting the 1988 edition, the International Association of Plumbing and Mechanical Officials recognizes that the ultimate has not yet been attained. They respectfully urge the users of this Code to present whatever amendments their experience may dictate to the Association's Code Changes Committee, so that, by formal adoption of such, uniformity may be maintained and all will benefit in health, standardization, and safety.

This document was designed to provide a good plumbing system with minimum regulations. The users of the Uniform Plumbing Code are urged to strive for not just a minimum plumbing system, but to keep the consumer in mind and go a step beyond and exceed the minimum.

The consumer is entitled to a sanitary plumbing system. With the exception of "high use and wear" portions of the system, the main plumbing system should have the same life as other components of the building.

The Uniform Plumbing Code is dedicated to all those who have unselfishly devoted their time, effort, and money to create and maintain this, the finest plumbing code in existence.

Vertical marginal lines denote changes from the 1985 edition except where the change was minor. Arrows denote a deletion.

The Uniform Plumbing Code, a publication of IAPMO, is endorsed by ICBO as a companion document to ICBO's Model Codes. The use of the ICBO logo is intended to reflect such support.

(f) **Water Supply System-** The water supply system of a building or premises consists of the building supply pipe, the water distributing pipes and the necessary connecting pipes, fittings, control valves, and all appurtenances carrying or supplying potable water in or adjacent to the building or premises.

(h) **Welder, Pipeline-** Is a person who specializes in welding of pipes and holds a valid certificate of competency from a recognized testing laboratory, based on the requirements of the A.S.M.E. Boiler and Pressure Vessels Code, Section IX.

Section 125 **-X-**
No definitions.

(a) **Yoke Vent-** A yoke vent is a pipe connecting upward from a soil or waste stack to a vent stack for the purpose of preventing pressure changes in the stacks.

(c) Standards listed or referred to in this chapter cover materials which will conform to the requirements of this Code, when used in accordance with the limitations imposed in this or other chapters thereof and their listing. Where a standard covers materials of various grades, weights, quality, or configurations, there may be only a portion of the listed standard which is applicable. Design and materials for special conditions or materials not provided for herein may be used only by special permission of the Administrative Authority after he has satisfied himself as to their adequacy. For the convenience of users of this Code, a list of generally accepted plumbing materials standards is included at the end of this chapter, in Table A. All IAPMO Installation Standards are included at the rear of this Code.

(d) In existing buildings or premises in which plumbing installations are to be altered, repaired, or renovated, the Administrative Authority has discretionary powers to permit deviation from the provisions of this Code, provided that such a proposal to deviate is first submitted for proper determination in order that health

and safety requirements, as they pertain to plumbing, shall be observed.

(e) The provisions of this Code are not intended to prevent the use of any alternate material or method of construction provided any such alternate has been first approved and its use authorized by the Administrative Authority.

(f) The Administrative Authority may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the intent of this Code and the material offered is for the purpose intended, at least the equivalent of that prescribed in this Code, in quality, strength, effectiveness, durability, and safety or that the methods of installation proposed conform to other acceptable nationally recognized plumbing standards.

(g) The Administrative Authority shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding the sufficiency of any proposed material or type of construction.

(h) When there is insufficient evidence to substantiate claims for alternates, the Administrative Authority may require tests, as proof of compliance, to be made by an approved testing agency at the expense of the applicant.

(i) Tests shall be made in accordance with approved standards, but in the absence of such standards, the Administrative Authority shall specify the test procedure.

(j) The Administrative Authority may require tests to be made or repeated if, at any time, there is reason to believe that any material or device no longer conforms to the requirements on which its approval was based.

Section 202- Iron Pipe Size (I.P.S.) Pipe

Iron, steel, brass, and copper pipe shall be standard weight iron pipe size (I.P.S.) pipe.

Section 203- Use of Copper Tubing

(a) Copper tube for underground drainage and vent piping shall have a weight of not less than that of copper drainage tube type DWV.

(b) Copper tube for above ground drainage and vent piping shall have a weight of not less than that of copper drainage tube type DWV.

(c) Copper tube shall not be used for chemical or industrial wastes as defined in Section 612 of this Code.

(d) Copper tube for water piping shall have a weight of not less than Type L. Exception: Type M copper tubing may be used for water piping when piping is above ground in, or on, a building or underground outside of structures.

(e) In addition to the required incised marking, all hard drawn copper tubing shall be marked by means of a continuous and indelibly colored stripe at least one quarter (1/4) inch (6.4 mm) in width, as follows: Type K, green; Type L, blue; Type M, red; Type DWV, yellow.

(f) Listed flexible copper water connectors shall be installed in exposed locations, unless otherwise listed.

Section 204- Lead

See Table A. Sheet lead shall be not less than the following:

For safe pans-not less than four (4) pounds per square foot or 1.6 mm thick.

For flashings or vent terminals-not less than three (3) pounds per square foot or 1.2 mm thick.

Lead bends and lead traps shall not be less than one-eighth (1/8) inch (3.2 mm) wall thickness.

Section 205- Ferrules and Bushings

(a) Caulking ferrules shall be manufactured from bronze or copper and shall be in accordance with Table 2-1.

(b) Soldering bushings shall be of bronze or copper in accordance with Table 2-2.

Section 206- Closet Rings (Closet Flanges)

(a) Closet rings (closet flanges) for water closets or similar fixtures shall be of an approved type and shall be bronze, copper, hard lead, cast iron, galvanized malleable iron, ABS, PVC, or other approved materials. Each such closet ring (closet flange) shall be approximately seven (7) inches (178 mm) in diameter and, when installed, shall, together with the soil pipe, present a one and one-half (1 1/2) inch (38 mm) wide flange or face to receive the fixture gasket.

(b) Caulked-on closet rings (closet flanges) shall be not less than one-fourth (1/4) inch (6.4 mm) thick and not less than two (2) inches (50.8 mm) in overall depth.

(c) Closet rings (closet flanges) shall be burned or soldered to lead bends or stubs, shall be caulked to cast iron soil pipe, shall be solvent cemented to ABS and PVC and shall be screwed or fastened in an approved manner to other materials.

(d) All such closet rings (closet flanges) shall be adequately designed and secured to support fixtures connected thereto.

(e) Closet screws, bolts, washers, and similar fasteners shall be of brass, copper, or other listed, equally corrosion resistant materials. All such screws and bolts shall be of adequate size and number to properly support the fixture installed.

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TABLE 2-3
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TABLE 2-4
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NOTE

Abbreviations used in Table A refer to standards or specifications issued by the organizations identified below:

AHAM	Association of Home Appliance Manufacturers, 20 North Wacker Drive, Chicago, Illinois 60606 (312) 984-5800.
ANSI	American National Standards Institute, 1430 Broadway, New York, New York 10018 (212) 354-3300.
ASME	American Society of Mechanical Engineers, United Engineering Center, 345 E. 47 Street, New York, New York 10017 (212) 705-7722.
ASSE	American Society of Sanitary Engineering, P.O. Box 40362, Bay Village, Ohio 44140 (216) 835-3040.
ASTM	American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103. Publish Standards and Tentative Standards (215) 299-5400.
AWWA	American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235 (303) 794-7711.
CISPI	Cast Iron Soil Pipe Institute, 1499 Chain Bridge Road, McLean, Virginia 22101 (703) 827-9177.
CS & PS	Commercial Standards and Product Standards, representing voluntary standards of trade, prepared under the procedures of the National Bureau of Standards and published by the United States Department of Commerce. Obtainable from the Superintendent of Documents, United States Government Printing Office, Washington, D.C. 20402 (202) 783-3238.
FS	Federal Specifications, published by the Federal Specifications Board. Obtainable from the Superintendent of Documents, United States Government Printing Office, Washington, D.C. 20402 (202) 783-3238.
IAPMO (UPC)	International Association of Plumbing and Mechanical Officials, 20001 Walnut Drive South, Walnut, California, 91789-2825 Publish Installation (IAPMO-IS) and Product (IAPMO-PS) Standards (714) 595-8449.
PDI	Plumbing and Drainage Institute, 5342 Boulevard Place, Indianapolis, Indiana 46208 (317) 251-5298.
UL	Underwriters' Laboratories, Incorporated, 333 Pfingsten Road, Northbrook, Illinois 60062 (312) 272-8800.
WQA	Water Quality Association, 4151 Naperville Rd., Lisle, Illinois, 60532 (312) 369-1600.

All standards and specifications for materials are subject to change. Designations, carrying indication of the year of issue, may thus become obsolete.

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
FERROUS PIPE AND FITTINGS:						
Cast Iron Screwed Fittings (125 & 250lb) (56.8 & 113.5 Kg)	B16.4-1963	A 126-66 A 74-82				Note 4
Cast Iron Soil Pipe and Fittings						
Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems					CISPI 301-85	Note 4
Cast Iron Threaded Drainage Fittings	B16.12-1871	A 377-66				Note 4
Gray Iron and Ductile Iron Pressure Pipe						
Hubless Cast Iron Sanitary Systems (Installation)				IS 6-82		
Malleable Iron Threaded Fittings (150 & 300 lb) (68.1 & 136.2 Kg)	B16.3-1977					
Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings					CISPI HSN-85	
Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless		A 53-83				
Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) welded and Seamless, For Ordinary Uses		A 120-82				
Pipe Threads (Except Dryseal)	B2.1-1968					
Roof Drains	A112.21.2M-1983					
Special Cast Iron Fittings				PS 5-84 PS 16-77		
Subdrains For Built-up Shower Pans						
Threaded Cast Iron Pipe For Drainage, Vent and Waste Services..	A40.5-1943					
Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples		A 733-76				
NONFERROUS PIPE AND FITTINGS:						
Brass-, Copper-, and Chromium-Plated Pipe Nipples		B 687-81				
Bronze Flanges and Flanged Fittings (150 & 300 lb)	B16.24-1979					
Cast Brass and Tubing P-Traps				PS 2-83		
Cast Copper Alloy Fittings and Flared Copper Tubes	B16.26-1975					
Cast Bronze Threaded Fittings (Class 120 & 250)	B16.15-1978					
Cast Bronze Solder-Joint Drainage Fittings-DWV	B16.23-1976					Note 4
Cast Copper Alloy Solder-Joint Pressure Fittings	B16.18-1978					

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Copper and Copper Alloy Welded Water Tube (Installation)				IS 21-80		
Copper Drainage Tube (DWV)		B 306-81				
Copper Plumbing Tube and Fittings (Installation)				IS 3-87 PS 9-84 PS 4-83 PS 14-81		
Diversion Tees and Twin Waste Elbow						
Drains for Prefabricated and Precast Showers						
Flexible Copper Water Connectors						
General Requirements for Wrought Seamless Copper and Copper-Alloy Tube		B 251-81				
Seamless Brass Tube		B 135-82				
Seamless Copper Pipe, Standard Sizes		B 42-83				
Seamless Copper Tube		B 75-81a				
Seamless Copper Water Tube		B 88-83				
Seamless Copper-Alloy Water Tube		B 585-80				
Seamless Red Brass Pipe, Standard Sizes		B 43-80				
Seamless and Welded Copper Distribution Tube (Type D)		B 641-78				
Threadless Copper Pipe		B 302-81				
Tubing Trap Wall Adapters				PS 7-84		
Welded Brass Tube		B 587-80				
Welded Copper-Alloy Water Tube		B 586-80				
Welded Copper-Alloy UNS No. C21000 Water Tube		B 642-78				
Welded Copper Tube		B 447-80				
Wrought Copper and Bronze Solder-Joint Pressure Fittings	B16.22-1980					
Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings	B16.29-1980					Note 4
NON-METALLIC PIPE:						
Acrylonitrile-Butadiene-Styrene (ABS) Building Drain, Waste and Vent Pipe and Fittings (Installation)				IS 5-87		
Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste and Vent Pipe and Fittings		D 2661-85(a)				Note 4
Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste and Vent Pipe With a Cellular Core		F 628-85				

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.....		D 2751-83a				
Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings (Installation)		C 428-74 C 296-73		IS 11-87	AWWA C400-72	Notes 1 & 3
Asbestos-Cement Nonpressure Sewer Pipe						
Asbestos Cement Pressure Pipe						
Asbestos-Cement Pressure Pipe For Water and other Liquids						
Asbestos Cement Pressure Pressure Pipe For Water Service and Yard Piping (Installation)				IS 15-82		
Borosilicate Glass Pipe and Fittings for Drain, Waste and Vent (DWV) Applications		C 1053-85 D 2672-85				
Bell-End Poly (Vinyl Chloride) (PVC) Pipe						
Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80		F 441-84				
Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold-Water Distribution Systems		D 2846-82				
Chlorinated Poly (Vinyl Chloride) (CPVC) Solvent Cemented Hot and Cold Water Distribution Systems (Installation)		C 412-80 C 14-80 D 3311-82		IS 20-85		Note 3
Concrete Drain Tile						Note 4
Concrete Sewer, Storm Drain and Culvert Pipe						
Drain, Waste and Vent (DWV) Plastic Fittings Patterns				IS 18-85		
Extra Strength Vitrified Clay Pipe in Building Drains (Installation) ..						
Fittings for Joining Polyethylene Pipe for Water Service and Yard Piping				PS 25-84 IS 1-85		
Non-Metallic Building Sewers (Installation)		F 845-84 D 2609-74				Note 6
Plastic Insert Fittings For Polybutylene (PB) Tubing						
Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe						
Polybutylene (PB) Cold Water Building Supply and Yard Piping				IS 17-82		
and Tubing (Installation)						
Polybutylene Hot and Code Water Distribution Tubing Systems Using Insert Fittings (Installation)				IS 22-84		
Polybutylene Hot and Code Water Distribution Tubing Systems Using Compression Joints (Installation)				IS 25-85		

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Polybutylene Hot and Cold Water Distribution Pipe, Tubing and Fitting Systems Using Heat Fusion (Installation)				IS 23-84		
Polybutylene Hot and Code Water Distribution Pipe, Tubing and Fitting Systems Using Pressure-Lock Fittings (Installation)				IS 24-85		
Polybutylene (PB) Plastic Hot-Water Distribution Systems		D 3309-85(b)				
Polybutylene (PB) Plastic Pipe (SDR-PR) Based On Controlled Inside Diameter		D 2662-83 D 2666-83				
Polybutylene (PB) Plastic Tubing						
Polyethylene (PE) Cold Water Building Supply and Yard Piping (Installation)				IS 7-83 IS 12-85		
Polyethylene (PE) For Gas Yard Piping (Installation)						
Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter		D 2239-85				
Poly (Vinyl Chloride) (PVC) Building Drain, Waste and Vent Pipe and Fittings (Installation)				IS 9-87		
Poly (Vinyl Chloride) (PVC) Code Water Building Supply and Yard Piping (Installation)				IS 8-84 IS 10-84		
Poly (Vinyl Chloride) (PVC) Natural Gas Yard Piping (Installation) ..						
Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings		D 2665-85 D 2241-84				Note A
Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)		D 1785-83*1 D 2466-78				
Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120						
Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings (Schedule 40)						
Primers For Use In Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings		F 656-80				
Rubber Rings For Asbestos-Cement Pipe		D 1869-79				
Safe Handling Of Solvent Cements and Primers Used For Joining Thermoplastic Pipe and Fittings		F 402-80				
Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40		F 438-82*1				

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80		F 439-82 ^{e1}				
Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 80		D 2467-76a				
Solvent Cement For Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings		D 2235-81				
Solvent Cements For Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings		F 493-85				
Solvent Cements For Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings		D 2564-84				
Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings		F 409-81 ^{e1}				Note 4
Thermoplastic Gas Pressure Pipe, Tubing and Fittings		D 2513-82				
Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings		F 789-85				
Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings		D 3034-85(a)				
Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings		D 3033-85				
Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 80		D 2464-76				
Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated		C 700-78				
PLUMBING FIXTURES:						
Enameled Cast Iron Plumbing Fixtures	A112.19.1M-1979		WWP-541-71			
Jetted Whirlpool Bathtubs				PS 32-84		
Plastic Bathtub Units	Z124.1-1980		WWP-541-71			
Plastic Lavatories	Z124.3-1986		WWP-541-71			
Plastic Shower Receptors and Shower Stalls	Z124.2-1980		WWP-541-71			
Plastic Water Closet Bowls and Tanks	Z124.4-1986		WWP-541-71			
Plumbing Fixtures For Land Use			WWP-541-71			
Porcelain Enameled Formed Steel Plumbing Fixtures	ANSI/ASME A112.19.4M-1984		WWP-541-71			
Stainless Steel Plumbing Fixtures (Designed For Residential Use)..	A112.19.3-1976		WWP-541-71	PS 13-79		Note 5
Testing and Rating Procedure For Grease Interceptors						

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Tile Lined Roman Bath Tubs (Installation)				IS 2-82		
Tile Lined Shower Receptors (and Replacements) (Installation) ...			WWP-541-71	IS 4-82		
Trim For Water Closet Bowls, Tanks and Urinals	A112.19.5-1979		WWP-541-71			
Vitreous China Plumbing Fixtures	A112.19.2M-1982					
VALVES:						
Backflow Prevention Devices				PS 31-77		
Backwater Valves				PS 8-77		
Bronze Gate Valves			WWV-54D-73			
Cast Iron Gate Valves			WWV-58b-71			
Constant-Level Oil Valves					UL 352-1982	
Earthquake Actuated Automatic Gas Shutoff Systems	Z21.70-81					
Finished and Rough Brass Plumbing Fixture Fittings	A112.18.1M-1979					
Globe-Type Loglighter Valves-Angle or Straight Pattern				PS 10-84		
Hose Connection Vacuum Breakers	ANSI/ASSE 1011-1976				ASSE 1011-1976	
Individual Shower Control Valves Anti-Scald Type	ANSI/ASSE 1016-1979				ASSE 1016-1979	
Laboratory Faucet Vacuum Breakers	ANSI/ASSE 1035-84					
Manually Operated Gas Valves	Z21.15-74					
Pipe Applied Atmospheric Type Vacuum Breakers	ANSI/ASSE 1001-1970				ASSE 1001-1970	
Pressure Reducing and Regulating Valves for Installation on Domestic Water Supply Lines				PS 15-77		
Pressure Regulating Valves For LP Gas					UL 144-1978	
Relief Valves and Automatic Gas Shutoff Devices For Hot Water Supply Systems and Addendum	Z21.22-1971				UL 132-1973	
Thermostatic Mixing Valves, Self Actuated For Primary Domestic Use	ANSI/ASSE 1017-1986				ASSE 1017-79	
Trap Seal Primer Valves (Drainage Type)	ANSI/ASSE 1044-86					

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Trap Seal Primer Valves (Water Supply Fed)	ANSI/ASSE 1018-86					
Valves For Anhydrous and LP-Gas (Other Than Safety Relief)					UL 125-1980	
Wall Hydrants, Frostproof Automatic Draining Anti-Backflow Types	ANSI/ASSE 1019-78					
Water Closet Flush Tank Ballcocks	ANSI/ASSE 1002-1986				ASSE 1002-1986	
Water Pressure Reducing Valves	ANSI/ASSE 1003-83					
APPLIANCES AND EQUIPMENT:						
Automatic Storage Type Water Heaters With Inputs Less Than 50,000 Btu Per Hour (Approved Requirements For, Vol. 1)	Z21.10.1-1971					
Chimneys, Factory-Built Residential Type and Building Heating Appliances					UL 103-1983	
Circulating Tank, Instantaneous and Large Automatic Storage Type Water Heaters (Approval Requirements for Vol. III)	Z21.10.3-1971					
Commercial Electric Dishwashers					UL 921-1978	
Draft Equipment					UL 378-1983	
Draft Hoods (Listing Requirements For)	Z21.12-1971					
Drinking Water Coolers					UL 399-1978	
Electric Booster and Commercial Storage Tank Water Heater					UL 1453-1982	
Gas Fired Steam and Hot Water Boilers and Addenda	Z21.13-1974					
Gas Vents					UL 441-1979	
Heating, Water Supply and Power, Boilers-Electric					UL 834-1980	
Home Laundry, Equipment (Plumbing Requirements For)	ANSI/AHAM HLW-2PR-1980					
Household Commercial and Portable Exchange Water Softners					WQA S-100-81	
Household & Commercial Water Filters					WQA S-200-73	
Household Dishwashers					UL 749-1978	
Household Dishwashers (Drain Hose)					AHAM DW-1-75	

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Household Dishwasher (Plumbing Requirements For)	ANSI/AHAM DW-2PR-1982				UL 174-1983	
Household Electric Storage Tank Water Heaters						
Household Food Waste Disposer Units (Plumbing Requirements For)	ANSI/AHAM FWD-2PR-1980				UL 563-1975	
Ice Makers	Z21.24-1973				UL 778-1980	
Metal Connectors For Gas Appliances and Addenda					UL 726-1975	
Motor Operated Water Pumps					UL 732-1974	
Oil-Fired Boiler Assemblies					UL 569-1980	
Oil-Fired Water Heaters						
Pigtails and Flexible Hose Connectors For LP-Gas					WQA S-300-84	
Point-of-Use Low Pressure Reverse Osmosis Drinking Water Systems					UL 343-1982	
Pumps For Oil-Burning Appliances					UL 443-1979	
Steel Auxiliary Tanks For Oil-Burner Fuel					UL 80-1980	
Steel Inside Tanks For Oil-Burner Fuel						
MISCELLANEOUS:						
Boiler and Pressure Vessel Code					ASME	
Chlorinated Polyethylene (CPE) Sheeting For Containment Membrane		D 4068-81 C 425-82 B 584-83 B 152-71a				
Compression Joints For Vitrified Clay Pipe and Fittings						
Copper Alloy Sand Castings For General Applications						
Copper Sheet Strip, Plate and Rolled Bar						
Dishwasher Drain Airgaps (Airbreaks)				PS 23-81		
Joints For Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets		C 443-79				
General Requirements For Steel Sheet, Zinc Coated (Galvanized) By The Hot-Dip Process		A 525-70				
Liquefied Petroleum Gases, Storage and Handling					NFPA 58-1974	
Low Pressure Air Test For Building Sewers (Installation)				IS 16-84		
Pipe Hangers and Supports-Materials, Design and Manufacture	ANSI/MSS SP-58-1979					
Plant Applied Protective Pipe Coatings				PS 22-84		

Note 2

TABLE A - PLUMBING MATERIAL STANDARDS

MATERIALS AND PRODUCTS	ANSI	ASTM	FS	IAPMO	OTHER STANDARDS	FOOTNOTE REMARKS
Prefabricated Concrete Septic Tanks				PS 1-87		
Protectively Coated Pipe (Installation)				IS 13-84		
Rubber Gaskets For Cast Soil Pipe and Fittings		C 564-82				
Rubber Rings For Asbestos-Cement Pipe		D 1869-79				
Solder; Tin Alloy; Lead-Tin Alloy; & Lead Alloy (and Flux, Type AC Only)		B 32-70	QQ-S-571e(72)			

- 1 Limited to domestic sewage
 2 Alloy C85200 for cleanout plugs
 3 Type II only
 4 Although this Standard is referenced in Table A, some of the pipe, tube or fittings shown in the Standard are not acceptable for use under the Uniform Plumbing Code.

- 5 PDI Standard G101 by reference
 6 Limited to nylon material only
 e¹ A superscript epsilon (e) indicates an editorial change since the last revision or reapproval.

CHAPTER 3

GENERAL INSTRUCTIONS AND REGULATIONS

Section 301- Disposal of Liquid Waste

It shall be unlawful for any person to cause, suffer, or permit the disposal of sewage, human excrement, or other liquid wastes, in any place or manner, except through and by means of an approved plumbing and drainage system, installed and maintained in accordance with the provisions of this Code.

Section 302- Connections to Plumbing System Required

All plumbing fixtures, drains, appurtenances and appliances, used to receive or discharge liquid wastes or sewage, shall be connected properly to the drainage system of the building or premises, in accordance with the requirements of this Code.

Section 303- Sewer Required

(a) Every building in which plumbing fixtures are installed shall have a connection to a public or private sewer except as provided in subsection (b) of this section.

(b) When a public sewer is not available for use, drainage piping from buildings and premises shall be connected to an approved private sewage disposal system.

(c) In cities and/or counties, where the installation of building sewers is under the jurisdiction of a department other than the Administrative Authority, the provisions of this Code relating to building sewers need not apply.

Section 304- Damage to Drainage System or Public Sewer

(a) It shall be unlawful for any person to deposit, by any means whatsoever, into any plumbing fixture, floor drain, interceptor, sump, receptacle, or device, which is connected to any drainage system, public sewer, private sewer, septic tank, or cesspool, any ashes, cinders, solids, rags, inflammable, poisonous or explosive liquids or gases, oils, grease, or any other thing whatsoever which would, or could cause, damage to the drainage system or public sewer.

(b) Roofs, inner courts, vent shafts, light wells or similar areas having rain water drain, shall discharge to the outside of the building or to the gutter and shall not be connected to the drainage system unless first approved by the Administrative Authority.

Section 305- Industrial Wastes

(a) Wastes detrimental to the public sewer system or detrimental

TABLE 12-10
Capacities of listed metal appliance connectors for use with gas pressures
less than an eight (8") inch water column

Semi-Rigid Connector O.D. (inches)	Flexible Connector Nominal I.D. (inches)	Capacities for Various Lengths, in Thousands BTU/Hr. (Based on Pressure Drop of 0.2" Water Column Natural Gas of 1100 BTU/Cu. Ft.)							
		1 foot	1-1/2 feet	2 feet	2-1/2 feet	3 feet	4 feet	5 feet	6 feet
All Gas Appliances							Clothesdryers and Ranges Only		
3/8	1/4	28	23	20	19	17			
1/2	3/8	66	54	47	44	41			
5/8	1/2	134	110	95	88	82	72	63	57
-	3/4	285	233	202	188	174			
-	1	567	467	405	378	353			

NOTES: 1) Flexible connector listings are based on nominal internal diameter; 2) Semi-rigid connector listings are based on outside diameter; 3) Gas connectors are certified by the testing agency as complete assemblies, including the fittings and valves. Capacities shown are based on the use of fittings and valves supplied with the connector; 4) Capacities for LPG are 1.6 times the Natural Gas capacities shown.

Example: Capacity of a 1/4" flexible connector one (1) foot long is 28,000 x 1.6 = 44,800 BTU/Hr.

CHAPTER 13

WATER HEATERS AND VENTS

Section 1301- General

The regulations of this chapter shall govern the construction, location, and installation of all fuel burning and other water heaters heating potable water, together with all chimneys, vents, and their connectors. All design, construction, and workmanship shall be in conformity with accepted engineering practices and shall be of such character as to secure the results sought to be obtained by this Code. No water heater shall be hereinafter installed which does not comply in all respects with the type and model of each size thereof approved by the Administrative Authority. (For the convenience of users of this Code, a list of generally accepted gas equipment standards is included at the end of Chapter 2 of this Code in Table A).

Section 1302- Definitions

- (a) **Chimney**- A vertical shaft enclosing one or more flues for conveying flue gases to the outside atmosphere.
- (b) **Chimney Connector**- The pipe which connects a fuelburning appliance to a chimney.
- (c) **Combustible Material**- Walls, floors, ceilings, shelves, or other parts of a building constructed of wood, wood lath and plaster, composition or paper.
- (d) **Dielectric Insulator**- A device used as a non-conductor.
- (e) **Direct Vent Appliances**- Appliances constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged to the outside atmosphere.
- (f) **Vent**- Listed factory-made vent pipe and vent fittings for conveying products of combustion to the outside atmosphere.
- (g) **Vent Connector**- That portion of a venting system which connects an appliance to a vent.
- (h) **Venting System**- The vent or chimney, its connectors assembled to form a continuous open passageway from an appliance to the outside atmosphere for the purpose of removing products of combustion. This definition shall also include the venting assembly which is an integral part of the appliance.
- (i) **Venting Systems- Types**
 - (1) Chimneys or vents of masonry, reinforced concrete or metal; and factory-built chimneys approved or listed for products of

combustion at temperatures in excess of five hundred fifty degrees (550° F) (287.8° C)

(2) **Type B-** Factory-made gas vents listed by a nationally recognized testing agency for venting listed or approved appliances equipped to burn only gas.

(3) **Type L-** A venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed gas appliances.

(j) **Water Heater-** An appliance designed primarily to supply hot water and is equipped with automatic controls limiting water temperature to a maximum of two hundred ten degrees (210°)F (98.9 deg. C).

Section 1303- Permit

It shall be unlawful for any person to install, remove, or replace, or cause to be installed, removed, or replaced any water heater without first obtaining a permit from the Administrative Authority to do so.

Section 1304- Inspection

(a) **Inspection of chimneys or vents:** This inspection shall be made after all chimneys, vents, or parts thereof, authorized by the permit, have been installed and before any such vent or part thereof has been covered or concealed.

(b) **Final water heater inspection:** This inspection shall be made after all work authorized by the permit has been installed. The Administrative Authority will make such inspection as he deems necessary to assure himself that the work has been installed in accordance with the intent of this Code. No equipment or part thereof shall be covered or concealed until the same has been inspected and approved by the Administrative Authority.

Section 1305- Gas-Fired Water Heater Approval Requirements

(a) Gas fired water heaters and gas fired hot water boilers shall conform to approved recognized applicable standards or to other standards acceptable to the Administrative Authority. Each such water heater or boiler shall bear the label of an approved testing agency, certifying and attesting that such equipment has been tested and inspected and meets the requirements of applicable standards.

(b) Except when reconditioned by the manufacturer or his approved agent in accordance with its original approval requirements and reinstalled at its original location, each reconditioned water heater or hot water boiler shall be tested for safety and conformity to approved standards, and shall bear the label of an approved testing agency certifying and attesting that such equipment has been tested

and inspected and meets the requirements of applicable standards. Such label shall also state clearly that the water heater has been reconditioned, and shall give the name and address of the reconditioner. Every person applying for a permit to install a used or reconditioned water heater shall clearly state on his application for permit that such equipment is used or reconditioned.

(c) Gas storage-type water heaters and hot water boilers shall be provided with, in addition to the primary temperature controls, an over-temperature safety protection device constructed, listed, and installed in accordance with nationally recognized applicable standards for such devices.

Section 1306- Oil Burning and Other Water Heaters

(a) Water heaters deriving heat from fuels or types of energy other than gas shall be constructed and installed in accordance with approved standards in a manner satisfactory to the Administrative Authority. Vents or chimneys for such appliances shall be approved or listed types and shall be made for an adequate supply of air for combustion and for adequate ventilation of heater rooms or compartments. Each such appliance shall be installed in an approved location satisfactory to the Administrative Authority and to local and State fire prevention agencies.

(b) All storage-type water heaters and hot water boilers deriving heat from fuels or types of energy other than gas, shall be provided with, in addition to the primary temperature controls, an over-temperature safety protection device constructed, listed, and installed in accordance with nationally recognized applicable standards for such devices.

Section 1307- Enclosures and Combustion Air

(a) Fuel burning water heaters shall be assured a sufficient supply of fresh air for proper fuel combustion and ventilation.

(b) Provisions shall be made to supply fresh air to the space in which fuel burning water heaters are located if the volume in cubic feet (liters) of this space is less than:

(1) One-twentieth (1/20) of the maximum rated input in BTU's (W) of gas burning water heaters, and other affected gas appliances, except listed ranges, hot plates, and refrigerators, in such space.

(2) One-tenth (1/10) of the maximum rated input in BTU's (W) of all water heaters and other affected appliances burning solid and liquid fuel in such space.

(c) Methods of Supplying Air.

Where provisions for fresh air are required in this section, one of the

following methods shall be used:

(1) Permanent openings or ducts leading from the water heater location to other interior areas, except unventilated attics, which meet the minimum required volume specified in subsection (b) of this section.

If such openings or ducts convey air from an attic space, the attic space shall be ventilated by fresh air openings or louvers on a vertical wall or at two (2) different levels or elevations.

(2) Permanent openings or ducts leading from the water heater enclosure to the outside of the building.

(3) For gas-burning water heaters, all openings or ducts shall have a total unobstructed area not less than that shown in Table 13-1.

For heaters burning solid or liquid fuels, the required areas shall be one and one-half (1 1/2) times those required for gas burning heaters.

A minimum of six (6) inches (152.4 mm) unobstructed space across the entire front of the water heater shall extend from the floor to at least the top of the appliance. Areas of ducts or openings shall be divided with at least one-half (1/2) of the total required area extending into the upper twelve (12) inches (.3 m) of the appliance enclosure and at least one-half (1/2) of the required area extending into the lower twelve (12) inches (.3 m) of the enclosure. Required openings shall not be less than three (3) inches (76.2 mm) in the least dimension.

(4) All combustion air openings in an enclosure may be located within the upper twelve (12) inches (.3m) of the enclosure, provided that the area of the enclosure is at least fifty (50) square feet (4.6m²) and there is an unobstructed area equal to the required opening area extending to the burner.

(d) Louvers and Grilles

In calculating free area of all louvers and grilles, consideration shall be given to the blocking effect of louvers, grilles, or screens protecting openings. Screens used shall not be smaller than one-fourth (1/4) inch (6.4 mm) mesh. If the free area through a design of louver or grille is known, it should be used in calculating the size opening required to provide the free area specified. If the design and free area is not known, it may be assumed that wood louvers will have twenty to twenty-five (20-25) percent free area and metal louvers and grilles will have sixty to seventy-five (60-75) percent free area.

(e) Alternate Methods of Supplying Combustion Air.

In lieu of the requirements of Table 13-1, combustion air supply may be designed in accordance with recognized engineering principles when first approved by the Administrative Authority.

TABLE 13-1
Combustion Air Requirements
For Gas Burning Water Heaters*

INPUT RATING **	CONDITION 1 Minimum Total Area of Ducts or Openings Where Floor Area of Compartment is Less Than Twice the Floor Area of the Appliances Therein	CONDITION 2 Minimum Total Area of Ducts or Openings Where Floor Area of Compartment is More Than Twice the Floor Area of All Appliances Therein
0-500,000 BTUs 0-146500 W)	2 sq. in. (1290.3 mm ²) per 1,000 BTUs (293 W)	1 sq. in. (645.2 mm ²) per 1,000 BTUs (293 W)
500,001 to 1,000,000 BTUS (146500.3 to 293000 W)	1,000 sq. in. (.7 m ²) plus 2 sq. in. (1290.3 mm ²) per 1,500 BTUs (439.5 W) over 500,000 BTUs (146500 W)	500 sq. in. (.3 m ²) plus 1 sq. in. (645.2 mm ²) per 1,500 BTUs (439.5 W) over 500,000 BTUs (146500 W)
In excess of 1,000,000 BTUs (293000 W)	1,666 sq. in. (1.1 m ²) plus 2 sq. in. (1290.3 mm ²) per 2,000 BTUs (586 W) over 1,000,000 BTUs (293000 W)	833 sq. in. (.5 m ²) plus 1 sq. in. (645.2 mm ²) per 2,000 BTUs (586 W) over 1,000,000 BTUs (293000 W)

**For water heaters burning solid or liquid fuels, the required areas shall be one and one-half (1 1/2) times that required for gas burning water heaters.*

***Minimum one hundred (100) sq. in. (0.07 m²) required equally divided top and bottom.*

Section 1308- Clearances

Uninsulated water heaters shall not be installed closer than six (6) inches (152.4 mm) to unprotected combustible construction nor closer than three (3) inches (76.2 mm) to protected combustible construction. Insulated water heaters shall not be installed closer than two (2) inches (50.8 mm) to unprotected combustible construction nor closer than one (1) inch (25.4 mm) to protected combustible construction. The clearances may be reduced for water heaters which are designed and listed or approved for installation

adjacent to combustible materials and installed in accordance with the conditions of such approval. Protected combustible construction will be considered as such if it has one-fourth (1/4) inch (6.4 mm) of insulating millboard *, covered with a No. 26 gauge metal covering, or not less than one (1) hour fire resistive protection.

***NOTE:** *Insulating millboard is a factory made product formed of noncombustible materials, normally fibers, and having a thermal conductivity of 1 BTU-inch per square foot per degree F. or less.*

Section 1309- Prohibited Locations

No water heater which depends on the combustion of fuel for heat shall be installed in any room used or designed to be used for sleeping purposes, bathroom, clothes closet, or in any closet or other confined space opening into any bath or bedroom.

EXCEPTION: *Sealed combustion chamber-type (direct vent) water heaters.*

Where not prohibited by other regulations, water heaters may be located under a stairway and landing.

Section 1310- Protection From Damage

(a) Water heaters generating a glow, or spark, or flame capable of igniting flammable vapors may be installed in a garage, provided the pilots and burners or heating elements and switches are at least eighteen (18) inches above the floor level in residential garages or eight (8) feet above the floor in a commercial garage.

(b) Where such water heaters installed within a garage are enclosed in a separate, approved compartment having access only from outside of the garage, such water heaters may be installed at floor level provided the required combustion air is also taken from the exterior of the garage. Fuel burning water heaters having sealed combustion chambers need not be elevated.

(c) All water heaters installed in areas where they may be subjected to mechanical damage shall be suitably guarded against such damage by being installed behind adequate barriers or by being elevated or located out of the normal path of a vehicle using any such garage.

(d) The Administrative Authority may require the use of an approved dielectric insulator on the water piping connections of water heaters and related water heating equipment.

(e) In seismic zone 3 and 4, water heaters having non-rigid water connections and more than four (4) feet (1.2 m) in height from the base to the top of the tank case shall be anchored or strapped to resist horizontal displacement due to earthquake motion.

(f) A water heater supported from the ground shall rest on level concrete or other approved base extending not less than three (3) inches above the adjoining ground level.

Section 1311- Access and Working Space

Every water heater installation shall be accessible for inspection, repair, or replacement. The appliance space shall be provided with an opening or doorway of sufficient size to remove the water heater. In no case shall such opening or doorway be less than twenty-four (24) inches (.6 m) in width. Such access shall be continuous and shall be one or any combination of the following means:

(a) By a passageway not less than three (3) feet (.9 m) in door width and six (6) feet, three (3) inches (1.9 m) in door height. Stairways and ramps leading to or part of such passageways shall comply with the Building Code.

(b) Every attic, roof, mezzanine, or platform more than eight (8) feet (2.4 m) above the ground or floor level shall be made accessible by a stairway or ladder permanently fastened to the building. Such ladder or stairway shall not be more than eighteen (18) feet (5.5 m) in length between landings and not less than sixteen (16) inches (400 mm) in width. Such ladder shall have rungs spaced not more than fourteen (14) inches (355 mm) center to center and not less than six (6) inches (152 mm) from face wall. Each stile to extend forty-two (42) inches (1007 mm) above surface to be reached, or as high as possible, if height is limited.

(c) By a trap door or opening and passageway not less than thirty (30) inches (762 mm) by thirty (30) inches (762 mm) but in no case smaller than the water heater, the passageway shall be continuous from the trap door or opening to the water heater. The trap door or opening shall be located not more than twenty (20) feet (6.1 m) from the water heater.

(d) Every passageway to an attic water heater shall have a solid continuous flooring not less than twenty-four (24) inches (609.6 mm) wide from the trap door or opening to the water heater. If the trap door opening is more than four (4) feet (1.2 m) above the floor, a door opening is more than four (4) feet (1.2 m) above the floor, a stairway or ladder permanently fastened to the building shall be provided. Such stairway or ladder shall lead directly to the edge of the trap door or opening and shall comply with the provisions of this section.

(e) By a catwalk not less than twenty-four (24) inches (609.6 mm) wide. Access to the catwalk shall be by ladder or stairs complying with the provisions of this section.

Attic water heater locations shall be provided with an electric light at or near the water heater. Such light shall be controlled by a switch located adjacent to the opening or trap door.

An unobstructed solidly floored working space not less than thirty (30) inches (762 mm) in depth and thirty-six (36) inches (914.4 mm)

in width shall be provided immediately in front of the firebox access opening. A door opening into such space shall not be considered as an obstruction.

Section 1312- Venting of Water Heaters;General

(a) Every water heater designed to be vented shall be connected to a venting system and such system shall comply with the provisions of this Chapter, except as provided in this section.

(b) Venting systems shall consist of approved chimneys, Type B vents, Type L vents, or a venting assembly which is an integral part of a listed appliance.

(c) Venting systems shall be so designed and constructed as to develop a positive flow adequate to convey all products of combustion to the outside atmosphere.

(d) Venting systems may be designed in accordance with the accepted engineering methods when such design method has been approved by the Administrative Authority.

(e) A venting system which is an integral part of the vented appliance shall be installed in accordance with the terms of its listing, manufacturer's installation requirements, and applicable requirements of this Code.

(f) Every factory-built chimney, Type B gas vent, or Type L vent shall be installed in accordance with the manufacturer's instructions, the terms of its listing and to the applicable requirements of this Code.

(g) Every metal chimney shall be installed according to the applicable requirements of this Chapter.

(h) Any unused opening in any venting system shall be closed or capped to the satisfaction of the Administrative Authority.

Section 1313- Limitations

(a) Type B vents shall not be used for venting the following:

(1) Water heaters which may be converted readily to the use of solid or liquid fuels.

(2) Water heaters listed for use with chimneys only.

(b) **Dampers:** Manually operated dampers shall not be placed in chimneys, vents, chimney or vent connectors of fuel burning water heaters.

EXCEPTION: Automatically operated vent dampers shall be listed and installed in accordance with the manufacturer's installation instructions.

Fixed baffles on the water heater side of draft hoods and draft regulators shall not be classified as dampers.

Section 1314- Vent Connector

(a) Connectors used for gas water heaters having draft hoods may be constructed of non-combustible materials having resistance to corrosion not less than that of galvanized sheet steel and be of a thickness not less than that specified in Section 1323(b) or they may be of Type B or Type L vent material.

(b) Single wall metal vent connectors shall be securely supported and joints fastened with sheet metal screws, rivets, or other approved means.

(c) Single wall metal pipe used as a connector shall not originate in an unoccupied attic or concealed space and shall not pass through any attic, inside wall, floor, or concealed space and shall be located in the same room or space as the fuel burning water heater.

Section 1315- Location and Support of Venting Systems

Combustion products vents, vent connectors, or exhaust ducts shall not extend into or through any air duct.

EXCEPTION: A venting system may pass through a combustion air duct.

The base of every vent which extends to the ground shall rest on a solid masonry or concrete base not less than two (2) inches (50.8 mm) in thickness. The base of every vent which does not extend to the ground and is not self-supporting, shall rest on a firm metal or masonry support.

No water heater shall be vented into a fireplace or into a chimney serving a fireplace.

All venting systems shall be adequately supported for the weight and the design of the material used.

Section 1316- Length, Pitch, and Clearance

(a) **Vent Offsets:** Except as provided for in Section 1312 (d), gravity vents shall extend in a generally vertical direction with offsets not exceeding forty-five (45) degrees. A vent may have one (1) offset of not more than sixty (60) degrees.

(b) Every offset shall be supported for its weight and shall be installed to maintain proper clearance, to prevent physical damage and to prevent separation of the joints.

(c) Any angle greater than forty-five (45) degrees from the vertical is considered horizontal. The total horizontal run of a vent, plus the horizontal vent connection, shall be not greater than seventy-five (75) percent of the vertical height of the vent.

(d) **Rise:** Every vent connector which is a part of a gravity-type venting system shall have a continuous rise of not less than one-fourth (1/4) inch per foot (20.9 mm/m) of length measured from the appliance vent collar to the vent.

(e) **Clearance:** Single wall metal vent connectors, where permitted to be used by Section 1314, shall be provided with clearances from combustible material of not less than six (6) inches (152.4 mm).

Section 1317- Vent Termination

(a) **General:** Vents shall extend above the roof surface, through a flashing, and terminate in an approved or listed vent cap which shall be installed according to its listing and manufacturer's instruction.

EXCEPTION: A direct vent or mechanical draft appliance shall be acceptable when installed according to its listing and manufacturer's instructions.

(b) **Gravity-type:** No gravity-type venting system, other than a venting system which is an integral part of a listed water heater shall terminate less than five (5) feet (1.5 m) above the highest vent collar which it serves.

(c) **Type B:** No Type B gas vent shall terminate less than one (1) foot (.3 m) above the roof through which it passes, nor less than four (4) feet (1.2 m) from any portion of the building which extends at an angle of more than forty-five (45) degrees upward from the horizontal nor less than shown in Figure No. 1.

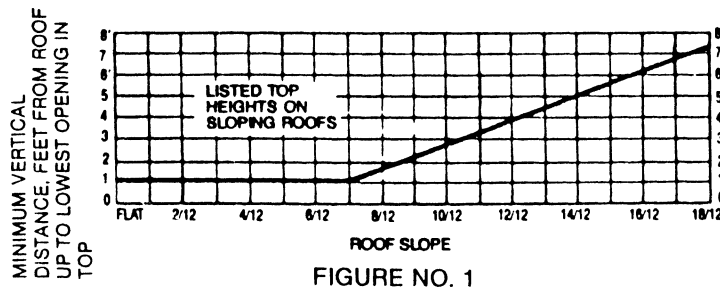


FIGURE NO. 1

(d) **Type L:** No Type L venting system shall terminate less than two (2) feet (.6 m) above the roof through which it passes, nor less than four (4) feet (1.2 m) from any portion of the building which extends at an angle of more than forty-five (45) degrees upward from the horizontal.

→ (e) **Venting Termination-** No vent system shall terminate less than four (4) feet (1.2 m) below or four (4) feet (1.2 m) horizontally from, nor less than one (1) foot (.3 m) above any door, openable window, or gravity air inlet into any building.

EXCEPTION: Vent terminals of direct vent appliances with inputs of 50,000 Btu/h or less shall be located not less than 9 inches (23 cm) from any opening through which combustion products could

enter a building. Such appliances with inputs over 50,000 Btu/h shall require 12-inch (.3m) vent termination clearances. The bottom of the vent terminal and the air intake shall be located at least 12 inches (.3 m) above grade.

(f) No venting system shall terminate less than three (3) feet (.9 m) above any forced air inlet located within ten (10) feet (3 m) or less than four (4) feet (1.2 m) from any property line except a public way.

Section 1318- Area of Venting System

Every venting system shall have an internal cross-sectional area of not less than the area of the vent collar on the water heater unless the venting system has been designed in accordance with Section 1312(d). In no case shall such area be less than seven square inches (4516.1 mm²), unless the venting system is an integral part of a listed water heater.

Section 1319- Multiple Appliance Venting

Two (2) or more oil or listed gas-burning appliances may be connected to one common gravity-type venting system provided the appliances are equipped with an approved primary safety control capable of shutting off the burners and the venting system is designed to conform with Section 1312(d) of this Code or complies with the following requirements:

(1) Appliances which are connected to a common venting system shall be located within the same story of the building, excepting engineered venting systems as provided in Section 1312(d).

(2) Two (2) or more connectors shall not enter a common venting system unless the inlets are offset in such a manner that no portion of any inlet is opposite the other inlets.

(3) Where two (2) or more appliances are connected to one venting system, the venting system area shall be not less than the area of the largest vent connector plus fifty (50) percent of the areas of the additional vent connectors. An oval vent may be used provided its area is not less than the area of the round pipe for which it is substituted.

(4) Each vent connector of a multiple venting system shall have the greatest possible rise consistent with the headroom available between the draft hood outlet, the barometric damper or the flue collar and the point of interconnection to a manifold, to a common vent, or to a chimney.

Section 1320- Existing Venting System

An existing venting system shall not be connected to a replaced

water heater unless the venting system complies with all the following requirements:

(1) The venting system shall have been lawfully installed in compliance with the Code in effect at the time of its installation and shall be in a safe condition.

(2) The internal area of the venting system shall comply with Section 1318.

(3) The venting system shall be connected to the water heater in a safe manner.

Section 1321- Draft Hoods

Every water heater draft hood shall be located in the same room or space as the combustion air opening of the water heater.

Every draft hood shall be installed in the position for which it was designed and shall be located so that the draft hood relief opening is not less than six (6) inches (152.4 mm) from any surface other than the water heater it serves, measured in a direction 90 degrees to the plane of the relief opening. When a greater clearance is indicated by the water heater approval, as shown on the water heater label, this greater clearance shall be provided.

Section 1322- Existing Masonry Chimneys

Gas venting into existing masonry chimneys.

(a) Existing lined masonry chimneys and unlined chimneys with not more than one (1) side exposed to the outside may be used to vent gas water heater provided:

(1) Approved liner shall be installed in an existing unlined masonry chimney when deemed necessary by the Administrative Authority considering local problems of vent gas condensation.

(2) The effective cross-sectional area is not more than four (4) times the cross-sectional area of the vent and chimney connectors entering the chimney.

(3) The effective area of the chimney when connected to more than one (1) appliance shall not be less than the area of the largest vent or chimney connector plus fifty (50) percent of the area of the additional vent or chimney connectors.

(4) Automatically controlled gas water heaters connected to a chimney which also serves equipment burning liquid fuel shall be equipped with an automatic pilot. A gas water heater chimney connector and a chimney connector from an appliance burning liquid fuel may be connected into the same chimney through separate openings providing the gas water heater is vented above the other fuel-burning appliance or both may be connected through a single opening if joined by a suitable fitting located at the chimney. If two (2)

or more openings are provided into one (1) chimney, they shall be at different levels so that no portion of one (1) inlet is in the same horizontal plane of another inlet.

(5) The chimney passage way shall be examined to ascertain that it is clear and free of obstruction and shall be cleaned if previously used for venting solid or liquid fuel-burning appliances.

(6) The vent or chimney connector shall enter the chimney not less than six (6) inches (152.4mm) from the bottom of the chimney. The chimney shall be provided with a cleanout. If six (6) inches (152.4mm) are not available, a cleanout shall be provided by installing a capped tee in the vent connector next to the chimney.

(b) Unlined chimneys with more than one (1) side exposed to the outside shall be lined with an approved liner unless otherwise approved by the Administrative Authority.

(c) When inspection reveals that an existing chimney is not safe for the intended application, it shall be rebuilt in a manner acceptable to the Administrative Authority or replaced with an approved gas vent or factory built chimney.

Section 1323- Chimney Connectors

(a) **Materials:** Chimney connectors shall be constructed of single wall metal conforming with subsection (b) of this section or of other materials approved for the use intended.

(b) **Single Wall Steel:** Chimney connectors made of single wall steel pipe and serving low-heat appliances shall be of not less than the following gauges:

Diameter of Connector		Galvanized
(in inches)	(in millimeters)	Sheet Gauge No.
5 or less	127 or less	28
Over 5 to 9	Over 127 to 228.6	26
Over 9 to 12	Over 228.6 to 204.8	22
Over 12 to 16	Over 304.8 to 406.4	20
Over 16	Over 406.4	16

(c) Installation:

(1) Two (2) or more chimney connectors shall not be joined unless the common connector, the manifold, and the chimney are sized properly to serve the appliances connected thereto and adequate draft is available to remove all products of combustion to the outdoors.

Connectors serving gravity vent-type water heaters shall not be connected to a venting system served by a power exhauster unless the connection is made on the negative pressure side of the power exhauster.

(2) Single wall metal chimney connectors shall be installed with clearance to combustibles of not less than six (6) inches (152.4 mm).

(3) All connectors shall be as short and straight as possible. A water heater shall be located as close as practicable to the venting system. The connector shall be not longer than seventy-five (75) percent of the portion of the venting system above the inlet connection unless a part of an approved engineered venting system.

(4) A connector to a masonry chimney shall extend through the wall to the inner face of liner but not beyond and shall be firmly cemented to masonry. A thimble may be used to facilitate removal of the connector for cleaning, in which case, the thimble shall be permanently cemented in place. Connectors shall not pass through any floor or ceiling.

(5) A draft regulator shall be installed in the connector serving a liquid fuel burning water heater unless the water heater is approved for use without a draft regulator.

A draft regulator, when used, shall be installed in the same room or enclosure as the water heater in such a manner that no difference in pressure between air in the vicinity of the regulator and the combustion air supply will be permitted.

Section 1324- Mechanical Draft Systems

(a) **Forced or Induced Draft Systems.** Water heaters may be vented by means of a mechanical draft system of either forced or induced draft design.

(b) **Positive Pressure System.** Forced draft systems and all portions of induced draft systems under pressure during operation shall be designed and installed so as to be gastight or as to prevent leakage of combustion products into a building.

(c) **Interconnected Systems.** Vent connectors serving gas appliances vented by natural draft shall not be connected into any portion of a mechanical draft system operating under positive pressure.

(d) **Interlock Controls.** When a mechanical draft system is employed, provisions shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the water heater for safe performance.

(e) **Exit Terminals.** The exit terminals of mechanical draft systems shall be located not less than twelve (12) inches (304.8 mm) from any opening through which combustion products could enter the building, nor less than two (2) feet (.6 m) from an adjacent building, and not less than seven (7) feet (2.1 m) above grade when located adjacent to public walkways.

Section 1325- Venting Through Ventilating Hoods and Exhaust Systems

(a) **Commercial Applications.** Ventilating hoods and exhaust systems may be used to vent gas-burning water heaters installed in commercial applications.

(b) **Dampers Prohibited.** When automatically operated water heaters are vented through natural draft ventilating hoods, dampers shall not be installed in the ventilating system.

(c) **Interlock Controls.** When the ventilating hood or exhaust system is equipped with power means of exhaust, the water heater control system shall be interlocked so as to permit water heater operation only when the power means of exhaust is in operation.

Tab C

**AMERICAN
NATIONAL
STANDARD**

**ANSI
Z21.10.1
1990**

GAS WATER HEATERS

**Volume I
Storage Water Heaters
With Input Ratings of
75,000 Btu Per Hour or Less**



Secretariat

AGA

American Gas Association

Twenty-Fourth Edition - 1990
(Volume I - Storage Water Heaters
With Input Ratings of 75,000 Btu Per Hour or Less)

Approved
April 30, 1990
AMERICAN NATIONAL
STANDARDS INSTITUTE, INC.

For standards covering other types of water heaters see:

Volume III - Storage, With Input Ratings Above
75,000 Btu Per Hour, Circulating and
Instantaneous Water Heaters

Printed in U.S.A.

by

American Gas Association Laboratories
8501 East Pleasant Valley Road
Cleveland, Ohio 44131

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PREFACE

This publication represents a standard for safe operation, substantial and durable construction, and acceptable performance of storage gas water heaters with input ratings of 75,000 Btu per hour (21 980 W) or less. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on water heaters designed for the utilization of gas. There are risks of injury to persons inherent in some appliances that, if completely eliminated, would defeat the utility of the appliance. The provisions in this standard are intended to reduce such risks while retaining the normal function of the appliance.

Nothing in this standard is to be considered in any way as indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow compliance of storage gas water heaters, the construction and performance of which may exceed the various provisions specified herein. In its preparation, full recognition has been given to possibilities of improvement through ingenuity of design. As progress takes place, revisions may become necessary. When they are believed desirable, recommendations should be forwarded to the Chairman of Accredited Standards Committee Z21, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131.

Safe and satisfactory operation of a storage gas water heater depends to a great extent upon its proper installation and it should be installed in accordance with the National Fuel Gas Code, Z223.1; manufacturer's installation instructions; and local municipal codes.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute, Inc., require that action be taken to reaffirm, revise or withdraw this standard no later than five (5) years from the date of approval. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018, (212) 354-3300.

EFFECTIVE DATE: An organization using this standard for product evaluation as a part of its certification program will normally establish the date by which all products certified by that organization should comply with this standard.

HISTORY OF DEVELOPMENT OF STANDARD FOR GAS WATER HEATERS

(This History is informative and is not part of the standard)

The "Gas Appliance Testing Code," published in 1924 by the Pacific Coast Gas Association, contained what appears to be the first printed specifications covering the construction and performance of gas water heaters. In April 1925, the Approval Requirements Committee of the American Gas Association (A.G.A.) appointed a subcommittee for the purpose of formulating a standard to be used as the basis for testing gas water heaters by the A.G.A. Testing Laboratories, which were then being organized.

Shortly thereafter, a joint investigation was started by the A.G.A. Testing Laboratories and the U. S. Bureau of Standards for the purpose of developing basic standards of safety, durability, and performance which all gas water heaters should be required to meet. The recommendations of these two organizations were considered by the subcommittee and a draft standard drawn up, which was approved by the A.G.A. Approval Requirements Committee in February 1927. After being printed and distributed to the industry for criticism, the standard was again reviewed by both groups, approved, and published in final form by the American Gas Association in July 1927. Revised editions were published in June 1928 and September 1930.

On September 11, 1930, the A.G.A. Approval Requirements Committee became Sectional Committee Z21 of the American Standards Association; consequently, subsequent editions of the gas water heater standard were developed in accordance with American Standards Association procedures.

Revisions to this standard reflecting the latest developments and improvements were approved by the subcommittee during 1931. This draft standard was adopted by the Z21 Committee and approved as American Standard by the American Standards Association in September 1933. Following this procedure, thirteen subsequent editions of this standard were approved by the American Standards Association from 1935 to 1966.

Addenda were issued to a number of the above standards. With the thirteenth edition, approved as American Standard by the American Standards Association in August 1956, a standard for side-arm type water heaters was published in a separate volume. With the fifteenth edition, approved as American Standard by the American Standards Association in July 1960, a standard for circulating

tank, instantaneous and large automatic storage type water heaters was published in a separate volume and provisions covering nonautomatic storage type water heaters were discontinued due to lack of interest in this type of appliance.

On August 24, 1966, the American Standards Association was reconstituted as the United States of America Standards Institute and, on October 6, 1969, was renamed the American National Standards Institute, Inc. As a result of this, plus the expansion of the standard to cover automatic storage water heaters with inputs of 75,000 Btu per hour or less, the eighteenth edition of this standard, retitled American National Standard for Gas Water Heaters, Volume I, Automatic Storage Type Water Heaters With Inputs of 75,000 Btu Per Hour or Less, was approved as American National Standard by the American National Standards Institute, in March 1971.

Following the procedures outlined above, five subsequent editions of the Volume I water heater standard were approved as American National Standard by the American National Standards Institute, Inc., between 1974 and 1987.

This, the twenty-fourth edition of Volume I of the water heater standard, which includes revisions consonant with industry developments, was approved as American National Standard by the American National Standards Institute, Inc., on April 30, 1990.

Previous editions of this standard and addenda thereto, which have been approved by the American National Standards Institute or its predecessor organizations are as follows:

Z21.10-1933		
Z21.10-1935		
Z21.10-1937		
Z21.10-1938		
Z21.10-1941		
Z21.10-1944	Z21.10a-1945	
Z21.10-1949		
Z21.10-1950	Z21.10a-1951	Z21.10b-1952
Z21.10-1953	Z21.10a-1954	Z21.10b-1955
Z21.10.1-1956	Z21.10.1a-1957	Z21.10.1b-1958
Z21.10.1-1959	Z21.10.1a-1960	
Z21.10.1-1960	Z21.10.1a-1961	
Z21.10.1-1962	Z21.10.1a-1963	
Z21.10.1-1966		
Z21.10.1-1971	Z21.10.1a-1972	Z21.10.1b-1972

Z21.10.1-1974	Z21.10.1a-1975	
Z21.10.1-1975	Z21.10.1a-1978	Z21.10.1b-1979
Z21.10.1-1981	Z21.10.1a-1982	Z21.10.1b-1983
Z21.10.1-1984	Z21.10.1a-1985	Z21.10.1b-1986
Z21.10.1-1987	Z21.10.1a-1988	Z21.10.1b-1989

NOTE: This 19 edition of Z21.10.1 incorporates changes to the 1987 edition of Z21.10.1 and addenda thereto. Changes other than editorial are denoted by a vertical line in the margin except the following:

- Former 1.12.15 relocated as 1.31.14;
- Former 1.12.16 relocated as 1.5.3;

- Former 2.5.5 relocated as 2.4.6;
- Former 2.5.9, which specified a test to verify the pilot effectively ignites the main burner, deleted;
- Former 2.5.10, which specified a continuous pilot no be extinguished when the main burner(s) is turned on or off, deleted;
- Former 2.5.12, which specified burners and pilots shall operate without undue noise, deleted.

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AMERICAN NATIONAL STANDARD FOR GAS WATER HEATERS

Volume I Storage Water Heaters With Input Ratings of 75,000 Btu Per Hour or Less

PART I CONSTRUCTION

1.1 SCOPE

1.1.1 This standard applies to newly produced, automatic storage water heaters having input ratings of 75,000 Btu per hour (21 980 W) or less (see Part IV, Definitions), hereinafter referred to as water heaters or appliances, constructed entirely of new, unused parts and materials:

- a. For use with natural gas;
- b. For use with manufactured gas;
- c. For use with mixed gas;
- d. For use with liquefied petroleum gases;
- e. For use with LP gas-air mixtures;
- f. For manufactured home (mobile home) installation for use with liquefied petroleum gases only (see 1.2.23);
- g. For recreational vehicle installation for use with liquefied petroleum gases only (see 1.2.24);
- h. For manufactured home (mobile home) installation convertible for use with natural gas and liquefied petroleum gases when provision is made for the simple conversion from one gas to the other (see 1.2.23); and
- i. For recreational vehicle installation convertible for use with natural gas and liquefied petroleum gases when provision is made for the simple conversion from one gas to the other (see 1.2.24).

Large automatic storage water heaters having input ratings above 75,000 Btu per hour (21 980 W), circulating water heaters, and instantaneous water heaters are covered in Volume III.

1.1.2 This standard covers the recovery efficiency and standby loss, and related markings, of only those water heaters whose efficiencies are not regulated by the Energy Policy and Conservation Act of 1975 and the National Energy Conservation Policy Act of 1978.*

1.1.3 Direct vent water heaters anticipated by this standard are essentially balanced flue appliances with the air intake and vent outlet in close proximity. Other designs shall be subjected to such additional tests as believed necessary at the discretion of the testing agency.

1.1.4 Water heaters for installation in recreational vehicles shall be of the direct vent type.

1.1.5 This standard also applies to water heaters with draft hoods which are factory equipped with automatic vent damper devices (see Part IV, Definitions), hereinafter referred to as vent damper devices.

1.1.6 This standard also applies to water heaters of other than the direct vent type which are factory equipped with electrically operated or mechanically actuated automatic flue damper devices (see Part IV, Definitions), hereinafter referred to as flue damper devices.

1.1.7 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated value is to be regarded as the specification.

1.1.8 Exhibit D contains a list of standards specifically referenced in this standard, and sources from which these reference standards may be obtained.

* At the time of this printing, the above acts regulate the recovery efficiency and standby loss of water heaters having a manufacturer's specified storage capacity of not less than 20 gallons (75.7 L) nor more than 100 gallons (378.5 L) having input ratings up to and including 75,000 Btu per hour (21 980 W), and which are not for recreational vehicle installation only. For information, contact the U.S. Department of Energy, Conservation and Solar Applications, Consumer Products Efficiency Branch, 20 Massachusetts Ave. N.W., Washington, DC 20545.

1.2 GENERAL CONSTRUCTION AND ASSEMBLY

1.2.1 Water heaters shall be tested for operation at an outlet water temperature of 160 F (71 °C). In addition, an appliance intended to deliver outlet water at a temperature in excess of 160 F (71 °C) shall be tested for operation at an outlet water temperature of 180 F (82 °C) during the conduct of 2.19 and 2.21, and shall comply with the special provisions of 1.31.18 and 2.13.2.

1.2.2 The construction of a water heater, whether specifically covered in this standard or not, shall be in accordance with reasonable concepts of safety, substantiality and durability.

All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance.

1.2.3 Every part of a water heater shall be secure against displacement and constructed to maintain a fixed relationship between essential parts under normal and reasonable conditions of handling and usage.

Parts not permanently secured shall be designed so they cannot be incorrectly assembled or improperly located when removed and replaced during cleaning or other servicing.

In submitting an appliance for test, the manufacturer may furnish a list of manufacturing tolerances applicable thereto and may have the appliance tested for compliance with this standard in both extremes of tolerances specified.

1.2.4 Legs or spacers necessary for installation of a direct vent water heater in accordance with the manufacturer's installation instructions shall be furnished by the manufacturer as an integral part of the appliance including the vent extension and terminal. These legs or spacers shall be located so as to preclude installation of the appliance at clearances from combustible construction less than those specified by the manufacturer. See Figure 1 for examples of spacer locations on typical appliances for installation in manufactured homes (mobile homes) and recreational vehicles.

1.2.5 The general construction and assembly of the water heater shall be of a neat and workmanlike character with parts well fitted and bolts or other fasteners drawn up tightly to give rigidity. Any exposed edges which might reasonably be brought in contact with the hand during servicing and usage shall be smooth.

1.2.6 Asbestos shall not be used in the construction of a water heater unless it is contained, protected or combined in a binder material in a manner which will not permit asbestos fibers to become airborne under normal conditions of appliance use.

1.2.7 An opening of sufficient size to permit ready access for cleaning the burner compartment shall be provided in the water heater casing.

1.2.8 Adequate means shall be provided to prevent products of combustion or condensation from the products of combustion from coming in contact with insulating material above the burner port level, unless the manufacturer submits evidence to the testing agency that the material used is satisfactory for the conditions to which it may be subjected. This provision shall not be construed to apply to the use of reasonable tolerances for assembly.

1.2.9 The means of flame adjustment shall be secure so the adjustment cannot be changed unintentionally.

1.2.10 A direct vent water heater shall be provided with the vent-air intake system as part of the appliance. Vent-air intake systems shall be provided with means for secure attachment to the appliance or wall structure.

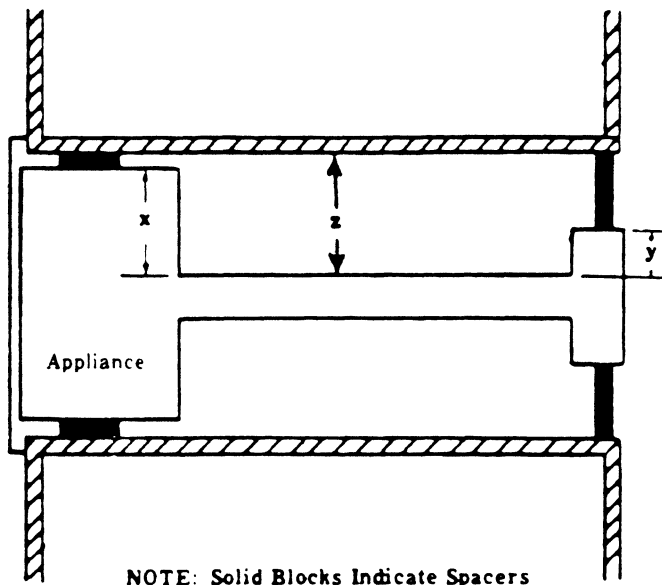
1.2.11 Storage vessels shall be equipped with a drain valve to facilitate emptying the tank for cleaning or withdrawing small quantities of water to eliminate foreign deposits. Drain valves on counter-type water heaters shall be accessible from the front of the appliance.

1.2.12 Bolts and screws, except sheet-metal screws, used in the general assembly of water heaters, shall have threads conforming to the Standard for Unified Inch Screw Threads (UN and UNR Thread Form), ANSI ASME B1.1.

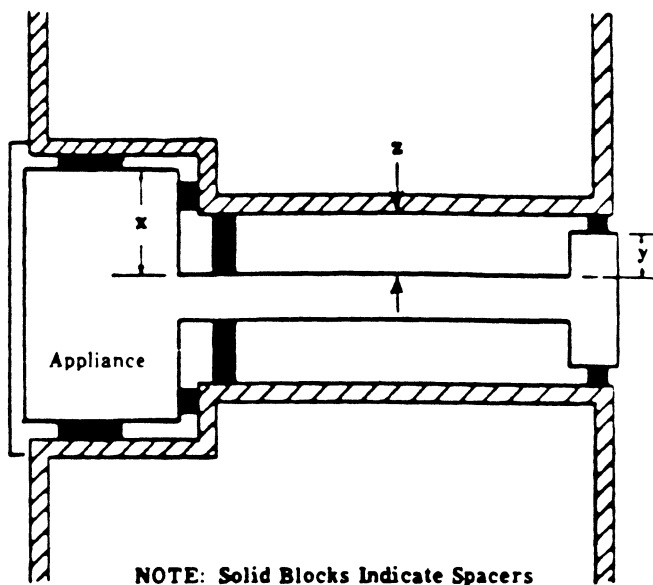
1.2.13 Slotted or recessed head screws used in the construction and assembly of water heaters shall conform to the Standard for Slotted Head Cap Screws, Square Head Set Screws and Slotted Headless Set Screws, ANSI B18.6.2, the Standard for Slotted and Recessed Head, Machine Screws and Machine Screw Nuts, ANSI B18.6.3, or the Standard for Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws (Inch Series), ANSI B18.6.4.

1.2.14 Wrench head bolts and nuts used in the construction or assembly of water heaters shall conform to the Standard for Square and Hex Bolts and Screws, Inch Series, ANSI B18.2.1, or the Standard for Square and Hex Nuts (Inch Series), ANSI ASME B18.2.2.

A For appliances where z , the manufacturer's specified clearance from vent extension is greater than x and y



B For appliances where z , the manufacturer's specified clearance from vent extension, is less than x and greater than y



C For appliances where z , the manufacturer's specified clearance from vent extension, is less than both x and y

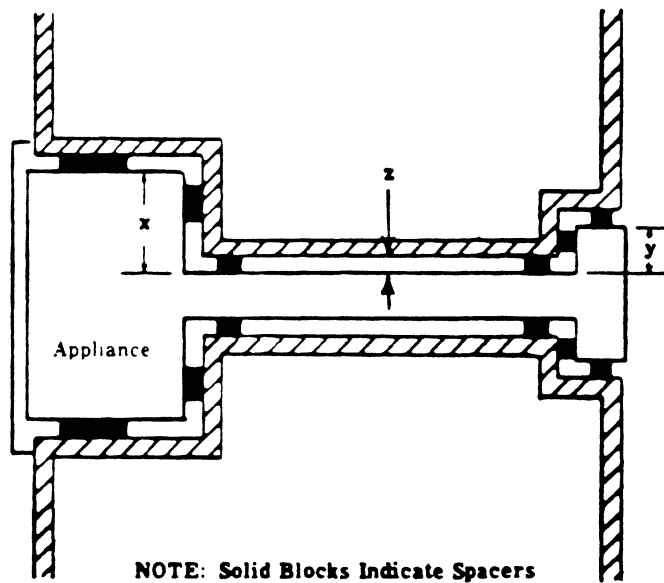


Figure 1*

Examples of Test Structure and Spacer Locations for a Typical Direct Vent Water Heater for Installation in Manufactured Homes (Mobile Homes) and Recreational Vehicles

* Figure 1 shows the basic principles of the construction of a test enclosure and the general location of spacers necessary to maintain the clearances from combustible construction and is not intended to restrict innovative appliance design

1.2.15 Tap bolts used to attach air shutters shall be of corrosion-resistant material, or, if of steel, shall have a metallic corrosion-resistant coating.

1.2.16 Tap screws used for attaching pipe supports shall not be less than $\frac{3}{16}$ inch (No. 10) size.

1.2.17 When it is necessary to remove the flue baffle to clean the flue gas passageways, flue baffles of internal flue type water heaters shall be designed for removal within the clearances specified by the manufacturer. Removal by means of bending the baffle shall be considered as complying with this provision provided that operation of the appliance is not adversely affected after the baffle has been so removed and replaced.

1.2.18 Water heaters shall be constructed to prevent incandescent particles from falling to the floor.

1.2.19 A water heater for installation in manufactured homes (mobile homes) and recreational vehicles shall be provided with means for secure attachment to the vehicle structure.

1.2.20 A water heater, except of the direct vent type, for installation in a manufactured home (mobile home) shall be provided with:

- a. Instructions for access of combustion and ventilation air to the appliance enclosure from the outside (see 1.4.3); and
- b. Means for venting flue gases to the outdoors unless the necessary parts to accomplish this are of specific types listed by a nationally recognized testing agency and the appliance manufacturer's instructions identify and specify the use of such specific parts.

1.2.21 A water heater for outdoor installation shall have all controls and electrical wiring adequately protected from climatic conditions as determined under 2.33.1.

1.2.22 A water heater for outdoor installation, which is not suitable for use with a conventional venting system, shall be provided with the venting system as a part of the appliance. Venting systems which are a part of the appliance shall be provided with a means for secure attachment to the water heater.

1.2.23 Special construction provisions applicable to water heaters for installation in manufactured homes (mobile homes) are outlined under 1.1.1-f and -h, 1.2.19, 1.2.20, 1.6.11, 1.9.3, 1.15.11, 1.16.3, 1.25.1, 1.28.41, 1.30.5, 1.31.2-a, 1.31.4, 1.31.30 and 1.31.32.

1.2.24 Special construction provisions applicable to water heaters for installation in recreational vehicles are outlined under 1.1.1-g and -i, 1.1.4, 1.2.19, 1.2.25, 1.6.11, 1.9.3, 1.15.4, 1.15.11, 1.16.3, 1.28.42, 1.28.43, 1.30.1, 1.30.5, 1.31.2-a and 1.31.7.

1.2.25 Special construction provisions applicable to direct vent water heaters are outlined under 1.1.3, 1.2.4, 1.2.10, 1.3.9, 1.4.3, 1.4.5, 1.5.1, 1.6.9, 1.25.1, 1.28.42, 1.29, 1.30.8, 1.31.2-a, 1.31.29 and 1.31.38.

1.2.26 Special construction provisions applicable to water heaters for outdoor installation are outlined under 1.2.21, 1.2.22, 1.3.8, 1.4.3, 1.4.4, 1.5.6, 1.5.7, 1.25.1, 1.28.40, 1.31.27 and 1.31.28.

1.3 MATERIALS

1.3.1 The manufacturer shall supply evidence that materials in contact with potable water are suitable for food contact surfaces.

1.3.2 Parts and fittings shall not sag, distort, melt, nor show leakage of gas when used as a gas conduit during any of the tests specified herein.

At the conclusion of all performance tests specified herein, parts and fittings shall be carefully examined for any evidence of distortion and leakage.

Parts which are free from leakage and show no evidence of distortion comply with this provision.

1.3.3 All parts, except trim, shall have rigidity and corrosion resistance not less than that of 0.0195* inch (0.495 mm) thick AISI C1010 steel.

1.3.4 Flue tubes having an outside diameter of 5 inches (127 mm) or less shall have a wall thickness in inches not less than:

$$\frac{D}{50} + FC$$

where

D = the outside diameter of the flue tube in inches (mm), and

FC = a corrosion factor, equal to 0.011 inch (0.279 mm) for uncoated flue tubes and 0.000 inch for flue tubes with a fired ceramic coating in the flueway.

Flue tubes having an outside diameter in excess of 5 inches (127 mm) shall have a minimum thickness of 0.100 inch (2.54 mm) if coated and 0.111 inch (2.82 mm) if uncoated.

* This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included

When a fired ceramic coating is used, it shall have a minimum average thickness of 3 mils (0.076 mm). Discontinuities, other than in girth weld zones or in ends projecting beyond these welds, shall be minimal.

1.3.5 All internal parts up to and including the flue collar, except flue baffles, with surfaces in contact with flue gases shall have rigidity, and heat and corrosion resistance not less than that of 0.0304* inch (0.772 mm) thick AISI C1010 steel. The manufacturer shall submit evidence to the testing agency that the material used in fabrication of internal parts is satisfactory for the temperature and corrosion conditions to which it may be subjected.

1.3.6 Flue baffles, if of sheet metal, shall have heat and corrosion resistance equivalent to 0.0399** inch (1.01 mm) thick AISI C1010 steel.

1.3.7 The finish of jackets and other exposed parts shall be durable and uniformly applied. After the conduct of all tests specified herein, it shall not show undue discoloration or deterioration.

1.3.8 On a water heater for outdoor installation, ferrous materials used in the construction of the outside casing, and in an outside cabinet which is the sole enclosure of current-carrying parts, shall be protected against corrosion by one of the coatings appropriate to the thickness of the part as outlined in Table I and the notes applicable thereto, or by other metallic or nonmetallic coatings which have been shown to give equivalent protection.

Nonferrous cabinets and enclosures may be employed without special corrosion protection. The design, thickness and the material is to be judged on the basis of its strength, rigidity, weather resistance and structural integrity.

1.3.9 Materials used in the construction of direct vent water heaters shall have strength, rigidity, durability, resistance to corrosion and other physical properties equivalent to:

Vent pipes and radiation shields exposed to combustion products as shown in Table XII. In addition, vent pipes of aluminum may be used provided the material is 0.020 inch (0.508 mm) thick having a corrosion resistance at least equivalent to Type 1100 (see 2.34.4).

Liners, air intakes within the exterior casings, radiation shields not exposed to combustion products, and recessed portion of casings 0.0152 inch* (0.386 mm) thick low carbon steel

Outside casings (casings of appliances which upon installation are isolated from physical contact are exempt from this specification) . . . 0.0254 inch** (0.645 mm) thick low carbon steel

Air intakes exterior to the casing 0.0152 inch* (0.386 mm) thick with a zinc or cadmium coating equivalent to that specified in Table I

Materials shall be of such composition that they will not disintegrate to the extent that particles will separate and drop upon the burner and affect the safe operation of the appliance.

1.3.10 Nonmetallic parts, except labels, finishes and parts immersed in water, shall be self-extinguishing if capable of being ignited in their operational environment. Nonmetallic parts shall be suitable for the temperature to which they are exposed under normal operating conditions.

1.4 COMBUSTION AIR SUPPLY

1.4.1 Construction of counter-type water heaters shall be such that air for combustion is supplied through fixed openings which terminate in locations at least 1 inch (25.4 mm) from the floor.

1.4.2 When combustion air is supplied through a member that can be removed from the water heater casing, said member shall be designed so as to prevent its being attached in an improper manner or being interchanged with other members on the same appliance that may interfere with its performance.

* This corresponds to No. 20 U.S. Standard gage sheet steel with all applicable minus tolerances included.

** This corresponds to No. 18 U.S. Standard gage sheet steel with all applicable minus tolerances included

* This corresponds to No. 26 U.S. Standard gage sheet steel with all applicable minus tolerances included.

** This corresponds to No. 22 U.S. Standard gage sheet steel with all applicable minus tolerances included

TABLE I
MINIMUM CORROSION PROTECTION OF FERROUS MATERIALS
USED IN THE CONSTRUCTION OF WATER HEATERS
FOR OUTDOOR INSTALLATION

<u>WATER HEATER PART</u>	<u>METAL THICKNESS</u>	<u>COMPLIANCE WITH NOTE(S):</u>
Outside Casing	Not less than 0.0508* inch (1.29 mm)	1, 2 or 3
Outside Casing	Less than 0.0508* inch (1.29 mm)	4, 5, 6, 7 or 8
Outside cabinet which is the sole enclosure of current-carrying parts	Of any thickness	4, 5, 6, 7 or 8

NOTES APPLICABLE TO TABLE I

- Hot-dipped mill galvanized sheet steel conforming with the coating designation G60 or A60 specified in Table I of General Requirements, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, ASTM A525, with not less than 40 percent of the zinc on either side. The weight of zinc coating may be determined by any suitable method. However, in case of question, the weight of coating shall be established in accordance with Methods of Test for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90. A hot-dipped mill galvanized A60 (alloyed) coating or an annealed zinc coating which is bent or similarly formed after annealing shall be additionally painted in the bent or formed area if the bending or forming process damages the zinc coating, except on the inside surfaces of a cabinet or enclosure not exposed to water when tested in accordance with 2.33.1. (This shall also apply to annealed coatings complying with Notes 2 and 5);
- A zinc coating, provided by a method other than that specified in Note 1, uniformly applied to an average thickness of not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established in accordance with Method for Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section, ASTM B487, Method for Measurement of Coating Thicknesses by the Magnetic Method: Non-magnetic Coatings on Magnetic Basis Metals, ASTM B499, or Method for Measuring the Thickness of Metallic Coatings by the Coulometric Method, ASTM B504; or
- Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The suitability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary.
- Hot-dipped mill galvanized sheet steel conforming with the coating designation G90 specified in Table I of ASTM A525, with not less than 40 percent of the zinc on either side. The weight of zinc coating may be determined by any suitable method. However, in case of question, the weight of coating shall be established in accordance with ASTM A90;
- A zinc coating, provided by a method other than that specified in Note 4, uniformly applied to an average thickness of not less than 0.00061 inch (0.0155 mm) on each surface, with a minimum thickness of 0.00054 inch (0.0137 mm). The thickness of the coating shall be established in accordance with ASTM B487, B499 or B504;
- A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of the coating shall be established in accordance with ASTM B487, B499 or B504;
- A zinc coating conforming with Note 1 or 2 with one coat of outdoor paint of the type specified in Note 3 applied to the outside surface.
- A cadmium coating not less than 0.00075 inch (0.0191 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.0005 inch (0.0127 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with ASTM B487, B499 or B504, and the paint shall be as specified in Note 3.

* This corresponds to No. 16 U.S. Standard gage sheet steel with all applicable minus tolerances included.

1.4.3 Circular openings in metal panels provided over outdoor combustion air or vent terminal openings on a direct vent water heater or an appliance for outdoor installation shall be not less than $\frac{1}{4}$ -inch (6.4 mm) in diameter. If openings in such panels are other than circular in shape, they shall permit entrance of a $\frac{9}{16}$ -inch (3.6 mm) diameter rod. All outdoor air inlet openings shall prevent the entrance of a $\frac{3}{4}$ -inch (13.1 mm) diameter rod.

1.4.4 The bottom of the combustion air opening shall not be less than 4 inches (102 mm) above the bottom of the water heater on an appliance for outdoor installation.

1.4.5 The construction of a direct vent water heater shall be such that when installed in accordance with the manufacturer's instructions, the combustion air supply will be taken from outside the structure and the vent outlet will terminate outside the structure in which the appliance is installed.

1.5 WATER HEATER OPENINGS

1.5.1 Connections on direct vent water heaters between the combustion chamber and the casing shall be constructed to prevent possible leakage of combustion products.

1.5.2 Cleanout panels, when provided, shall prevent leakage through the joint. This may be attained by the use of mechanical joints or fireproof gaskets with adequate joining pressure applied.

1.5.3 Water connections and gas connections on counter-type water heaters shall terminate in locations that will provide ample clearance to permit easy manipulation of standard tools, to install gas and water shutoff valves and to connect the appliance to house piping.

1.5.4 Gaskets shall be suitable for the temperatures to which exposed.

1.5.5 Gaskets of access panels or doors shall have sufficient durability to withstand expected usage.

1.5.6 Any access door or panel of a water heater for outdoor installation shall be constructed so that, with the door or panel in place, no water will accumulate within the appliance or appliance enclosure as a result of the test specified under 2.33.1.

1.5.7 Any access door or panel of a water heater for outdoor installation shall require the use of a tool to open.

1.6 BURNERS

1.6.1 Main burners and mixer tubes shall be properly placed and securely positioned so the burners will not twist, slide or drop out of position while in service. This shall be accomplished without the use of bolts, cotter pins or screws within the burner compartment. The construction shall be such that the burner(s) cannot be installed in other than the correct position.

1.6.2 Main burners and pilot devices, or any assemblies thereof, shall be easily removable and replaceable without disconnecting threaded joints of the manifold assembly other than those of a union type. This shall be accomplished without the use of special tools or requiring tool manipulation within the burner compartment.

1.6.3 The burner head shall be a single casting or shall be of an equally gastight and durable construction.

1.6.4 Burners shall be constructed of a corrosion-resistant material, or have a corrosion-resistant finish to resist corrosion by condensate. Steels with coatings, such as paint suitable to the temperature to which exposed, and cast iron are considered corrosion resistant.

1.6.5 Ports shall be machined or otherwise accurately made.

1.6.6 Bolt holes shall not intersect gasways unless adequate provision is made to provide permanent gastightness.

1.6.7 Joints, when used in the pressure zone of a burner assembly, shall not depend for mechanical strength or primarily for tightness on cement or other material of a similar nature. Joints shall be securely bolted, screwed, machined, welded, brazed or be of equivalent construction.

1.6.8 Provision shall be made to permit satisfactory visual observation (direct or indirect) of main burner flames and pilot(s) during adjustment and under operating conditions with the combustion chamber door in place.

1.6.9 Flame observation ports of direct vent water heaters shall be constructed of heat-resistant material and, unless located within the cabinet casing, shall be protected from mechanical damage. Glass, if used, shall be framed and of not less than $\frac{1}{8}$ -inch (3.2 mm) thickness.

1.6.10 All burners shall be constructed and installed so they can be easily removed, thoroughly cleaned and replaced in the field without the use of

special tools. Ribbon burners shall be constructed so the ribbon assembly is securely fixed in position.

1.6.11 Burners of water heaters for manufactured home (mobile home) and recreational vehicle installation convertible for use with natural gas and liquefied petroleum gases shall, without change, operate satisfactorily with test Gases A and E.

1.7 FLAME SPREADERS

1.7.1 When metal is used in the construction of a flame spreader, its support, or baffles located in the combustion chamber above the burner port level which serve as a flame spreader, the metal shall be in accordance with that specified under 2.22.

1.7.2 Flame spreaders and flame spreader supports used with upshot type burners shall be constructed so they cannot be incorrectly fitted together or they shall be marked to indicate the correct method of assembly. When it is necessary to remove the flame spreader for service or assembly, the spreader shall not be attached to its support by a threaded joint or other fixed means unless the support and spreader can be removed and replaced as a unit with the water heater installed as it would be in service.

1.7.3 Flame spreader supports used with upshot type burners shall be constructed so the flame spreader cannot be supported at other than the correct distance above the burner.

1.7.4 Burners shall be provided with means to prevent disintegrated ceramic flame spreader material from falling into the burner port(s). They shall also be designed so disintegration of the ceramic will not cause a hazardous change in the operating characteristics of the burner.

1.8 PRIMARY AIR ADJUSTMENT MEANS

1.8.1 Primary air adjustment means shall be designed so the flow of primary air can be controlled to provide proper flame characteristics.

1.8.2 When adjustable means are provided for control of primary air to the main burner they shall be constructed so as to permit adjustment of flames to yellow tips and to lifting, a hard flame or flash back. The range of adjustment of flames from yellow tips to lifting, hard flames or flash back shall be easily obtained and of reasonable magnitude.

1.8.3 When air shutters are used, there shall be no openings other than the adjustable openings through which primary air may be entrained.

Clearances, such as between air shutters and air mixer faces or around the orifice projection, shall be reduced to a practical minimum so as to have no appreciable effect on the flame characteristics when stopped by lint or other materials.

It is recommended that air shutters be of such design that they have not more than two primary air openings each approximating a circular opening near point of closure or be of such design and construction as can be demonstrated to provide equally effective protection against stoppage by lint and dust.

1.8.4 Means shall be provided to secure air shutters in any desired position. Such means shall be conveniently accessible for adjustment with the burner(s) in place and the water heater in operation and shall be located so as not to interfere with adjustment of orifice caps when used.

1.8.5 Sheet-metal air shutters shall be not less than 0.0254* inch (0.645 mm) thick. If less than 0.0508** inch (1.29 mm) thick, air shutters shall have the outer edge turned at 90 degrees (1.57 rad) or be otherwise properly reinforced. Air shutters shall be constructed of a corrosion-resistant material or have a corrosion-resistant finish. Cast-iron air shutters shall be considered as complying with this provision.

1.8.6 On a water heater provided with an induced draft or power burner, the appliance design shall be such as to prevent gas flow to the main burner(s) in the event the blower motor providing the draft becomes inoperative.

A properly applied centrifugal or sail switch, or equivalent device, meets the intent of this provision. If a centrifugal switch is used, the blower shall be secured to the shaft on which the centrifugal switch is located by means of: keying, two set screws with at least one on a flatted shaft, a locking type set screw on a flatted shaft, or the equivalent.

1.9 MAIN BURNER ORIFICES AND ORIFICE FITTINGS

1.9.1 Orifice fittings, except those used with multiple injection tube burners, shall be readily accessible for adjustment and replacement. In all cases, orifice fittings shall be securely positioned to prevent misalignment with the burner mixer.

1.9.2 Fixed orifices shall be provided for use with liquefied petroleum gases.

* This corresponds to No. 22 U.S. Standard gage sheet steel with all applicable minus tolerances included.

** This corresponds to No. 16 U.S. Standard gage sheet steel with all applicable minus tolerances included.

1.9.3 Threaded hexagon head or equivalent fixed orifice spuds shall be provided for the main burners of water heaters for installation in manufactured homes (mobile homes) and recreational vehicles convertible for use with natural gas or liquefied petroleum gases. They shall be readily accessible after the burner(s) and mixer tube(s) have been removed.

Orifices for both natural and liquefied petroleum gases shall be supplied and shall be properly identified. One set of orifices shall be in place in the pilot and main burners when the appliance is shipped from the factory.

Proper identification as to which orifices are in place in the appliance as shipped shall be provided on the outside front of the appliance, including reference to the location of conversion instructions. This marking may be a tear-off type label worded as follows:

**"THIS WATER HEATER IS EQUIPPED FOR
NATURAL (LP) GAS**

**This heater is equipped with orifices sized for
operation with natural (LP) gas.**

**For conversion to LP (natural) gas see
instruction plate on water heater.**

**Orifices necessary for LP (natural) conversion
are provided ____ *."**

(* Location to be determined by manufacturer.)

1.9.4 Main burner orifice spuds shall be threaded to their holders at least 3½ full threads.

1.9.5 Main burner orifice spuds shall be constructed of metal having a melting point of not less than 1450 F (788 °C).

1.10 AUTOMATIC GAS IGNITION SYSTEMS

1.10.1 Automatic gas ignition systems (see Part IV, Definitions) and components shall comply with the applicable construction provisions of the Standard for Automatic Gas Ignition Systems and Components, ANSI Z21.20.

1.10.2 Every water heater shall be equipped with an automatic gas ignition system(s). This system(s) shall be designed to function in either of the following manners:

- a. Provide for ignition of main burner gas by means of a proved igniter or pilot.

If the presence of the ignition source is not proved, provide for automatic shutoff of:

1. The main burner gas.
2. The pilot burner gas:
 - (a) On an appliance for use indoors, except an appliance for use only with a gas having a specific gravity less than 1.0 and equipped with an automatic relight pilot system;
 - (b) On an appliance for outdoor installation, except an appliance equipped with an automatic relight pilot system and having a pilot input of 1,500 Btu per hour (440 W) or less.

- b. Provide for ignition of main burner gas by means of a direct ignition device.

If the presence of the main burner flame is not proved, provide for automatic shutoff of main burner gas.

In the event of main burner flame outage during an operating cycle, provide for automatic shutoff of main burner gas without reenergizing the direct ignition device or provide for prompt and safe reignition of main burner gas by reenergizing the direct ignition device as stipulated in 2.7.5.

1.10.3 In addition to the automatic gas ignition system functions specified in 1.10.2-a, a system having an interrupted ignition source shall provide for supervision of the main burner flame only following the main burner flame-establishing period. If the presence of the main burner flame is not proved within the flame-establishing period, the system shall provide for automatic shutoff of main burner gas.

1.10.4 When an automatic relight pilot system is used, it shall be of the type that will act to reestablish the ignition means in 0.8 second or less, or a mechanical or electrical interlocking means shall be provided to prevent the flow of gas to the main burner(s) when the automatic relight pilot system is energized.

1.10.5 Safety shutoff devices shall be designed to shut off the gas supply (main or total) in the event of failure of the actuating means which permits gas flow.

1.10.6 Fixed primary air openings on blue flame pilots shall be of a size that will give a satisfactory flame when using the manufacturer's recommended

orifice size for each of the test gases. Otherwise, blue flame pilots shall be equipped with fully accessible adjustable primary air control devices with adequate means for holding them in the desired adjustment position.

1.10.7 Frames and mounting brackets for automatic ignition devices and flame responsive elements shall be constructed of metal having a melting point of not less than 1450 F (788 °C). Pilot burner bodies and orifice spuds shall be constructed of a material having a melting point above 1000 F (538 °C).

1.10.8 The construction of push-button or trigger valves shall be such that they cannot accidentally be blocked in the open position.

1.10.9 An automatic gas ignition device shall be placed so as to be easily seen or, if concealed in normal operation, shall be capable of being viewed by the simple removal of an access cover without the use of special tools.

1.10.10 A manually lighted pilot burner shall be located so as to be capable of being lighted without burning the hand. If a pilot burner ignition device or lighter rod is necessary for safe and convenient pilot ignition, it shall be provided, with means for permanently attaching it to the water heater.

1.10.11 When a manually lighted pilot is provided, the design of the control shall be such that main burner gas flow cannot occur while the pilot is being lighted. The interruption of main burner gas flow shall not depend on the operation of a manual valve which is not mechanically interlocked with the pilot gas control, nor on the thermostat or a separate switch. After the pilot has been established and the safety shutoff device remains in a position that would permit main burner gas flow, an additional manual operation of the control shall be necessary to permit main burner gas flow.

1.10.12 Pilot burners shall be placed so their flames may be directly observed with the main burner(s) off and, unless other means are available for checking operation, shall be observable with the main burner(s) on.

1.10.13 Automatic gas ignition system components shall be installed so the operation of these components and main burner ignition will not be affected by falling scale or dirt during normal operation.

1.10.14 Pilot orifice adjustment means shall be fully accessible for adjustment and servicing. When a fixed orifice is used, the orifice spud shall be easily accessible for removal and replacement.

1.10.15 Automatic gas ignition devices shall be positively positioned with respect to the main burner port(s).

1.10.16 Automatic gas ignition system components, and bleed assemblies when used, shall be made secure against accidental displacement. Except as noted below, pilot burner and igniter assemblies shall be constructed and installed so they may be removed without the use of special tools and without removing main burners, controls or accessories, or breaking or disturbing any gas connection other than that of the pilot supply, bleed supply or manifold unions. Automatic gas ignition system components which are easily removed with main burners and controls as a unit are considered as complying with this provision.

1.10.17 When the pilot supply line is taken from a horizontal line, the connection shall be made on the side, top or, if means are provided to prevent condensate from entering the pilot line, the bottom of the horizontal line. When a pilot gas supply line is taken from a vertical line, the connection shall be above the main burner gas supply line.

1.10.18 The design of pilot gas adjustment devices shall be such as to eliminate leakage. An adjustment screw is considered to comply with this provision if concealed by a gastight closure. Plug core-type pilot adjustment devices shall be spring-loaded.

1.11 PILOT GAS FILTERS

1.11.1 Pilot gas filters complying with the Standard for Pilot Gas Filters, ANSI Z21.35, shall be provided for continuous pilots.

1.11.2 Manufacturer's specified capacities of pilot gas filters shall not be less than the rated capacities of the pilot burners with which they are used.

1.11.3 The pilot gas filter shall be located on the upstream side of the pilot, pilot adjustment device, or other accessory in the pilot supply line, except pilot valves of the plug type when not used as a pilot adjustment device.

1.12 GAS AND WATER CONNECTIONS

The following construction provisions apply to the gas supply lines used within an appliance.

1.12.1 When iron pipe size connections are used, the threads shall be in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

1.12.2 Steel pipe employed as gas conduit on water heaters shall comply dimensionally with the Standard for Welded and Seamless Wrought Steel Pipe, ANSI ASME B36.10.

1.12.3 Tapped holes for gas valves, pilots or other branch supply lines shall provide a continuous run of not less than 3½ taper pipe threads in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI ASME B1.20.1.

1.12.4 Semi-rigid tubing employed as gas conduit shall have a wall thickness in accordance with Table II.

TABLE II

MINIMUM ACCEPTABLE WALL THICKNESS
FOR SEMI-RIGID TUBING

Outside Diameter,		Minimum Acceptable Wall Thickness,	
Inch	(mm)	Inch	(mm)
1 8	(3.2)	0.020	(0.51)
3 16	(4.8)	0.025	(0.64)
1 4	(6.4)	0.029	(0.74)
5 16	(7.9)	0.029	(0.74)
3 8	(9.5)	0.032	(0.81)
7 16	(11.1)	0.032	(0.81)
1 2	(12.7)	0.038	(0.97)
9 16	(14.3)	0.038	(0.97)
5 8	(15.9)	0.038	(0.97)
3 4	(19.1)	0.045	(1.14)
7 8	(22.2)	0.045	(1.14)

1.12.5 Pilot and other gas supply lines made of tinned copper shall not attain temperatures in excess of 350 F (176.5 °C). Pilot and gas supply lines made of other materials shall not attain temperatures in excess of 700 F (371 °C).

All pilot and gas supply lines shall not be subject to other conditions tending to cause corrosion or burnout.

1.12.6 Semi-rigid tubing constructed of aluminum shall not be acceptable for use where the tubing passes through or contacts insulating material of other than neutral reaction unless the tubing is adequately protected from the insulation. Such tubing shall not be exposed to condensate.

1.12.7 Tubing and fittings used as gas conduit shall be capable of withstanding a temperature of 1000 F (538 °C) without melting.

1.12.8 Semi-rigid tubing constructed of brass or copper, or tubing having internal copper surfaces,

when used for conveying gas, shall be internally tinned or equivalently treated to resist corrosion by sulfur compounds.

1.12.9 Ends of piping and tubing shall be carefully cleaned and reamed to remove obstructions and burrs. Bent supply piping shall have the bends smoothly made, and shall reveal no imperfections occasioned by the bending process.

1.12.10 Gas supply piping, tubing and fittings shall be rigidly supported and readily removable without the use of special tools.

1.12.11 Gas supply piping to which connections are made for burners, pilots, lighters or other branch supply lines shall be rigidly supported to prevent turning or displacement in making connections to the building piping or during the ordinary handling of the appliance.

1.12.12 A test gage connection to measure gas pressure, shall be furnished downstream from or on the downstream side of the gas appliance pressure regulator. The test gage connection shall be a tapping sealed by:

- A minimum ¼ inch N.P.T. plugged tapping with threads in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI ASME B1.20.1. If the plug is of the slotted type it shall also incorporate square or hex flats; or
- A fitting capable of accommodating a hose which incorporates a captured sealing means.

The fitting shall have a minimum length of 0.355 inch (9.02 mm) and a 0.355 inch (9.02 mm) maximum/0.335 inch (8.50 mm) minimum outside diameter.

1.12.13 Compounds used on threaded joints of gas piping shall be resistant to the action of liquefied petroleum gases.

1.12.14 Threaded unions used in gas lines shall be of the metal-to-metal type.

1.13 OPENING FOR RELIEF VALVES

1.13.1 Except as outlined in 1.13.2, a storage vessel shall have a tapping separate from the tapping for the water connections to accommodate a temperature and pressure relief valve of adequate size to protect the water heater. This tapping shall be clearly identified on Class III marking material and shall be located (a) in the top of the tank, or (b) in the side of the

tank with its centerline within the upper 6 inches (152 mm) of the tank. The tapping shall be threaded in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI ASME B1.20.1.

1.13.2 A separate tapping is not required if the water heater is equipped with a factory installed fitting which incorporates all of the following features:

- a. An outlet water tapping;
- b. A relief valve opening which is not less than the minimum internal diameter specified in the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22;
- c. A temperature and pressure relief valve as a permanent part. The fitting shall be so constructed that a substitution for the relief valve cannot be made and replacement can only be accomplished with a like part; and
- d. The fitting shall provide that the sensing element of the temperature and pressure relief valve will be located within the upper 6 inches (152 mm) of the tank.

1.14 DIP TUBES

1.14.1 Dip tubes shall be provided with an anti-siphoning hole located so when the dip tube is installed the hole will be within 6 inches (152 mm) of the top of the tank. The anti-siphoning hole shall have a minimum $\frac{1}{8}$ -inch (3.2 mm) diameter, or equivalent.

1.14.2 Nonmetallic dip tubes shall be accompanied by evidence acceptable to the testing agency that the material is suitable for the service, particularly with respect to toxicity, solubility, brittleness, temperature limits, etc.

Evidence of current certification under National Sanitation Foundation Standard 14 for Plastics Piping System Components and Related Materials with appropriate end use shall be deemed acceptable.

1.14.3 Nonmetallic dip tubes shall be permanently marked with the manufacturer's name or trademark and, if possible, the lot number.

1.14.4 Nonmetallic dip tubes shall comply with 2.30.

1.14.5 Nonmetallic dip tubes having a specific gravity less than 1.0 shall be held in place by a positive means which will limit any vertical displacement to not more than $\frac{1}{4}$ inch (6.4 mm).

1.15 MANUALLY OPERATED GAS VALVES

1.15.1 Gas valves shall comply with the applicable construction provisions of the Standard for Manually Operated Gas Valves, ANSI Z21.15.

1.15.2 A manual valve or pilot shutoff device for turning on and shutting off the gas supply to the pilot burner shall be provided and shall be located so as to be readily accessible.

1.15.3 A water heater not for installation in a recreational vehicle shall have a manual gas shutoff valve provided in a readily accessible location for turning on or shutting off the gas to the main burner(s).

1.15.4 A water heater for installation in a recreational vehicle shall have either:

- a. A manual gas shutoff valve provided in a readily accessible location for turning on or shutting off the gas to the main burner(s); or
- b. A readily accessible means at the appliance for manually interrupting the ungrounded leg of the electrical power to both appliance control valves if the appliance has a nominal 12 volt, or less, direct current (d.c.) direct ignition system and two solenoid valves for controlling main burner gas flow.

1.15.5 When the valve is exposed to view, lever or tee handles shall be at 90 degrees (1.57 rad) to the line of flow when in the "off" position and parallel when in the "on" position. If this cannot be done, or if the valve handle only is exposed to view, the "on" and "off" positions or directions of rotation to open and close shall be clearly indicated.

1.15.6 Removable handles shall be constructed so they cannot be attached so as to confuse the "on" and "off" positions.

1.15.7 Gas burner valves shall be located or constructed so they will not be liable to accidental change of setting.

1.15.8 Gas burner valves shall be readily accessible for repair and adjustment.

1.15.9 Adjusting screws for regulating the gas admitted to the pilot or main burner shall be concealed, protected or enclosed.

1.15.10 Lubricants used on valves shall be resistant to the action of liquefied petroleum gases.

1.15.11 When a selector valve is provided on a water heater for installation in manufactured homes (mobile homes) or recreational vehicles convertible for use with natural gas or liquefied petroleum gases to convert the appliance from one fuel to another it shall be arranged so gas cannot enter two sets of orifices simultaneously nor flow through the gas appliance pressure regulator and bypass simultaneously.

1.16 GAS APPLIANCE PRESSURE REGULATORS

1.16.1 Each water heater shall be supplied with one or more gas appliance pressure regulators which will limit the gas pressure to:

- a. The main and pilot burners on appliances equipped with continuous pilot ignition systems; or
- b. The main burner(s) on appliances equipped with intermittent or interrupted ignition systems.

1.16.2 Gas appliance pressure regulators, including vent limiters when so equipped, shall comply with the applicable construction provisions of the Standard for Gas Appliance Pressure Regulators, ANSI Z21.18.

When a single gas appliance pressure regulator is used to control the pressure of both the pilot and main burner gas, it shall be of the type suitable for pilot and main burner load application as designated by the following symbol adjacent to the regulator model number:

- a. $\textcircled{\text{P}}$ for an appliance having a pilot gas flow rate less than 0.50 but not less than 0.15 cubic foot per hour (less than 3.93 but not less than 1.18 cm^3/s); or
- b. $\textcircled{\text{P}}$ or $\textcircled{\text{P}}$ for an appliance having a pilot gas flow rate of 0.50 cubic foot per hour (3.93 cm^3/s) or greater.

1.16.3 Water heaters for installation in manufactured homes (mobile homes) or recreational vehicles convertible for use with natural or liquefied petroleum gases shall be provided with a convertible gas appliance pressure regulator (see Part IV, Definitions).

Gas appliance pressure regulators provided on appliances not for installation in manufactured homes (mobile homes) or recreational vehicles shall be of either the adjustable or nonadjustable type (see Part IV, Definitions).

1.16.4 Gas appliance pressure regulators shall be readily accessible for servicing and replacement.

1.17 ADJUSTMENT OF MINIMUM INPUT RATING

Any field adjustment means on controls designed for two or more rates shall be readily accessible and leakproof. Controls not equipped with field adjustment means shall be set by the manufacturer so the low-flow condition is not lower than the manufacturer's specified minimum input rating.

In the case of power burners, the control shall be constructed so no adjustment of the rate of gas flow is permitted, unless the burner system is such that adjustment of the valve will not adversely affect the proportion of gas and air supplied to the burner.

1.18 THERMOSTATS

Thermostats, when provided, shall be readily accessible for servicing or replacement and shall comply with the applicable construction provisions of the Standard for Gas Appliance Thermostats, ANSI Z21.23.

A thermostat shall have no setting higher than 180 F (82 °C).

1.19 AUTOMATIC VALVES

Automatic valves, when provided, shall be readily accessible for servicing and replacement and shall comply with the applicable construction provisions of the Standard for Automatic Valves for Gas Appliances, ANSI Z21.21.

1.20 BLEEDS AND VENTS

1.20.1 Bleed lines from diaphragm control valves shall be furnished and shall vent into the combustion chamber.

1.20.2 Gas appliance pressure regulators shall be furnished with either a vent line or a vent limiting means.

1.20.3 A common bleed line and vent line shall not be used.

1.20.4 Bleed lines from diaphragm control valves and vent lines from gas appliance pressure regulators shall terminate in suitable burner tips made of a metal having a melting point not less than 1450 F (788 °C). They shall be located so the escaping gas will be readily ignited by the pilot and the heat liberated

thereby will not adversely affect the normal operation of the safety shutoff system. Bleed line burners shall be securely held so the ports are in a fixed position relative to the pilot.

1.20.5 When a vent line is provided for a gas appliance pressure regulator, a No. 40 mesh brass, aluminum or equivalent wire screen sufficient in size to provide free area equal to the area of the escapement orifice, shall be installed in and made a part of the connecting fitting for installation at the regulator vent tapping. The fitting, when tightened against the screen, shall provide no opening larger than the mesh of the screen specified. This provision is only applicable to gas appliance pressure regulators having escapement orifices larger than 0.0165 inch (0.419 mm) in diameter.

1.21 AUTOMATIC GAS SHUTOFF SYSTEMS

1.21.1 Each water heater shall be provided with an automatic gas shutoff system actuated by high water temperature as an integral part of the appliance. The automatic gas shutoff system shall be readily accessible for servicing or replacement and shall incorporate an automatic gas shutoff device which complies with the applicable construction provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22.

1.21.2 A water heater provided with an automatic gas shutoff system which depends for actuation on gas pressure contained in piping or tubing between components shall also be equipped with a manual reset or single-use type secondary temperature limiting device to shut off the gas supply in the event the shutoff system fails to contain the pressure necessary for its operation.

1.21.3 Automatic gas shutoff devices shall act to shut off the gas supply to all burners including the pilot burners.

1.21.4 Automatic gas shutoff systems shall be of the manual reset type or shall be of the single use type.

1.21.5 The valve of an automatic gas shutoff system shall be separate from the valve controlled by the thermostat. Both valves may be incorporated in the same casing.

1.21.6 Immersion type automatic gas shutoff devices shall be located so the temperature sensitive element is immersed in the water within the tank and controls the temperature of the water within the top 6 inches (152 mm) of the tank.

1.21.7 Surface-mounted automatic gas shutoff devices shall be securely mounted and located so the temperature sensitive element controls the water temperature within the top 6 inches (152 mm) of the tank. Such surface mounted temperature sensitive elements shall be adequately insulated or located to provide isolation from flue gas heat or other ambient conditions that are not indicative of stored water temperature.

1.21.8 Functional parts of automatic gas shutoff devices shall be accessible for servicing and replacement without disconnecting the water lines or removing the water heater casing. Raising of the appliance top for the purpose of such accessibility or replacement is acceptable under this provision.

1.22 RELIEF VALVES

1.22.1 Each water heater shall either:

- a. Have instructions that a temperature and pressure relief valve shall be installed on the storage vessel at the time of installation in the location specified by the manufacturer (see 1.30.1-b14) complying with the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22; or
- b. Be provided with such a temperature and pressure relief valve.

1.22.2 When relief valves to prevent excessive water pressure, temperature or vacuum are provided, they shall be readily accessible for servicing or replacement, and shall comply with the applicable construction provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22.

1.22.3 When provided, the hourly Btu rated temperature steam discharge capacity of a temperature and pressure relief valve as determined under the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22, shall not be less than the manufacturer's hourly Btu input rating of the water heater.

1.22.4 Devices having pressure relief features shall not have a relieving pressure exceeding the maximum working pressure of the water heater.

1.23 FLUE COLLARS

1.23.1 When a draft hood is not furnished as standard equipment, the flue collar shall accommodate a vent connector or draft hood of integral inch

diameter, and it is recommended that this practice also be followed when a draft hood is furnished as standard equipment with the water heater.

1.23.2 Provision shall be made to provide a firm support for the draft hood or vent connector to the flue collar.

1.23.3 Means shall be provided to prevent the restriction of the flueway by attachment of a draft hood or vent connector to the flue collar.

1.24 FLUE PIPE EXTENSIONS

When a flue pipe extension other than a standard 90-degree (1.57 rad) elbow is used between the flue outlet and the draft hood, it shall be permanently attached to either the flue outlet or the draft hood. The extension shall be constructed of a material equivalent in strength and in resistance to corrosion to that of the draft hood. (See 1.31.13.)

1.25 DRAFT HOODS

1.25.1 A draft hood shall be provided as standard equipment, except:

- a. When a direct vent system is employed, the inlet and outlet of which communicate only with the outside air; or
- b. When the water heater is for outdoor installation and is provided with a venting system as part of the appliance.

The draft hood provided on an appliance, except for manufactured home (mobile home) installation, shall have a nominal outlet diameter of not less than: (1) 3 inches (76.2 mm) for an appliance having an input rate of 40,000 Btu per hour (11 723 W) or less; and (2) 4 inches (102 mm) for an appliance having an input rate greater than 40,000 Btu per hour (11 723 W).

The outlet of such a draft hood shall not be of a smaller area than that of the effective flue outlet of the appliance and shall accommodate a vent connector of integral inch diameter. Means for reducing the flue outlet may be a removable part in the flueway or must be a permanent part of the draft hood.

1.25.2 All parts of the draft hood shall be constructed of a corrosion-resistant material or of a material having a corrosion-resistant finish.

1.25.3 Provision shall be made for the firm support of the vent piping. A horizontal outlet shall have a 1-inch (25.4 mm) minimum lip for attachment of vent piping of 5 inches (127 mm) diameter or less and

a 1¼-inch (31.8 mm) minimum lip for vent piping of 6 inches (152 mm) diameter or larger.

1.25.4 Means shall be provided to secure the draft hood against displacement on a water heater for installation in a manufactured home (mobile home). (Also see 1.30.1-b13.)

1.25.5 All parts of the draft hood shall be constructed of a material not less than 0.0152* inch (0.386 mm) thick.

1.25.6 A detachable draft hood shall be designed so removal and replacement in normal usage will not permanently deform any part or alter the relative position of any part with respect to another.

1.25.7 Joints used in the construction of draft hoods shall not depend primarily on solder for strength or tightness.

1.25.8 A draft hood shall be constructed of such material so there will be no melting, softening or distortion of any part as a result of the tests specified herein.

1.25.9 The outlet collar of a draft hood shall be of such size as to accommodate vent pipe of integral inch diameter.

1.25.10 A draft hood shall be sufficiently rigid in construction and supported on the water heater so it will comply with 2.24.6.

1.25.11 Counter-type water heaters shall be provided with an access opening through which the connection between the draft hood outlet and the vent connector can be visually inspected. Such openings which do not affect the appliance performance may be provided with a cover which can be removed for inspection.

1.25.12 Manually operated dampers shall not be used.

1.26 AUTOMATIC VENT DAMPER DEVICES

1.26.1 The damper of a vent damper device shall be downstream of both the draft hood inlet and the draft hood relief opening and shall not restrict either.

1.26.2 A vent damper device shall be suitable for attachment to the draft hood outlet or shall be an integral part of the draft hood. If an interconnecting section of vent connector is required, it shall be supplied by the water heater manufacturer attached to either the draft hood or the vent damper device.

* This corresponds to No. 26 U.S. Standard gage sheet steel with all applicable minus tolerances included

1.26.3 All parts of a vent damper device, including fasteners, shall be corrosion resistant, suitable for the application and temperatures to which exposed and shall not show evidence of deterioration during the tests specified herein.

Metal parts in contact with flue gases or subject to condensation shall be at least one of the following:

- a. Aluminum-coated steel at least 0.018 inch (0.457 mm) thick with not less than 0.40 ounces per square foot (0.123 kg m²) of aluminum with the bond between the steel and aluminum being an iron-aluminum alloy;
- b. Chromium-coated low-carbon steel in which the chromium is diffused into the surface of the steel to form an iron-chromium alloy;
- c. Type 1100 aluminum at least 0.016 inch (0.406 mm) thick; or
- d. Other metal having equivalent durability and resistance to corrosion and heat.

Cast iron may be used for nonmoving parts if it can be demonstrated that corrosion or heat will not impair the intended function and durability of the damper.

1.26.4 A vent damper device that is not an integral part of the draft hood shall have a single inlet, a continuous vent gas passageway and a single outlet. The outlet connection shall accommodate a vent connector of integral inch diameter size. Both the inlet and outlet connections shall have at least a 1¼-inch (31.8 mm) lip for attachment.

1.26.5 For a water heater equipped with a continuous pilot, the minimum internal free venting area of the vent gas passageway of a vent damper device, with the damper in the closed position, shall be not less than ½ square inch (3.2 cm²).

1.26.6 A water heater equipped with a vent damper device shall have two automatic valves, in series, each of which opens and closes the main gas supply when called upon to function. For the purposes of this provision, a thermostatically operated valve is an automatic valve.

1.26.7 All electrical components of an electrically operated vent damper device shall be factory wired into the electrical circuit of the water heater, or the vent damper device shall be supplied with a wiring harness. A connection diagram shall be supplied showing the exact arrangement of the wiring. (See 1.30.3-d.)

1.26.8 The mechanical circuits and connections of a mechanically actuated vent damper device shall comply with the following:

- a. All materials and fittings built in or supplied by the manufacturer with the vent damper device shall be submitted for examination.
- b. All materials and fittings supplied for use with and as a part of the vent damper device shall be judged with respect to their suitability for the particular application.
- c. The general construction and assembly of mechanical circuits shall be of a neat and workmanlike character and shall be mechanically secure without strain on any member. The circuits shall be positively located, supported and protected against damage from moving parts. Mechanical circuit material shall be protected from any combustion product condensate unless suitable for such service.
- d. Connections which need to be broken for any component intended to be serviced shall be made in such a manner that they may be disconnected and reconnected without new connections being required.

1.26.9 A thermally actuated vent damper device shall have no friction surfaces, bearings or hinges, unless the vent damper device includes features that will prevent draft hood spillage in the event of seizure of friction surfaces, bearings or hinges.

1.26.10 The damper of an electrically operated or mechanically actuated vent damper device shall assume its open position in the event of motive power failure or deenergization of the vent damper device, unless electrically interlocked with an automatic gas ignition system so as to prevent operation of the automatic gas ignition system when the damper is in other than the fully open position, or unless the loss of motive power will prevent operation of the automatic gas ignition system when the damper is in other than the fully open position.

1.26.11 Operation of an electrically operated or mechanically actuated vent damper device shall produce a single closed position of the damper.

1.26.12 Electrically operated and mechanically actuated vent damper devices shall be equipped with means which will visually indicate the position of the damper when the vent damper device is installed as intended.

1.26.13 Electrically operated and mechanically actuated vent damper devices shall incorporate integral means actuated directly by the damper, or by the assembly of parts securely attached to the damper so as to maintain a fixed relationship to the damper, which will provide an interlock with both the automatic valves specified in 1.26.6 to prevent main burner firing unless the damper is in the fully open position

1.27 AUTOMATIC FLUE DAMPER DEVICES

1.27.1 A flue damper device, if provided, and all its components shall be factory installed, except those components which may be external to the water heater casing and must be installed at the time of appliance installation. These components, including their connecting means, shall be supplied with the appliance by the manufacturer (Also see 1.30.4-a.)

1.27.2 All parts of a flue damper device, including fasteners, shall be corrosion resistant, suitable for the application and temperatures to which exposed and shall not show evidence of deterioration during the tests specified herein

Metal parts in contact with flue gases or subject to condensation shall be at least one of the following:

Aluminum-coated steel at least 0.018 inch (0.457 mm) thick with not less than 0.40 ounces per square foot (0.123 kg m²) of aluminum with the bond between the steel and aluminum being an iron-aluminum alloy;

- b. Chromium-coated low-carbon steel in which the chromium is diffused into the surface of the steel to form an iron-chromium alloy;
- c. Type 1100 aluminum at least 0.016 inch (0.406 mm) thick; or
- d. Other metal having equivalent durability and resistance to corrosion and heat

Cast iron may be used for nonmoving parts if it can be demonstrated that corrosion or heat will not impair the intended function and durability of the damper.

1.27.3 The outlet connection of a flue damper device for a water heater not equipped with a draft hood (other than a direct vent appliance) shall accommodate a vent connector of integral inch diameter size and shall have at least a 1¼-inch (31.8 mm) lip for attachment of the vent connector.

1.27.4 For a water heater equipped with a continuous pilot that has an input rate over 1,500 Btu per hour (440 W), the internal free venting area of the flue gas passageway of the flue damper device, with the damper in the closed position, shall not be less than ½ square inch (3.2 cm²).

1.27.5 A water heater equipped with a flue damper device shall have two automatic valves, in series, each of which opens and closes the main gas supply when called upon to function. These valves may or may not be in a single control body. For purposes of this provision, a thermostatically operated valve is an automatic valve

1.27.6 All electrical components of an electrically operated flue damper device shall be factory wired into the electrical circuit of the water heater, or the flue damper device shall be supplied with a wiring harness. (Also see 1.30.4-c.)

1.27.7 The mechanical circuits and connections of a mechanically actuated flue damper device shall comply with the following

- a. All materials and fittings built in or supplied by the manufacturer with the flue damper device shall be submitted for examination.
- b. All materials and fittings supplied for use with and as a part of the flue damper device shall be judged with respect to their suitability for the particular application.
- c. The general construction and assembly of mechanical circuits shall be of a neat and workmanlike character and shall be mechanically secure without strain on any member. The circuits shall be positively located, supported and protected against damage from moving parts. Mechanical circuit material shall be protected from any combustion product condensate unless suitable for such service.
- d. Connections which need to be broken for any component intended to be serviced shall be made in such a manner that they may be disconnected and reconnected without new connections being required.

1.27.8 The damper of a flue damper device shall assume its open position in the event of motive power failure or deenergization of the flue damper device unless electrically interlocked with an automatic gas ignition device so as to prevent operation of the automatic gas ignition device when the damper is in other than the open position, or unless the loss of motive power will prevent operation of the automatic ignition device when the damper is in other than the open position.

1.27.9 Operation of a flue damper device shall produce a single closed position of the damper.

1.27.10 The design of the water heater shall be such that the flue damper position can be visually determined when the appliance is installed in accordance with the manufacturer's installation instructions.

1.27.11 Flue damper devices shall incorporate integral means actuated directly by the damper, or by the assembly of parts securely attached to the damper, so as to maintain a fixed relationship to the damper, which will provide an interlock with both the automatic valves specified in 1.27.5 to prevent main burner firing unless the damper is in the open position.

1.27.12 A water heater shall be equipped with a means, in addition to the interlock specified in 1.27.11, which will either prevent main burner firing, provide for main burner shutdown if the damper is in other than the open position, or bring the damper to a permanent full open position if the interlock specified in 1.27.11 fails unsafe, when tested in accordance with 2.27.3.

A flue damper device having two systems, either of which will prevent main burner gas flow with the damper in other than the full open position, one of which complies with 1.27.11 and the other being either means specified in this section, shall be deemed as complying with the intent of this section. Each system shall operate completely independently of the other and each shall have a separate switch for operating either a separate automatic valve or two automatic valves in series.

1.28 ELECTRICAL EQUIPMENT AND WIRING

The provisions of this section apply to all wiring and electrical components unless otherwise specified.

1.28.1 All electrical equipment, wiring and accessories built in or supplied by the manufacturer for direct attachment to the water heater shall be submitted for examination with the appliance.

1.28.2 Electrical equipment and line-voltage and safety-circuit wiring supplied for use with and as a part of a water heater shall be of approved types and shall also be judged with respect to their suitability for the particular application, or shall be tested as an integral part of and with the appliance. All other low-voltage wiring shall be suitable for the application and shall not be less than No. 18 AWG (0.82 mm²) with neoprene, thermoplastic or equally durable insulation with a minimum thickness of 0.012 inch (0.305 mm).

Electrical equipment and wiring listed or certified by a nationally recognized testing agency qualified to certify or list electrical equipment or wiring shall be deemed to be an approved type.

1.28.3 When line voltage is required at the water heater, a suitable junction box shall be provided for the permanent connection of the line-voltage supply circuit. This box shall have provisions to accommodate fittings for metal-clad cable or conduit and shall be located on a part of the assembly that does not require movement for servicing.

If wiring larger than No. 14 AWG is used in the conduct of the test specified in 1.28.38, or if the temperature rise of conductors within the junction box, or of surfaces of the box likely to be in contact with conductors, exceeds 63 F (35 °C) when the appliance is tested in accordance with 1.28.38, the following statement, or that part of it which may be applicable, shall be prominently displayed on the box by means of a Class V marking: "For field-wired connections use No. _____ AWG wires rated for at least _____ C (_____ F)." The specified wire size shall be that use in the test, and the specified temperature rating shall not be more than 90 °C. When connections for more than one supply circuit are made in the junction box, the marking shall be modified as appropriate, and shall require that all connections be with wire rated for the highest temperature encountered in the test.

Compartments or junction boxes for connection of field wiring shall not be ventilated.

The size of a junction box in which field-installed conductors are to be connected by splicing shall not be less than that indicated in Table III. A conductor passing through the box is counted as 1 conductor and each conductor terminating in the box is also counted as 1 conductor. A field-furnished conductor for line-voltage circuits is considered to be not smaller than No. 14 AWG (2.1 mm²).

A junction box shall be fabricated in accordance with Table IV, except that steel shall not be less than 0.032 inch (0.81 mm) thick [0.034 inch (0.86 mm) thick if zinc coated] and nonferrous metal shall not be less than 0.045 inch (1.14 mm) thick at points where conduit or metal-clad cable is to be connected.

TABLE III

Conductor,		Free Space	
AWG	(mm ²)	Per Conductor,	
		in. ³	(cm ³)
18, 16	(0.82, 1.3)	1.5	(24.6)
14	(2.1)	2.0	(32.8)
12	(3.3)	2.25	(36.9)
10	(5.3)	2.5	(41.0)
8	(8.4)	3.0	(49.2)

1.28.4 Enclosures of listed devices which contain terminals for electrical connections need not comply with the free space specifications of 1.28.3. However, the space provided shall be sufficient to provide ample room for the distribution of wires and cables required for the proper wiring of the device.

1.28.5 The general construction and assembly of electrical equipment and wiring shall be of a neat and workmanlike character. The wiring shall be positively located and adequately supported. Electrical wiring shall be adequately protected against damage from movable parts.

1.28.6 When within a burner, control or similar compartment, factory wiring involving line voltage of not more than 300 volts between parts attached to the same assembly with a predetermined fixed relationship, one to the other, may be done with Type SJO, SJT and SPT-3 cord or appliance wiring material having neoprene, thermoplastic or equally durable insulation of a thickness no less than that specified in Group B of Table V, or Group A of the table when the wiring material is covered as specified in the footnote to Table V, judged on temperature limitation and usage suitability as defined in the National Electrical Code, ANSI NFPA 70, provided:

The compartment normally is closed;

- b. Wiring below openings located in other than vertical surfaces is protected
- c. Openings in vertical surfaces will not permit the entrance of a $\frac{3}{4}$ -inch (13.1 mm) diameter rod where such straight rod may cause damage to the wiring; and
- d. Permitted openings are at least 2 inches (50.8 mm) above the bottom of the compartment, if the compartment contains a motor.

Cords and other wiring material permitted in the preceding paragraphs shall be arranged to avoid being mechanically injured, such as by closely following surfaces, and shall be supported.

1.28.7 Factory wiring of a low voltage safety circuit may be done with SP-2 cord having all-neoprene insulation; SPT-2 cord; or appliance wiring material having neoprene, thermoplastic or equally durable insulation of equivalent thickness [$\frac{3}{4}$ inch (1.2 mm)]; or "Power Limited Circuit Cable," if such wiring is located in a cavity or compartment of a water heater and shielded from damage.

Thermoplastic or equally durable insulation having a minimum thickness of $\frac{3}{4}$ inch (0.8 mm) shall be acceptable for millivoltage safety circuit wiring.

1.28.8 Line-voltage and safety-circuit wiring which is external to the water heater jacket when all panels are in place, and which is part of the appliance, shall be protected by metal conduit, metal-clad cable or raceways. "Power Limited Circuit Cable" need not be provided with the protection specified above if it is securely fastened to the appliance jacket and follows the contour of the appliance jacket. Thermoelectric circuit wiring shall be exempt from this provision.

1.28.9 Splices in wiring shall be located only in accessible junction boxes. Splices shall be made mechanically secure, soldered, and suitably insulated with tape, or suitable fixture-type splicing connectors shall be employed. Provision shall be made to prevent accidental mechanical strain on splicing devices. (Strain relief is not necessary when wiring is done in conduit, metal-clad cable or raceways.)

1.28.10 Splicing devices and uninsulated live-metal parts having a potential in excess of 30 volts shall be installed within an enclosure having a cover or access panel provided with means for firmly securing it in place.

Terminals in a low-voltage safety circuit external to a water heater to which wiring is connected shall be enclosed, to the extent specified above, when accidental shorting would result in an unsafe condition. Terminals of a millivoltage safety circuit are exempt from the provisions of this paragraph, provided such terminals are recessed with insulating barriers between each terminal.

Terminals in a low-voltage safety circuit within an appliance compartment or cavity to which factory wiring is connected need not otherwise be enclosed, if such terminals are recessed and located so the terminals are shielded from accidental shorting or damage.

1.28.11 Strain relief shall be provided for all conductors leaving an enclosure. For low-voltage wiring, strain relief at the point of exit from an enclosure is not necessary if, by wire location or support, protection is provided against accidental strain.

1.28.12 An enclosure for uninsulated live parts at line voltage shall have no openings which are not closed when the appliance is installed, except that an enclosure for parts other than a fuse or thermal cutout may have openings as needed for ventilation or for the device to function. Such openings shall prevent the entrance of a $\frac{3}{4}$ -inch (13.1 mm) diameter rod. If the distance measured from a straight edge placed across the outer face of any opening to the nearest uninsulated live part within the enclosure is 4 inches (102 mm) or more, such openings shall prevent the entrance of a $\frac{1}{2}$ -inch (12.7 mm) diameter rod.

TABLE IV
MINIMUM AVERAGE THICKNESS OF
SHEET-METAL JUNCTION BOXES*

MAXIMUM DIMENSIONS OF ENCLOSURE		STEEL				COPPER, BRASS, OR ALUMINUM	
		Without Supporting Frame		With Supporting Frame or Equivalent Reinforcing		Without Supporting Frame	With Supporting Frame or Equivalent Reinforcing
Length or Width	Area	Zinc Coated	Uncoated	Zinc Coated	Uncoated		
Inches (mm)	Sq In (cm ²)	Inch (mm)	Inch (mm)	Inch (mm)	Inch (mm)	Inch (mm)	Inch (mm)
3 (76.2)	6 (39)	.023 (0.58) (24) ⁻⁻⁻	.020 (0.51) (24) ⁻⁻⁻	.023 (0.58) (24) ⁻⁻⁻	.020 (0.51) (24) ⁻⁻⁻	.023 (0.58) (22) [§]	.023 (0.58) (22) [§]
8 (203)	36 (232)	.029 (0.74) (22) ⁻⁻⁻	.026 (0.66) (22) ⁻⁻⁻	.023 (0.58) (24) ⁻⁻⁻	.020 (0.51) (24) ⁻⁻⁻	.036 (0.91) (18)	.029 (0.74) (20)
12 (305)	90 (581)	.034 (0.86) (20)	.032 (0.81) (20)	.023 (0.58) (24) ⁻⁻⁻	.020 (0.51) (24) ⁻⁻⁻	.045 (1.14) (16)	.029 (0.74) (20)
18 (457)	135 (871)	.045 (1.14) (18)	.042 (1.07) (18)	.034 (0.86) (20)	.032 (0.81) (20)	.058 (1.47) (14)	.045 (1.14) (16)
24 (610)	360 (2323)	.056 (1.42) (16)	.053 (1.35) (16)	.045 (1.14) (18)	.042 (1.07) (18)	.075 (1.91) (12)	.058 (1.47) (14)
48 (1219)	1200 (7742)	.070 (1.78) (14)	.067 (1.70) (14)	.056 (1.42) (16)	.053 (1.35) (16)	.095 (2.41) (10)	.075 (1.91) (12)
60 (1524)	1500 (9677)	.097 (2.46) (12)	.093 (2.36) (12)	.056 (1.42) (16)	.053 (1.35) (16)	.122 (3.10) (8)	.075 (1.91) (12)
more than 60 (1524)	more than 1500 (9677)	.126 (3.20) (10)	.123 (3.12) (10)	.056 (1.42) (16)	.053 (1.35) (16)	.153 (3.89) (6)	.075 (1.91) (12)

* The figures in parentheses below the minimum average thicknesses are the Galvanized Sheet Gage numbers (for zinc-coated steel), the manufacturers' Standard Gage numbers (for uncoated steel), and the American Wire Gage (B&S) numbers (for copper, brass, or aluminum) which provide the specified minimum average thickness of metal.

- Volume of enclosure not more than 12 cubic inches (197 cm³)

-- Sheet steel for an enclosure intended for outdoor use (raintight) shall not be less than 0.034 inch (0.86 mm) in thickness if zinc coated and not less than 0.032 inch (0.81 mm) in thickness if uncoated (No. 20 gage).

§ Sheet copper, brass, or aluminum for an enclosure intended for outdoor use (raintight) shall not be less than 0.029 inch (0.74 mm) in thickness (No. 20 gage).

TABLE V
INSULATION THICKNESS OF FACTORY WIRING
EXPOSED IN BURNER OR FAN COMPARTMENT

Group*	Type of Wire, Cord, Cable or Appliance Wiring Material
A	<p>RF-2, FF-2, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, RUH, RUW, T, THW, XHHW, MTW, THW-MTW, THWN, TW, or thermoplastic appliance wiring material with insulation thickness of:</p> <p>2 64 inch (0.8 mm) for No. 10 AWG (5.3 mm²) and smaller</p> <p>3 64 inch (1.2 mm) for No. 8 AWG (8.4 mm²)</p> <p>4 64 inch (1.6 mm) for No. 6, 4, 3 or 2 AWG (13.3, 21.2, 26.7 or 33.6 mm²)</p> <p>5 64 inch (2.0 mm) for No. 1, 1 0, 2 0, 3 0 or 4 0 AWG (42.4, 53.5, 67.4, 85.0 or 107.2 mm²)</p>
B	<p>SO, ST, SJO, SJT, or thermoplastic or neoprene appliance wiring material with insulation thickness of:</p> <p>4 64 inch (1.6 mm) for No. 18 or 16 AWG (0.82 or 1.3 mm²)</p> <p>5 64 inch (2.0 mm) for No. 14, 12 or 10 AWG (2.1, 3.3 or 5.3 mm²)</p> <p>6 64 inch (2.4 mm) for No. 8 AWG (8.4 mm²)</p> <p>8 64 inch (3.2 mm) for No. 6 AWG (13.3 mm²)</p>

*Thermoplastic wiring materials, as referenced in Group A, with insulation thickness of 2 64 inch (0.8 mm) for No. 18 or 16 AWG (0.82 or 1.3 mm²) and 3/64 inch (1.2 mm) for No. 14, 12, 10 or 8 AWG, (2.1, 3.3, 5.3 or 8.4 mm²) are considered equivalent to the wiring material referenced in Group B, when the wiring materials are covered with 1/32 inch (0.8 mm) wall thickness thermoplastic insulating tubing of a type recognized as suitable for the purpose from the standpoint of dielectric properties, heat resistance, moisture resistance, flammability, etc.

Such live-metal parts as indicated above shall not be located where contact could reasonably be made during normal servicing.

1.28.13 At points where conduit or metal-clad cable terminate, conductors shall be protected from abrasion unless the boxes or fittings are such as to afford such protection. In addition, in the case of metal-clad cable, an insulating bushing or its equivalent shall be provided between the conductors and the metal cover. The connector or clamp by which metal-clad cable is fastened to boxes or devices shall be such that the insulating bushing or its equivalent will be visible for inspection.

1.28.14 Wireways shall be smooth and entirely free from sharp edges, burrs, fins, etc., which may cause abrasion of the insulation on wiring. Openings in metal walls through which insulated wires not in wireways pass shall be provided with smoothly rounded bushings, or shall have smooth well-rounded surfaces as formed by rolling or extrusion of the metal around the opening, or an acceptable metal grommet to prevent abrasion of the insulation. Bushings shall be phenolic, porcelain, hard fiber or other suitable material having a smoothly rounded surface.

1.28.15 Wiring shall be done with insulated conductors having voltage and temperature ratings consistent with their use. A conductor, other than an integral part of a component, shall be not smaller than No. 18 AWG (0.82 mm²).

1.28.16 Switches shall have current and voltage ratings not less than those of the circuit loads they control.

1.28.17 Electrical connections which need be broken to service any controls shall be made in such a manner that they may be disconnected and reconnected without breaking a soldered connection and without breaking or cutting the wire(s).

1.28.18 Connections from low-voltage electrical devices on the same water heater shall be made in such a manner as to be identifiable in the field.

1.28.19 The electrical circuit of low-voltage control equipment shall be free from and protected from grounds or short-circuiting when the accidental grounding of any circuit wiring could render any safety device inoperative.

1.28.20 Low-voltage circuits shall be supplied by a transformer suitable for an NEC Class 2 circuit (see Article 725, Section 725-31, National Electrical Code, ANSI/NFPA 70) or by a suitable combination of transformer and fixed impedance having output characteristics in compliance with what is required for a Class 2 circuit.

Overcurrent protection shall be accomplished by an integral means other than a replaceable fuse. When a combination of transformer and fixed impedance is used, the electrical interconnection between the two shall be of wiring materials suitable for Class 1 circuits unless the two components are incorporated in a single enclosure and located in a normally closed compartment.

A low-voltage supply shall not be obtained from a source above 30 volts by the use of voltage-dropping resistors.

1.28.21 Detachable plug connectors shall not be used in circuits when disconnection or connection of the circuit may allow unsafe operation of the water heater, unless means are provided to prevent accidental disconnection.

1.28.22 Unless supplied with insulation suitable for the highest voltage involved, insulated conductors of different circuits shall be separated by barriers or shall be segregated from each other, and shall in any case be so separated or segregated from uninsulated current-carrying parts connected to different circuits.

1.28.23 The electrical clearance resulting from the assembly of parts into the complete equipment, including clearances to grounded metal or enclosure when assembled by the manufacturer and furnished as a part of the water heater, shall comply with the spacing specifications of Table VI. Electrical clearances in motors and in components listed by a nationally recognized testing agency shall be deemed to comply with this provision.

1.28.24 Conductors or terminals for line voltage intended for connection to an external grounded supply conductor shall be identified (e.g., finished a white or gray color, given a metallic-plated coating substantially white in color, or ribbed). Other line-voltage conductors shall be finished in colors other than white or natural gray.

Any conductor intended solely for grounding purposes shall be identified by a covering finished a continuous green color or a continuous green color with one or more yellow stripes unless it be bare. A conductor having such coloring shall not be used for other than grounding purposes when this conductor terminates within an enclosure used for field connections.

1.28.25 The water heater shall be constructed so the enclosure, frame and similar noncurrent-carrying metal parts are electrically continuous to the point of connection of the equipment grounding means. This provision shall be deemed met when the electrical resistance between the point of connection of the equipment grounding means and any noncurrent-carrying metal part is not more than 0.1 ohm.

Method of Test

The electrical resistance between the point of connection of the equipment grounding means and each concurrent-carrying metal part shall be determined by either a Wheatstone bridge or by measuring the potential drop between the two points when an alternating current of 20 amperes, derived from a power supply of not more than 12 volts, is passed between the two points and dividing the measured potential drop by the current. The electrical resistance shall not be more than 0.1 ohm. (Insulating resistant finishes may be scraped from the enclosure test points.)

TABLE VI
ELECTRICAL CLEARANCES,
INCHES (mm)

		0-150v	151-300v	301-600v
Between any uninsulated live-metal part and uninsulated live-metal part of opposite polarity and uninsulated grounded dead-metal part other than the enclosure, or an exposed dead-metal part which is isolated insulated.	Thru Air	1 8 (3.2) *a,b	1 4 (6.4) *b,c	3 8 (9.5) *b
	Over Surface	1 4 (6.4)	3 8 (9.5) *d	1 2 (12.7)
Between an uninsulated live-metal part and the walls of a metal enclosure, including fittings for conduit or metal-lad cable. *c	Shortest Distance	1 2 (12.7) *d	1 2 (12.7) *d	1 2 (12.7)

- a. The spacing between wiring terminals of opposite polarity and the spacing between a wiring terminal and a grounded dead-metal part shall not be less than 1 4 inch (6.4 mm); except that if short-circuiting or grounding of such terminal will not result from projecting strands of wire, the spacing need not be greater than that indicated in the table.
- b. In a safety control the spacing between wiring terminals regardless of polarity and between a wiring terminal and a dead-metal part (including the enclosure which may be grounded when the device is installed, shall not be less than 1 4 inch (6.4 mm) if a short circuit between such parts may result in unsafe operation of the appliance.
- c. A metal piece attached to the enclosure is considered to be a part of the enclosure if deformation of the enclosure is liable to reduce spacings between the metal piece and uninsulated live-metal parts.
- d. This spacing may be reduced to 1 4 inch (6.4 mm) on listed devices having a maximum rating of 2000 volt-amperes, 300 volts and provided with a factory-built enclosure.
- e. This spacing may be reduced to 1 8 inch (3.2 mm) on listed devices having a maximum rating of 2000 volt-amperes, 300 volts and provided with a factory-built enclosure.

1.28.26 Single-pole switches, including those of safety controls or protective devices, shall not be wired in a grounded line.

1.28.27 A switch, or similar device provided as a part of a water heater shall be mounted securely and prevented from turning.

1.28.28 High-tension terminals for transformers and wire leads shall provide protection against electrical shocks.

1.28.29 High-tension terminals on transformers shall be located on the water heater so as to be free from contact with metal parts during normal use of the appliance.

1.28.30 High-tension leads shall be fabricated from cable recognized as acceptable for the purpose and conforming to a nationally recognized standard. Such leads shall be provided at each end with means to facilitate positive connection. The leads may be integrally joined to the transformer windings provided proper strain relief is furnished.

1.28.31 High-tension leads or cables shall be as short as possible, free from any sharp bends, and protected from rough usage, soakage with water or condensate, or abrasion.

1.28.32 Electrodes and bus bars of the uninsulated type shall be suspended away from metal parts and insulated and arranged so as to be free from arc-overs at any point throughout the assembly when an a.c. voltage 50 percent in excess of the maximum possible voltage to ground is impressed for a period of 1 minute between the normal point of transformer connection and ground. Such tests shall be conducted both before and after the other performance tests specified herein.

1.28.33 Electrodes or bus bars supporting electrodes shall be designed so they may be readily locked into proper position and no adjustment of any mechanical nature shall be allowed in electrodes of this type.

1.28.34 Electrode tips shall be designed so extreme burning of the points will not result over a period of time.

1.28.35 Flexibility in electrodes at their outer ends may be permitted if designed to resist warping and accidental dislocation.

1.28.36 If electric ignition is used, the means for igniting the pilot gas shall be designed and located so as to eliminate the collection of carbon or other materials, or the dislocation, distortion or burning of parts as the result of normal conditions of heating or vibration of parts.

1.28.37 Insulators shall consist of high-grade porcelain or equivalent noncombustible insulating material. Such insulating material shall be glazed or otherwise made impervious to internal collection of moisture from the gas and shall be readily cleanable. Insulators shall not be used where carbon may accumulate.

1.28.38 Electrical equipment and wiring shall be suitable for the temperatures to which they are exposed and the service to which they are subjected. Maximum allowable temperature rises of some typical wires and components are shown in Table VII.

Method of Test

The manufacturer shall specify the supply conductor size to be used for the conduct of this test (see 1.28.3). The specified conductor size shall be consistent with the requirements of the National Electrical Code, ANSI NFPA 70, and if the appliance has pigtail leads for electrical power connection, the supply conductors shall not be more than two AWG sizes larger than the leads. All unused electrical connection openings shall be closed during the test.

The appliance shall be operated in a normal manner at normal inlet test pressure until equilibrium temperatures are attained as specified in 2.19.

Temperatures of electrical equipment, controls and wiring shall be determined for each component at points subjected to maximum temperatures by means of thermocouples not larger than No. 24 AWG (0.20 mm²) placed in good thermal contact with the material. At the option of the manufacturer, the temperature of motor windings and coils may be measured by the resistance method. Observed temperatures shall not be in excess of those for which wires or components are approved.

1.28.39 The leakage current measured on a water heater tested in accordance with the following Method of Test shall not exceed the limits specified below.

Method of Test

When connected in the manner intended to a supply circuit of rated voltage and frequency, the appliance shall be operated as specified in 2.19. When equilibrium temperatures have been attained and with continued application of rated voltage and frequency, leakage current between each of the supply terminals and all noncurrent-carrying metal parts (ungrounded) which might become energized shall be measured using the instrumentation specified in the Standard for Leakage Current for Appliances, ANSI C101.1. The leakage current shall not exceed 0.5 milliamperes.

1.28.40 Adequate dielectric shall be interposed between ungrounded current-carrying parts and those external surfaces which can be contacted.

Method of Test

When connected in the manner intended to a supply circuit of rated voltage and frequency, the appliance shall be operated as specified in 2.19. At the conclusion of the

operating period specified, the applicable dielectric withstand test(s) specified below shall be conducted.

During conduct of the dielectric withstand tests, a 500 volt-ampere or larger transformer, having an essentially sinusoidal output voltage which can be varied, shall be used. The applied potential shall be increased gradually from zero until the required test voltage is reached and shall be held at that value for 1 minute. The use of a 500 volt-ampere or larger transformer is not necessary if the high potential testing equipment used maintains the specified high potential voltage at the equipment during the test.

a. An appliance shall be capable of withstanding, for 1 minute without breakdown, the application of a 60 hertz potential between high-voltage live parts and dead-metal parts, and between live parts of high- and low-voltage circuits. The test potential shall be:

1,000 volts plus twice rated voltage, except

1,000 volts for motors rated at not more than ½ horsepower (373 W) and not more than 250 volts.

When higher than rated voltage is developed in a motor circuit through the use of capacitors, the rated voltage of the appliance shall be employed to determine the dielectric withstand test potential, unless the developed steady-state capacitor voltage exceeds 500 volts, in which case the test potential for the parts affected shall be 1,000 volts plus twice the developed voltage.

b. A low-voltage circuit shall be capable of withstanding, for 1 minute without breakdown, a 60 hertz potential of 500 volts applied between low-voltage live parts of opposite polarity and between low-voltage live parts and dead-metal parts.

The dielectric withstand test between low-voltage parts of opposite polarity need not be conducted on the complete assembly if the components have been separately subjected to this test condition.

The arrangement of the test circuit shall be such that if the dielectric material breaks down, a positive signal will be obtained, rather than depending upon a visual inspection of the material.

On an appliance for outdoor installation, the above test shall be conducted at the conclusion of the operating period specified in 2.33.1.

1.28.41 Water heaters for installation in manufactured homes (mobile homes), which require connection to an electrical wiring system shall be suitable for use on a wiring system nominally rated 120/240 volts, 3 wire, a.c. with grounded neutral.

TABLE VII

**MAXIMUM ALLOWABLE RISE ABOVE ROOM
TEMPERATURE FOR VARIOUS COMPONENT PARTS**

Part	Maximum Allowable Rise Above Room Temperature, F. (C) (*)
WIRE CODE (*)	
Types RF, FF, RW, RU	63 (35)
Types RH, RFH, FFH	90 (50)
Types T, TF, TFF, TW	63 (35)
Type TA	117 (65)
Type CF	117 (65)
Types AF (*3), SFF (*4)	225 (125)
Type SF (*4)	315 (175)
Type GTF (CSA)	180 (100)
APPLIANCE WIRING MATERIAL	
Thermoplastic 80 C Rating	99 (55)
Thermoplastic 90 C Rating	117 (65)
Thermoplastic 105 C Rating	144 (80)
Power Limited Circuit Cable	108 (60) or Higher as Marked
FLEXIBLE CORD, LINE OR LOW VOLTAGE (*)	
Types ST, SJT, SO, SJO, SPT-3	63 (35)
Type SPT-3 with Thermoplastic Class 12	75 (41.5)
FLEXIBLE CORD, LOW-VOLTAGE	
Types SP-2, SPT-2	63 (35)
Type HPN	117 (65)
ELECTRICAL INSULATING MATERIAL (*)	
Class A	144 (80)
Class B	180 (100)
Class C	Unspecified
Class H	As Determined by Test
Fiber	117 (65)
Phenolic Composition	225 (125)
Windings of Relays, Solenoids, and Other Coils (*) (*)	
Class A Insulation	
Thermocouple Method	117 (65)
Resistance Method	153 (85)
Class B Insulation	
Thermocouple Method	153 (85)
Resistance Method	171 (95)
Coil Windings of d.c., Universal, and Integral Horsepower a.c. Motors (*) (*)	
Thermocouple Method	
Class A Insulation	
open motors	117 (65)
totally enclosed motors	126 (70)
Class B Insulation	
open motors	153 (85)
totally enclosed motors	162 (90)
Resistance Method	
Class A Insulation	
open motors	135 (75)
totally enclosed motors	144 (80)
Class B Insulation	
open motors	171 (95)
totally enclosed motors	180 (100)
Coil Windings of Fractional Horsepower a.c. Motors (*) (*)	
Thermocouple or Resistance Method	
Class A Insulation	
open motors	135 (75)
totally enclosed motors	144 (80)
Class B Insulation	
open motors	171 (95)
totally enclosed motors	180 (100)
CLASS 2 TRANSFORMER ENCLOSURE	108 (60)
POWER AND IGNITION TRANSFORMER ENCLOSURE	117 (65)
CAPACITORS - Electrolytic Types (*)	72 (40)
- Other Types (*)	117 (65)
HEALING COMPOUND	Maximum Temperature 27 (15) less than melting point
DIAPHRAGMS	73 (40.5)
FILTERS	90 (50)

NOTES APPLICABLE TO TABLE VII

- (*) - The values shown are applicable to all water heaters and are the limits permitted during conduct of test specified in 2.19.
- (*) - Wires, other than those listed above, may be used providing the application and temperature limitation are in accordance with Article 310 of the National Electrical Code, ANSI NFPA 70.
- (*) - This wire is satisfactory if temperatures are such as to require the use of this type of wire and other approved wire is not readily available.
- (*) - This wire may not meet the insulation thickness specifications.
- (*) - Flexible cords, other than those listed above, may be used providing the application is in accordance with Table 400-4, Article 400, of the National Electrical Code, ANSI NFPA 70, and the temperature limitation is in accordance with the Standard for Flexible Cord and Fixture Wire, ANSI UL 62.
- (*) - The classes of material used for electrical insulation referred to include materials as follows:
- Class A** - A Class A insulation system is one which by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class A temperature specified in the temperature rise standard for the device under consideration. Typical materials used in Class A systems include cotton, paper, cellulose acetate films, enamel-coated wire and similar organic materials impregnated with suitable substances.
- Class B** - A Class B insulation system is one which by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class B temperature specified in the temperature rise standard for the device under consideration. Typical materials used in a Class B system include mica, glass fiber, asbestos and other materials, not necessarily inorganic, with compatible bonding substances having suitable thermal stability.
- Class C** - Inorganic materials such as pure mica, quartz, porcelain, etc.
- Class H** - A Class H insulation system is one which by experience or accepted test can be shown to have suitable thermal endurance when operating at the limiting Class H temperature specified in the temperature rise standard for the device under consideration. Typical materials used in Class H systems include mica, glass fiber, asbestos, silicone elastomer, and other materials, not necessarily inorganic, with compatible bonding substances, such as silicone resins, having suitable thermal stability.
- (*) - At a point on the surface of an insulated coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may be 9 F (5 °C) (for fractional-horsepower a.c. motors) and 27 F (15 °C) (for d.c., Universal, and integral-horsepower a.c. motors) more than the indicated maximum, provided that the temperature rise of the coil, as measured by the resistance method, is not more than that specified in the table.
- (*) - For a thermocouple-measured temperature on the coil of a fractional-horsepower a.c. motor (other than a Universal motor) the thermocouple is to be applied to the conducting material, or it is to be separated from that material by not more than the integrally applied insulation of the conductor itself. For a thermocouple-measured temperature of a coil of any other motor, the thermocouple is to be mounted as described above, or it may be separated from the conductor by not more than the integrally applied insulation of the conductor itself and the conventional coil wrap normally encountered. Ordinarily, temperatures are to be measured by means of thermocouples, except that motor-coil temperatures may be determined by the resistance method if the coil is inaccessible for mounting thermocouples.
- (*) - For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure may not be more than 117 F (65 °C).
- (*) - These limitations do not apply to capacitors which are recognized as being suitable for service at higher temperatures.

1.28.42 Direct vent water heaters for installation in recreational vehicles that require connection to an electrical wiring system shall be suitable for use on a wiring system:

- a. Nominally rated 115 volts, 2 wire, a.c. with ground; or
- b. Nominally rated 120 240 volts, 3 wire, a.c. with grounded neutral; or
- c. Nominally rated 12 volts, direct current; or
- d. A combination of "a" and "c."

1.28.43 Circuits of water heaters for use on direct current wiring systems shall be two wire and shall not terminate in a plug cap or receptacle designed for line-voltage connection.

1.28.44 Conductors of wiring materials supplied on water heaters for installation in recreational vehicles for use on direct current wiring systems shall be of the stranded copper type and provided with insulation as required for line-voltage circuits.

1.28.45 Overcurrent protective devices, when provided, shall not be rated in excess of the ampacity of the conductors in the appliance circuit. Circuit breakers or fuses shall be of the listed or approved type, including automotive types conforming to the Standard for Electric Fuses (Cartridge Type), ANSI SAE J554b, or the Safety Standard for Automotive Glass-Tube Fuses, UL 275. Fuseholders shall be clearly marked with maximum fuse size.

1.28.46 Water heaters for use on direct current electrical wiring systems shall bear a Class III marking adjacent to the point of connection of the electrical service which reads:

"THIS CONNECTION IS FOR LOW-VOLTAGE BATTERY OR DIRECT CURRENT ONLY. DO NOT CONNECT TO 120 OR 240 VOLTS AC."

1.29 VENT AND AIR-INTAKE PIPES OF DIRECT VENT SYSTEMS

1.29.1 Pipe size for vent and air-intake pipes shall be determined by the manufacturer, and construction shall be in accordance with reasonable concepts of safety, substantiality and durability. Component parts shall be secured against distortion, warpage or other damage and supported to maintain a fixed

relationship between essential parts under normal and reasonable conditions of handling and usage.

1.29.2 The design and specifications of a direct vent system shall be such that the vent and air-intake pipes are supplied as parts of the water heater.

1.29.3 Specifications for materials used in the construction of vent and air-intake pipes shall be in accordance with 1.3.

1.29.4 Lock-seam joints are acceptable for the longitudinal joints in vent and air-intake pipes.

1.29.5 If a telescoping slip-fit connection is used in the vent and air-intake pipes to provide for installation in walls of varying thickness, the minimum overlap shall be 1¼ inches (31.8 mm).

1.29.6 If a slip-fit connection is used at the junction of the vent pipe with the water heater and the vent cap, the minimum overlap shall be 1¼ inches (31.8 mm).

1.29.7 If a slip-fit connection is used at the junction of the air-intake pipe with the water heater and the vent cap, the minimum overlap shall be ½ inch (12.7 mm).

1.29.8 Construction at the outer ends of the vent and air-intake pipes shall provide a firm connection.

1.29.9 Exterior grilles, vent caps and vent and air-intake piping shall be constructed of corrosion-resistant material or have a corrosion-resistant finish.

1.30 INSTRUCTIONS

1.30.1 Each water heater shall be accompanied by clear, concise printed instructions and diagrams, stated in terms clearly understandable to the consumer, and adequate for the proper field assembly, installation, maintenance, safe use and operation of the appliance.

These instructions shall be supplied in a pocket which is a part of the appliance whenever practical. If no pocket can be provided, the instructions shall be supplied in an envelope marked with instructions (1) to the installer to affix the adjacent to the appliance, and (2) to the consumer to retain them for future reference.

The front cover or, in the absence of a cover, the first page shall bear the following boxed statements. They shall be boxed as shown.

Water Heaters For Other Than Recreational Vehicle Installation Only

WARNING: If the information in these instructions are not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- **WHAT TO DO IF YOU SMELL GAS**
 - Do not try to light any appliance.
 - Do not touch any electrical switch; do not use any phone in your building.
 - Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
 - If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

The letters used for the boxed statements above shall be boldfaced type having a minimum uppercase letter height of 0.120 inch (3.05 mm). The minimum vertical spacing between lines of type shall be 0.046 inch (1.17 mm).^{*} Lowercase letters shall be compatible with the uppercase letter size specification.

The instructions shall be reviewed by the testing agency for comprehensibility, accuracy and compatibility with results of test and with the National Fuel Gas Code, ANSI Z223.1.

The instructions shall include:

- a. Assembly instructions for field-installed parts and components, including all controls and accessories (when applicable).
- b. Installation instructions indicating:
 1. The installation must conform with one or more of the following, as applicable:
 - (a) Local codes or, in the absence of local codes, the National Fuel Gas Code, ANSI Z223.1,

^{*} This letter height and line spacing correspond to 12 point type.

Water Heaters For Recreational Vehicle Installation Only

WARNING: If the information in these instructions are not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- **WHAT TO DO IF YOU SMELL GAS**
 - Evacuate all persons from the vehicle.
 - Shut off the gas supply at the gas container or source.
 - Do not touch any electrical switch, or use any phone or radio in the vehicle.
 - Do not start the vehicle's engine or electric generator.
 - Contact the nearest gas supplier or qualified service technician for repairs.
 - If you cannot reach a gas supplier or qualified service technician, contact the nearest fire department.
 - Do not turn on the gas supply until the gas leak(s) has been repaired.
- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

(b) The Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280.

(c) Local codes or, in the absence of local codes, the Standard for Recreational Vehicles, ANSI A119.2/NFPA 501C.

2. The appliance and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of $\frac{1}{2}$ psig (3.5 kPa).

The appliance must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than $\frac{1}{2}$ psig (3.5 kPa).

3. The appliance and its gas connection must be leak tested before placing the appliance in operation.
4. If an external electrical source is utilized, the appliance, when installed, must be electrically grounded in accordance with local codes or, in the absence of local codes, with the National Electrical Code, ANSI NFPA 70.
5. Provisions for adequate combustion and ventilation air.
6. Clearances from combustible material.

The installation instructions for an appliance for installation on combustible flooring shall state that when the appliance is installed directly on carpeting, the appliance shall be installed on a metal or wood panel extending beyond the full width and depth of the appliance by at least 3 inches (76.2 mm) in any direction or, if the appliance is installed in an alcove or closet, the entire floor shall be covered by the panel.

7. Adequate clearances for servicing and proper operation.
8. Proper vent installation.
9. For other than a direct vent appliance, the appliance must be located as close as practicable to a chimney or gas vent.
10. The appliance should be located in an area where leakage of the tank or connections will not result in damage to the area adjacent to the appliance or to lower floors of the structure. When such locations cannot be avoided, it is recommended that a suitable drain pan, adequately drained, be installed under the appliance. The pan must not restrict combustion air flow.
11. The maximum inlet gas pressure must not exceed the value specified by the manufacturer and the minimum value listed is for the purpose of input adjustment.
12. If a water heater is installed in a closed water supply system, such as one having a back-flow preventer in the cold water supply line, means shall be

provided to control thermal expansion. Contact the water supplier or local plumbing inspector on how to control this situation.

13. Proper use of the means provided to secure the draft hood against displacement on an appliance for installation in a manufactured home (mobile home).
14. A temperature and pressure relief valve of the type specified in 1.22.1, must be installed on each water heater in the marked opening provided and in the manner specified by 1.30.7.

c. Maintenance instructions (including recommended frequency guidelines) suggesting:

1. Lubrication of moving parts (when applicable), including type and amount of lubricant.
2. Periodic examination of venting systems.
3. Information covering the cleaning of the burner(s).
4. Periodic visual check of pilot and burner flames by comparison with pictorial sketches or drawings.
5. Keeping appliance area clear and free from combustible materials, gasoline and other flammable vapors and liquids.
6. Not obstructing the flow of combustion and ventilation air.
7. Manual operation of pressure-temperature relief valves at least once a year. These instructions shall also provide information to the user regarding precautions which must be taken prior to operating the relief valve to avoid contact with hot water coming out of the relief valve and to prevent water damage.
8. If the temperature and pressure relief valve on the appliance discharges periodically, this may be due to thermal expansion in a closed water supply system. Contact the water supplier or local plumbing inspector on how to correct this situation. Do not plug the temperature and pressure relief valve.

- d. Lighting and shutdown instructions as specified in 1.31.4 and 1.31.7, including sketches or diagrams.
- e. Thermostat information to the effect that:
 - 1. The thermostat is adjusted to its lowest temperature position when shipped from the factory.
 - 2. The detent or marking, as applicable, on the thermostat is the preferred starting point for setting the temperature control (see 1.31.15).
 - 3. Procedures for adjusting the thermostat for energy efficient operation at the minimum water temperature setting consistent with the consumer's needs.
 - 4. There is a hot water scald potential if the thermostat is set too high.
- f. The following statement: "Should overheating occur or the gas supply fail to shut off, turn off the manual gas control valve to the appliance."
- g. For appliances for other than recreational vehicle installation only, the following statement: Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.
- h. Electrical diagrams in the form(s) specified in 1.31.26.
- i. When cathodic protection devices are incorporated in the appliance design, a statement to the effect that:

Hydrogen gas can be produced in a hot water system that has not been used for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To prevent the possibility of injury under these conditions, we recommend the hot water faucet be open for several minutes at the kitchen sink before you use any electrical appliance which is connected to the hot water system. If hydrogen is present, there will probably be an unusual sound such as air escaping through the pipe as the hot water begins to flow. There should be no smoking or open flame near the faucet at the time it is open.

- j. A list of replacement parts and the source where such parts are available.
- k. Adjustment procedure to provide a low-flow rate setting equal to or greater than the manufacturer's specified minimum input rating as shown on the rating plate. (See 1.17.)

1.30.2 Counter-type water heaters shall be accompanied by diagrams or templates adequate for their proper field installation and safe operation, including all controls and accessories which are not an integral part of the appliance.

1.30.3 The manufacturer's instructions for a water heater equipped with a vent damper device shall also include the following:

- a. Location and method of installation, without modification of either the draft hood or the vent damper device.
- b. A statement to the effect that the venting system be so arranged that only the appliance is served by the vent damper device supplied with the appliance.
- c. Instructions that a minimum clearance of not less than 6 inches (152 mm) between the vent damper device and combustible material be maintained and that there be provisions for access for service of the vent damper device.
- d. Method of the proper interconnection of the wiring harness. (See 1.26.7.)
- e. Instructions and illustrations indicating the manner in which field installed mechanical connections shall be made and routed, and the materials to be used. (See 1.26.8.)
- f. A statement that the damper position indicating means be in a visible location following installation. (See 1.26.12.)
- g. The statement "Damper must be in open position when appliance main burner(s) is operating." (See 1.26.13.)
- h. If the vent damper device is thermally actuated, a description of how the damper operates.

1.30.4 The manufacturer's instructions for a water heater equipped with a flue damper device shall also include the following:

- a. Location and method of installation of those flue damper device components external to the appliance, without modification of either the draft hood, if provided, or the flue damper device.
- b. A statement of the minimum clearances from the flue damper device for access for service and, if applicable, the minimum distance from combustible material.
- c. Method of the proper interconnection of the wiring harness (see 1.27.6).
- d. Instructions and illustrations indicating the manner in which field installed mechanical connections shall be made and routed, and the materials to be used (see 1.27.7).
- e. A statement that the damper position indicating means be in a visible location following appliance installation (see 1.27.10).
- f. The statement "Damper must be in open position when appliance main burner(s) is operating." (See 1.27.11 and 1.27.12.)

1.30.5 Water heaters for installation in manufactured homes (mobile homes) and recreational vehicles shall also be accompanied by:

- a. Specifications for means of attachment. (See 1.2.19.)
- b. Instructions which specify that combustion air shall not be supplied from occupied spaces. Such instructions shall clearly describe the method(s) of installation to accomplish this.
- c. Instructions, where applicable, covering installation and including location of properly identified parts used for access of combustion and ventilation air to the appliance enclosure. When only a screened opening(s) is required the size of opening(s) and the type of screen to be used shall be specified. The screen specified shall be of metal with no less than 1/4-inch (6.4 mm) mesh.
- d. Instructions covering the installation of properly identified parts to provide for the venting of the flue gases to the outdoors, including instructions which specify that the draft hood, when applicable, shall be installed so as to be in the same atmospheric pressure zone as the combustion air

inlet of the appliance. When the parts for venting the flue gases are not provided by the appliance manufacturer and are specific types listed by a nationally recognized testing agency, these instructions shall clearly identify and specify the use of the specific parts (see 1.2.20 and 1.31.30).

- e. Instructions which specify that installation of a direct vent appliance in recreational vehicles must conform with the Standard for Recreational Vehicles, ANSI A119.2/NFPA 501C.

1.30.6 The manufacturer's instructions for a water heater suitable for water (potable) heating and space heating shall also include the following:

- a. A statement to the effect that piping and components connected to the water heater for the space heating application shall be suitable for use with potable water.
- b. A statement to the effect that toxic chemicals, such as used for boiler treatment, shall not be introduced into the potable water used for space heating.
- c. A statement to the effect that a water heater which will be used to supply potable water shall not be connected to any heating system or component(s) previously used with a nonpotable water heating appliance.
- d. Instructions that when the system requires water for space heating a temperatures higher than required for other uses, a means such as a mixing valve shall be installed to temper the water for those uses in order to reduce scald hazard potential. These instructions shall include a piping diagram(s) for a typical installation.

1.30.7 Instructions for pressure, temperature and vacuum relief valves shall specify that no valve is to be placed between the relief valve and the tank. The instructions shall specify installation in such a manner that the discharge from temperature and pressure relief valves will be conducted to a suitable place for disposal when relief occurs and that no reducing coupling or other restriction be installed in the discharge line. In addition, the instructions shall specify that the discharge line be installed to allow complete drainage of both the valve and line.

1.30.8 For a direct vent water heater, complete information shall be provided covering wall thickness and part numbers of vent kits, if several vent kits are available, for use with various ranges of wall thickness. See 1.31.29.

31 MARKING

1.31.1 Marking material shall be identified by class number and shall meet the following specifications. All metal marking materials shall be rustproof. All markings shall be suitable for application to the type of surface upon which applied and the temperature determined during the conduct of 2.19. Class II and III marking material shall either be recognized as complying with the Standard for Marking and Labeling Systems, ANSI UL 969, or be tested as specified under 2.35. The designation of any class of marking shall not preclude the use of marking of a lower number class.

Class I. Integral Marking

Marking that is embossed, cast, stamped or otherwise formed in the part. This includes markings baked into an enameled surface.

Class IIA-1. Permanent Plate

Shall be made of metal having a minimum thickness of 0.012 inch (0.30 mm) and shall be securely attached by mechanical means.

Class IIA-2. Permanent Plate

Shall be made of metal having a thickness of 0.006 to 0.012 inch (0.15 mm to 0.30 mm) and shall have mechanical attachment means at all corners with a maximum spacing of 6 inches (152 mm) between mechanical fasteners.

Class IIA-3. Permanent Plate

Shall be made of metal having a thickness less than 0.006 inch (0.15 mm). Such plates shall be attached by means of nonwater-soluble adhesive.

Class IIA-4. Permanent Plate

Shall be made of pressure-sensitive metal foil requiring no solvent or activator.

Class IIIA-1. Permanent Label

Shall be made of material not adversely affected by water, shall be attached by means of nonwater-soluble adhesive.

Class IIIA-2. Permanent Label

Shall be made of material not adversely affected by water, shall be attached by means of nonwater-soluble adhesive. These materials shall not be located on surfaces having temperatures exceeding 175 F (79.5 °C) as determined during the conduct of 2.19.

Class IIIB. Waterproof Marking

Shall be printed directly on the part with waterproof marking not adversely affected by a temperature of 175 F (79.5 °C). This marking shall not be used on surfaces having temperatures exceeding 175 F (79.5 °C) as determined during the conduct of 2.19.

Class IV. Semi-Permanent Label

Shall be made of material which may be soluble in water, and may use water-soluble adhesive for attachment means.

Class V. Printed Marking

Marking shall be clear and prominent and may be applied directly by any printing means.

Class VI. Attached Tags

1.31.2 RATING PLATE(S). Each water heater shall bear a plate, or a combination of adjacent plates, of Class IIIA marking material, located so as to be easily read when the appliance is in a normally installed position, on which shall appear the following:

- a. The class of product shall be marked "Automatic Storage Water Heater" and, as applicable, the following:
 1. Appliances for installation with direct venting shall be marked: "For Direct Vent Installation."
 2. Appliances for installation in manufactured homes (mobile homes) shall be marked: "For Installation in a Manufactured Home (Mobile Home)."
 3. Appliances for installation in recreational vehicles shall be marked: "For Installation in a Recreational Vehicle."
 4. Appliances which comply with the requirements of manufactured home (mobile home) and recreational vehicle installation may be marked: "For Installation in a Manufactured Home (Mobile Home) or Recreational Vehicle."
 5. Appliances which comply with the requirements of manufactured home (mobile home) and direct vent installation may be marked: "For Direct Vent Installation in a Manufactured Home (Mobile Home)."

6. Appliances which comply with the requirements of recreational vehicles and direct vent installation may be marked: "For Direct Vent Installation in a Recreational Vehicle."
 7. Appliances which comply with the requirements of manufactured home (mobile home), recreational vehicle and direct vent installations may be marked: "For Direct Vent Installation in a Manufactured Home (Mobile Home) or Recreational Vehicle."
- b. On an appliance suitable for use only with a vent damper device:

"For use only with automatic vent damper device Part No. ____ . Follow installation instructions."
 - c. On an appliance suitable for use with or without a vent damper device:

"May be used with automatic vent damper device Part No. ____ . Follow installation instructions."
 - d. On an appliance suitable for use only with a flue damper device:

"For use only with automatic flue damper device Part No. ____ . Follow installation instructions."
 - e. The following marking:

FOR YOUR SAFETY

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

- f. The manufacturer's or distributor's name and address.
- g. A model number to positively identify the construction of the appliance.
- h. A distinctive serial number which will identify an individual appliance. This number may be shown on a separate Class IIIA marking located where it can easily be read when the appliance is in a normally installed position.
- i. Type or types of gas for which equipped: Nat., Mfd., Mix., LP, or ____ Btu LP gas-

air mixture (the heating value for the LP gas-air mixture shall be indicated.)

On an appliance for manufactured home (mobile home) or recreational vehicle installation convertible for use with natural gas and liquefied petroleum gases, this marking shall be as follows:

"Orifice Drill Size: ____ For Nat. ____ For LP."

(Each orifice shall be clearly identified with regard to the gas for which it will be used, and the orifice size shall be indicated on the spud. Also see 1.9.3.)

- j. Maximum inlet gas pressure (____ " wc).
- k. Minimum inlet gas pressure (____ " wc).
- l. Manifold pressure (____ " wc).
- m. Total hourly Btu input rating.
- n. Minimum hourly Btu input rating for appliances for automatic operation at ratings less than full input rating.
- o. Recovery rating, as defined in Part IV, Definitions, for those appliances not covered by Federal agency acts (see 1.1.2).
- p. Storage vessel capacity in U. S. gallons.
- q. Maximum working pressure. (The maximum working pressure shall not be more than 50 percent of the hydrostatic test pressure specified in 2.30.)
- r. Electrical rating—voltage, frequency (Hz) and total input in amperes. If the total input of all components is less than 12 amperes, the input marking may optionally be shown as "less than ____ * amperes."

(*This amperage rating shall be equal to or greater than the total input in amperes.)

- s. Identification of this standard by indicating either this edition of the standard, or the most recent effective addenda thereto, with one of the following markings:

"ANS Z21.10.1-(year),"
"ANS Z21.10.1a-(year)," or
"ANS Z21.10.1b-(year)."

- t. Symbol of the organization making the tests for compliance with this standard.

1.31.3 Each water heater shall bear a marking on the rating plate, or on a separate label of Class IIIA marking material, the applicable statement as follows:

- a. "Suitable for water (potable) heating only," or
- b. "Suitable for water (potable) heating and space heating."

1.31.4 INSTRUCTIONS TO PUT THE WATER HEATER IN OPERATION. A water heater for other than recreational vehicle installation only shall bear a single label or a series of adjacent labels of Class IIA marking material located in a conspicuous position where the label(s) can be easily read by the operator during the lighting operating and shutdown procedures.

Where a series of labels is used, they shall:

- a. Be capable of being viewed simultaneously (in the same plane) in the sequence as shown in Exhibit A, B or C, as applicable; and
- b. Not be separated from each other by more than one inch.

A separate means may be provided for mounting the lighting operating instructions label(s). This means shall be permanently attached to the appliance in a manner such that, when lighting the appliance, the lighting operating instructions can be easily read without detachment from the appliance.

The label(s) may be on the interior of a removable panel which provides access to the gas controls.

If the above label(s) is not visible on the appliance when all panels are in place, a Class IIIA marking shall be affixed on the exterior of the appliance in a location where it can be easily read when the appliance is installed at the minimum clearances for which the appliance is to be listed. This marking shall indicate where the lighting operating instructions are to be found.

1.31.5 The lighting/operating instructions label(s) specified in 1.31.4 shall contain at least the following:

- a. For a water heater equipped with a continuous (piloted) ignition system, as outlined in Exhibit A.
- b. For a water heater equipped with an intermittent pilot or interrupted pilot ignition system, as outlined in Exhibit B.

- c. For a water heater equipped with a direct ignition system, as outlined in Exhibit C.

The statements in quotes in the above referenced Exhibits shall be worded as shown in the applicable Exhibit.

1.31.6 The physical specifications of the lighting operating instructions label(s) specified in 1.31.4 shall be as follows:

- a. Each of the three sections shall be boxed by a red border, the top dimensions being a minimum 1/4-inch (6.4 mm) solid red line.
- b. The titles of each section shall be black boldfaced type having a minimum letter height of 0.140 inch (3.56 mm)* and located within the top border line.
- c. The word "WARNING" shall be black boldfaced letters type having a minimum letter height of 0.120 inch (3.05 mm).**
- d. The text of the label(s) shall be black boldfaced letters on a white background having a minimum uppercase letter height of 0.100 inch (2.54 mm) with a minimum vertical spacing between lines of type of 0.038 inch (0.96 mm).*** Lowercase letters shall be compatible with the uppercase letter size specification.

1.31.7 INSTRUCTION PLATE. A water heater for recreational vehicle installation only shall bear clearly defined, legible and complete instructions for lighting and shutting down the appliance on Class IIIA marking material on or adjacent to the controlling device, or in an equally conspicuous position on the top front of the appliance casing where they can be easily read while lighting or shutting down the appliance. On an appliance equipped with a manually lighted pilot, the lighting instructions shall specify a 5-minute complete shutoff period before relighting the appliance.

The letters used for the instructions shall be boldfaced uppercase type having a minimum letter height of 0.100 inch (2.54 mm). The minimum vertical spacing between lines of type shall be 0.066 inch (1.68 mm).†

* This letter height corresponds to 14 point type.

** This letter height corresponds to 12 point type.

*** This letter height and line spacing correspond to 10 point type and normal vertical spacing, zero leaded.

† This letter height and line spacing correspond to 10 point type, 2 point leaded.

The information on the instruction plate may be combined with the information on the rating plate as specified in 1.31.2.

1.31.8 A water heater for manufactured home (mobile home) or recreational vehicle installation convertible for use with natural gas or liquefied petroleum gases shall bear a Class IIIA marking, located so as to be easily read when the appliance is in a normally installed position, outlining instructions for converting the appliance from the use of one gas to another.

The letters used for the instructions shall be boldfaced uppercase type having a minimum letter height of 0.100 inch (2.54 mm). The minimum vertical spacing between lines of type shall be 0.066 inch (1.68 mm).*

The information on this marking may be combined with the information on the rating plate as specified in 1.31.2 or, if applicable, with the information on the instruction plate as specified in 1.31.7.

1.31.9 The water heater shall bear a Class IV marking on which appears the trade name designated by the manufacturer and recorded with the organization making the tests for compliance with this standard.

1.31.10 Each water heater shall bear a marking on Class III marking material located on an exterior surface which will be visible at the time of installation stating the following, as applicable:

- a. "This appliance must be installed in accordance with local codes or, in the absence of local codes, the National Fuel Gas Code, ANSI Z223.1-1988."
- b. "This appliance must be installed in accordance with the Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280."
- c. "This appliance must be installed in accordance with local codes or, in the absence of local codes, the Standard for Recreational Vehicles, ANSI A119.2 NFPA 501C-1987."

1.31.11 Water heater installation locations shall be clearly marked on the rating plate, or on a separate label of Class IIIA marking material that can be easily read when the appliance is in a normally installed position, in substance as follows:

- a. Appliances for installation on noncombustible floors and adjacent to noncombustible walls: "For use only in noncombustible locations."
- b. Appliances for installation on combustible floors and adjacent to noncombustible walls: "For use only in locations having noncombustible walls."
- c. Appliances for installation on noncombustible floors and adjacent to combustible walls: "For use only on noncombustible floors. Minimum clearances from combustible material, _____ inches from sides and _____ from back."
- d. Appliances for installation on combustible floors and adjacent to combustible walls shall bear a Class IIIA marking indicating the type of installation (alcove or closet) and all minimum clearances to combustible material established by performance tests (see 2.19).

If the appliance is tested with a listed Type B flue or vent connector, the appliance shall be provided with a Class V marking in a location conspicuous prior to installation, clearly indicating the type of vent or vents such as B-0, B-1, B-1½ with which the appliance is to be used.

- e. Appliances with draft hoods or venting systems extending beyond the side(s) or rear of the appliance: "Minimum clearance from the draft hood to combustible material, _____ inches."
- f. Appliances which require clearances from any type of construction for serviceability shall bear a marking on Class III marking material, located on the surface(s) requiring such clearance, indicating the minimum distance required.

The lettering used shall be boldfaced uppercase type having a minimum letter height of 0.100 inch (2.54 mm). The minimum vertical spacing between lines of type shall be 0.066 inch (1.68 mm).*

1.31.12 Counter-type water heaters having externally attached draft hoods shall bear a marking on the rating plate or on a separate plate of Class IIIA marking material attached adjacent to the rating plate stating: "To be installed with draft hood relief opening not less than 6 inches from adjacent wall." This statement shall also appear on a label of Class IV marking material attached to the appliance.

* This letter height and line spacing correspond to 10 point type, 2 point leaded

* This letter height and line spacing correspond to 10 point type, 2 point leaded

1.31.13 Flue pipe extensions used between the flue outlet and the draft hood shall be clearly labeled on Class V marking material to the effect that the extension must be installed and used without modification.

1.31.14 Hot water connections, cold water connections, or both, shall be clearly and permanently identified by a Class IIIA marking.

1.31.15 Each adjustable thermostat shall have a detent or legible marking on Class IIIA material consistent with a water temperature of approximately 130 F (54.5 °C).

1.31.16 Each water heater equipped with an adjustable thermostat shall bear a label of Class IIIA marking material located adjacent to the adjustment means so as to be visible with the control cover, if provided, in place. This label shall bear the word "CAUTION," followed by the wording, "Hotter water increases the risk of scald injury. Before changing temperature setting, see instruction manual," or the equivalent. The word "CAUTION" shall be in letters having a minimum uppercase height of 0.090 inch (2.29 mm). The minimum vertical spacing between lines of type shall be 0.034 inch (0.86 mm).^{*} Lowercase letters shall be compatible with the uppercase letter size specification.

1.31.17 Each water heater shall bear a Class IIIA marking located on a vertical or horizontal surface in proximity to the relief valve tapping referring the consumer to the instructions specified under 1.30.1-c7. (Also see 1.31.20.)

1.31.18 Water heaters intended to deliver outlet water at a temperature in excess of 160 F (71 °C) shall have a Class IIIA marking as follows: "For operation at outlet water temperature(s) not in excess of 180 F."

1.31.19 Water heaters incorporating a nonmetallic dip type shall bear a warning on Class VI marking material attached to the cold water inlet of the appliance stating: "Do not apply heat to this fitting when making sweat connections to heater. Sweat tubing to adapter before fitting adapter to cold water inlet of heater. It is imperative that no heat be applied to the cold water inlet, as it contains a nonmetallic dip tube."

1.31.20 Each water heater shall bear, on Class IIIA marking located on a vertical or horizontal surface in proximity to the relief valve tapping stating, the applicable statement below:

- a. "A temperature and pressure relief valve listed as complying with the Standard for

Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22-1986 shall be installed at the time of installation of the heater in the location specified by the manufacturer. Local codes shall govern installation of relief devices. For safe operation of the water heater, the relief valve must not be removed or plugged."

- b. "This water heater is provided with a combination temperature-pressure relief valve. For safe operation of the water heater, the relief valve(s) must not be removed from its designated point of installation or plugged."

The markings required under 1.31.17 and 1.31.20 if shown on the same label, must be separated, such as by separate paragraphs or the equivalent.

1.31.21 Water heaters equipped with manual reset type automatic gas shutoff systems shall be provided with clearly defined, legible and complete instructions on Class IIIA marking material for manually resetting the automatic gas shutoff device.

1.31.22 Water heaters equipped with single-use type automatic gas shutoff devices shall be provided with clearly defined, legible and complete instructions for replacement on Class IIIA marking material.

1.31.23 Water heaters shall bear a Class VI marking which states, "The gas pressure regulator(s) supplied must be used with this heater," if the regulator(s) is shipped detached from the appliance. If the appliance is shipped with the regulator attached as an integral part of the appliance, no such marking is necessary.

1.31.24 A water heater suitable for water (potable) heating and space heating shall bear Class IIIA markings indicating:

- a. The water heater shall not be connected to any heating system or component(s) previously used with a nonpotable water heating appliance.
- b. Toxic chemicals, such as used for boiler treatment, shall not be introduced into the potable water heater used for space heating.

1.31.25 A water heater equipped with a vent damper device shall bear a Class III marking, located so as to be easily read when the appliance is in a normally installed position, indicating that the appliance is equipped with a vent damper device and warning against tampering with or modifications of the device.

^{*} This letter height and line spacing correspond to 9 point type.

1.31.26 ELECTRICAL DIAGRAMS.

- a. Except when electrical equipment is limited to a simple series circuit, electrical diagrams (see Part IV, Definitions) applicable to all electrical circuits within the water heater shall be supplied on Class IV marking material in each of the following forms:

1. A connection diagram to aid in locating components for field service.
2. A schematic diagram of the ladder form, in addition to the connection diagram. When necessary for clarification, a cycle chart or printed sequence of switching action shall accompany the schematic diagram.

If wire other than that conforming with the temperature limitation for Type T wire [63 F (35 °C) rise] is used on the appliance, the wiring diagram shall incorporate a statement to the effect that, "If any of the original wire as supplied with the appliance must be replaced, it must be replaced with _____ wire or its equivalent."

If wiring larger than No. 14 AWG or with a temperature rating greater than 60 °C (140 F) has been specified for field-wired connections, the marking required by Section 1.28.3 shall appear on all electrical diagrams.

- b. Electrical diagrams shall conform to the Standard for Electrical and Electronics Diagrams, ANSI Y14.15. See Appendix A for reference to pertinent provisions of ANSI Y14.15. The wire color designations specified under 15-3.11 of ANSI Y14.15 are shown in Appendix B.
- c. It is recommended that the usage of wire colors be as shown in Appendix C.
- d. Unidentified graphical symbols used for electrical diagrams shall conform to the Standard for Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Class Designation Letters), ANSI/IEEE Standard 315. See Appendix D for preferred symbols of commonly used items, as extracted from ANSI/IEEE Standard 315. Abbreviations for identified items shall be as shown in Appendix D.

- e. The electrical diagrams specified in "a" above shall be attached to the appliance in a location where they are accessible during servicing of the electrical components. Some means of color, letter or number coding corresponding to the appliance wiring shall be used in the diagrams to facilitate circuit identification.

1.31.27 A water heater for outdoor installation only shall bear a statement on Class III marking material reading:

"For outdoor installation only."

1.31.28 A water heater for outdoor installation shall bear complete information on Class III marking material relative to clearances from combustible material.

1.31.29 A direct vent water heater shall bear a Class IIIA marking to indicate the minimum and maximum thickness of the wall through which it may be installed.

1.31.30 A water heater for installation in a manufactured home (mobile home) which is not of the direct vent type shall bear statements on the rating plate, or a separate marking on Class IIIA marking material adjacent to the rating plate, indicating:

- a. The appliance manufacturer's part number(s) of the means to provide combustion and ventilation air to the appliance enclosure when provided or, for screened openings not supplied, the size of the opening(s) and the type of screen to be used. [The screen specified shall be of metal with not less than ¼-inch (6.4 mm) mesh.]
- b. The appliance manufacturer's part number(s) of the means to provide for venting of the flue gases to the outdoors. When venting system components are listed by a nationally recognized testing agency, the listing identification by manufacturer and specific part number may be used in lieu of the appliance manufacturer's part number. When special design and listing is involved, the vent manufacturers is also to be identified.

1.31.31 When an electrical switch interconnected with the automatic valve(s) controlling main burner gas is provided, the "on" and "off" positions shall be clearly marked on Class III marking material.

1.31.32 On a water heater for installation in a manufactured home (mobile home) which is not of the

direct vent type, parts supplied by the appliance manufacturer (see 1.2.20) for providing access of combustion and ventilating air to the appliance enclosure and for venting flue gases from the appliance to the outdoors, shall bear identification in accordance with 1.31.30 on Class IIIA marking material.

1.31.33 For water heaters for manufactured home (mobile home) installation, the marking information specified in 1.31.2, 1.31.4 and 1.31.11 shall be easily readable both when the appliance is in a normally installed position and when shut down for transporting of the manufactured home (mobile home).

1.31.34 A vent damper device shall bear a plate Class II marking material on which shall appear the following:

- a. The water heater manufacturer's part number of the vent damper device.
- b. A distinctive number which will identify each individual vent damper device or a separate date code marking.

If a separate date code marking is used, it shall consist of at least four consecutive digits determined as follows:

1. The first and second digits shall indicate the calendar year in which the vent damper device is manufactured (e.g., 84 for 1984).
2. The third and fourth digits shall indicate the week in which the vent damper device was manufactured (e.g., 03 for the third week of the year). For purposes of this marking, a week shall begin at 0001 hours on Sunday and end at 2400 hours on Saturday.

A date code may be used for more than one week; however, it shall not be used for more than four consecutive weeks, nor for more than two weeks into the next calendar year.

Additional numbers, letters or symbols may follow the four digit number specified in "1" and "2." If additional numbers are used, they must be separated from the date code.

- c. The inlet, outlet or direction of vent gas flow.

- d. On mechanically actuated vent damper devices, type and range of motive power which will permit normal functioning of the vent damper device.

1.31.35 A vent damper device shall bear a Class III marking attached to the device or a marking on the carton in which it is supplied, stating clearly and legibly: "WARNING - Follow instructions for proper installation." The word "WARNING" shall be in letters having a minimum height of 0.240 inch (6.10 mm).^{*} The remainder of the warning shall be in letters having a minimum uppercase letter height of 0.120 inch (3.05 mm) with a minimum vertical spacing between lines of 0.046 inch (1.17 mm).^{**} Lowercase letters shall be compatible with the uppercase letter size specification.

1.31.36 A flue damper device shall bear a Class III marking on which shall appear the following:

- a. The water heater manufacturer's part number of the flue damper device.
- b. Unless the device can be installed only in the correct position, the inlet, outlet or direction of flue gas flow.
- c. On mechanically actuated flue damper devices, type and range of motive power which will permit normal functioning of the flue damper device.

1.31.37 A flue damper device shall bear a Class III marking attached to the device stating clearly and legibly: "WARNING - Follow instructions for proper installation." The word "WARNING" shall be in letters having a minimum height of 0.240 inch (6.10 mm).^{*} The remainder of the warning shall be in letters having a minimum uppercase letter height of 0.120 inch (3.05 mm) with a minimum vertical spacing between lines of 0.046 inch (1.17 mm).^{**} Lowercase letters shall be compatible with the uppercase letter size specification.

1.31.38 The water heater casing exterior to the structure in which installed and vent terminals of a direct vent appliance shall be marked "HOT" on Class II marking material located on or adjacent to areas of excessive temperature.

1.31.39 Also see 1.7.2, 1.9.3, 1.13, 1.14.3, 1.15.5, 1.28.3, 1.28.46 and 1.31.14.

^{*} This letter height corresponds to 24 point type.

^{**} This letter height and line spacing correspond to 12 point type.

PART II

PERFORMANCE

2.1 GENERAL

2.1.1 This standard covers automatic storage water heaters:

- a. For use with natural gas;
- b. For use with manufactured gas;
- c. For use with mixed gas;
- d. For use with liquefied petroleum gases;
- e. For use with LP gas-air mixtures;
- f. For manufactured home (mobile home) installation for use with liquefied petroleum gases only (see 2.1.15);
- g. For recreational vehicle installation for use with liquefied petroleum gases only (see 2.1.16);
- h. For manufactured home (mobile home) installation convertible for use with natural gas and liquefied petroleum gases (see 2.1.15); and
- i. For recreational vehicle installation convertible for use with natural gas and liquefied petroleum gases (see 2.1.16).

2.1.2 Water heaters submitted for examination under this standard shall be tested with the type(s) of gas selected to the manufacturer.

2.1.3 Vent limiters, when provided on gas appliance pressure regulators, shall be in place during all performance tests.

2.1.4 When a thermocouple is specified for the measurement of air, water, flue or vent gas temperatures, a thermocouple or an equivalent temperature measuring device complying with the Performance Test Codes, Supplement on Instruments and Apparatus, Part 3, Temperature Measurement, ANSI ASME PTC 19.3, shall be used.

2.1.5 When a water heater with a vent damper device is submitted for examination, the manufacturer shall specify whether the appliance is for use only with the vent damper device or for use both with and without the vent damper device.

If the appliance is for use only with the vent damper device, the vent damper device shall be in place for all tests specified herein, except 2.25.3, 2.25.4 and 2.25.5 which are tests of the vent damper device itself.

If the appliance is for use both with and without the vent damper device, the tests specified in 2.24.2, 2.24.3, 2.24.4 and 2.24.5 shall be conducted both with and without the vent damper device in place. The tests specified in 2.4, 2.20 and 2.24.1 shall be conducted without the vent damper device in place. All other tests specified herein shall be conducted with the vent damper device in place, except 2.25.3, 2.25.4 and 2.25.5 which are tests of the vent damper device itself.

All appliance performance tests for which an electrically operated or mechanically actuated vent damper device is specified to be in place shall be conducted with the damper open to the minimum degree that would permit the appliance's automatic valve to open.

2.1.6 When a water heater equipped with a flue damper device is submitted for examination, the flue damper device shall be in place for all tests specified herein, with the exception of 2.26.4 and 2.26.5, which are tests of the flue damper device itself and which may be conducted separately.

All appliance performance tests shall be conducted with the damper open to the minimum degree that would permit the appliance's automatic valves to remain open.

2.1.7 Direct vent water heaters may take many forms, so for their testing, principles must be established for the guidance of the testing agency which will assure compliance with basic standards for safe operation and acceptable performance, without restricting their design to preconceived forms. With this in mind, the principles stated within this standard are to be used by the testing agency in determining the acceptability of direct vent appliances.

Direct vent water heaters are appliances for permanent attachment to or incorporation in the structure of a building, manufactured home (mobile home) or recreational vehicle, and may be partly or entirely enclosed in combustible construction. The manufacturer having designed for this condition, it is proper that the appliance be tested as a unit when

installed in accordance with the manufacturer's published instructions and with commonly observed practice. Also see 1.1.3 and 2.1.8.

2.1.8 During the conduct of the tests specified in 1.1, 2.4.2, 2.19, 2.24 and 2.28, the water heater shall be installed in either an alcove or a closet, as specified by the manufacturer, with clearances from the walls and ceiling in accordance with the manufacturer's installation instructions. For alcove installations the side walls shall extend 18 inches (457 mm) beyond the front of the appliance. Appliances not of the direct vent type for installation in manufactured homes (mobile homes) shall be installed in a closet. Mounting brackets for securing the appliance to the vehicle structure shall not be considered as a part of the appliance for establishing clearances.

Walls and ceilings of enclosures of combustible material shall be constructed of nominal 1-inch-thick sheetrock or 3/4-inch-thick plywood set at 90 degrees (57 rad) and finished in dull black on the interior surfaces. Flooring of combustible material shall be constructed of nominal 1-inch-thick pine flooring covered with one thickness of building paper superimposed by 1-inch tongue-and-groove oak flooring finished with clear varnish. (See 2.19 for details of thermocouple construction and location.)

For direct vent appliances, the wall through which the vent-air intake system passes shall be constructed with nominal 2-inch-thick studs spaced 16 inches (406 mm) on center covered on both sides by 1/2-inch-thick plywood finished in dull black. The depth of the studs shall provide a total wall thickness specified by the manufacturer. The vent-air intake terminal shall be installed through this wall in accordance with the manufacturer's instructions and the portion of the vent-air intake terminal located within the wall shall be enclosed on the top, bottom and sides, as close as the configuration of the appliance will permit, with nominal 2-inch-thick wood framing of the same width as used to construct the wall.

The height of the enclosure for appliances other than for installation in manufactured homes (mobile homes) shall not exceed 7 feet 6 inches (2.29 m) above the floor.

The height of the enclosure for appliances for installation in manufactured homes (mobile homes) shall not exceed 6 feet 6 inches (1.98 m) above the floor.

For closet installation tests of appliances, other than for installation in manufactured homes (mobile homes), a simulated door shall be provided. This door shall have two openings located so the lower edge of the lower opening is 6 inches (152 mm) above the floor level of the enclosure, and the other being located so

its upper edge is 6 inches (152 mm) below the top of the enclosure. The free area of each of the two openings shall be 100 square inches (645 cm²). The height of each opening shall be one-half of the width.

Appliances not of the direct vent type shall be tested with either a single-wall galvanized vent connector or a listed Type B vent connector, at the option of the manufacturer. When a single-wall vent connector is used, it shall have a clearance of 6 inches (152 mm) between its surface and the walls and ceiling of the test enclosure. Where the connector pierces the enclosure, an opening having a diameter 4 inches (102 mm) larger than the diameter of the vent connector shall be provided and the vent connector centered in the opening. The 2-inch (50.8 mm) annulus thus formed shall be sealed on the outer surface. (See Figure 2.) If a Type B vent connector is used, the clearance from its surface to the walls and ceiling of the enclosure shall be in accordance with its listing. At its point of passage through the enclosure, the annulus shall be sealed as specified for single-wall vent connectors.

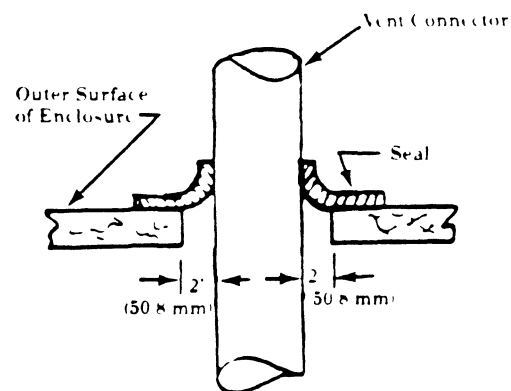
Appliances not of the direct vent type with vertical flue outlets shall be tested with vent arrangement Style I as shown in Figure 2 unless otherwise specified herein. Appliances not of the direct vent type with horizontal flue outlets shall be tested with vent arrangement Style II as shown in Figure 2 unless otherwise specified herein.

For closet installation tests of appliances for installation in manufactured homes (mobile homes) the means provided for access of combustion and ventilation air into the appliance closet and for venting the flue gases shall be in place. (See 1.2.20.)

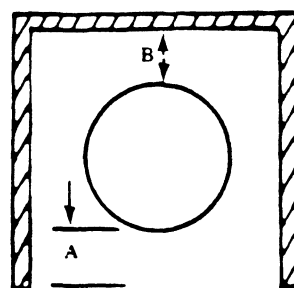
2.1.9 During tests for compliance with this standard a water heater shall not be connected to a vent connector but shall depend for venting of the flue gases solely on the principles of design incorporated in it, unless otherwise specified herein. The fact that appliances are tested without flue connections is not to be interpreted as an indication that flue connections are not necessary when appliances are installed under actual operating conditions.

A direct vent appliance or an appliance for outdoor installation with the venting system provided as part of the appliance shall be tested with the venting system in place.

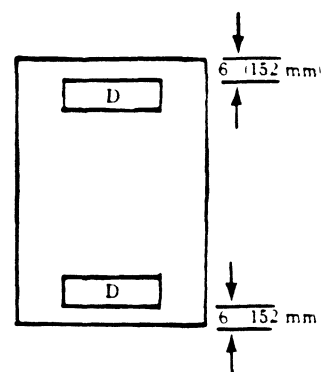
An appliance, except of the direct vent type, for installation in a manufactured home (mobile home) which uses either (1) a listed venting system as specified by the manufacturer (see 1.2.20), or (2) a venting system supplied by the manufacturer as a part of the appliance, shall be tested with the venting system in place, unless otherwise specified herein.



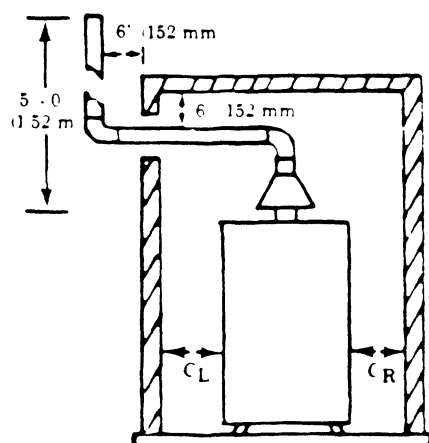
**METHOD OF SEALING
ANNULUS AROUND
VENT CONNECTOR**



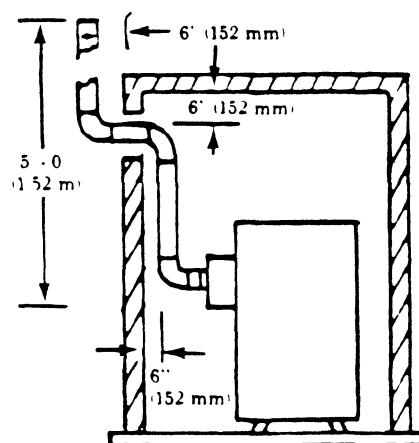
TOP VIEW



**OPTIONAL CLOSET
CONSTRUCTION**



**FRONT ELEVATION
VENT ARRANGEMENT
STYLE I**



**SIDE ELEVATION
VENT ARRANGEMENT
STYLE II**

SYMBOL DESIGNATION

- A** - From Front of Water Heater
- B** - From Back of Water Heater
- CL** - From Left Side of Water Heater
- CR** - From Right Side of Water Heater
- D** - Area of Each Opening—1 sq. in. for each 1000 Btu per hour (22 cm² per kW) input, but not less than 100 square inches, (645 cm²). Width to height ratio, 2:1

Figure 2. Enclosure Types and Clearance Nomenclature for Alcove and Closet Installation Tests for Water Heaters

2.1.10 A draft hood, if provided, shall be in place during all performance tests, unless otherwise specified herein.

2.1.11 Accessories shall be investigated as an integral part of the water heater for which they are supplied.

2.1.12 Water heaters for installation in manufactured homes (mobile homes) and recreational vehicles shall be tested at the manufacturer's specified input rating, except that the combustion test at 12.5 percent increased manifold pressure or at the increased inlet test pressure as specified under 2.4.1 and the blocked outlet and spillage tests specified under 2.24.1 and 2.24.5 shall be conducted with the appliance initially adjusted to an input 10 percent above the manufacturer's specified input rating to simulate operating conditions at altitudes up to 5,000 feet (1525 m). The blocked outlet and spillage tests specified under 2.24.1 and 2.24.5 shall also be conducted with the appliance adjusted to the manufacturer's specified input rating.

2.1.13 For purposes of test under this standard for water heaters for installation in manufactured homes (mobile homes), the manufacturer shall provide any special means recommended in his installation instructions for providing combustion air from outside the vehicle. This special means shall be in place during all performance tests.

2.1.14 Water heaters having controls providing automatic multi-rate control of the input rating for automatic modulating controls which permit the main burner gas to be turned on at a reduced rate shall also be tested at the minimum input rating under the provisions of 2.5, 2.6, 2.7 and 2.24.5.

Appliances having automatic modulating controls which act to reduce the input rating after ignition of the main burner shall also be tested at the minimum input rating under the provisions of 2.5.1, 2.5.4, 2.5.7 and 2.24.5.

The appliance shall also comply with the applicable provisions of the combustion tests specified in 2.4.1 when operating at the minimum input rating. If the minimum test input rating (see 2.3.4) is less than 50 percent of the normal input rating, the maximum permissible carbon monoxide concentration in an air-free sample of the products of combustion shall be determined from the following formula:

$$\frac{\text{normal input rating}}{\text{minimum test input rating}} \times .01$$

Tests at the minimum input rating (see 2.3.4) shall be conducted at normal inlet test pressure only.

2.1.15 Special performance provisions applicable to water heaters for installation in manufactured homes (mobile homes) are outlined under 2.1.1-f and -h, 2.1.7, 2.1.8, 2.1.9, 2.1.12, 2.1.13, 2.2-g, 2.24 and 2.28.

2.1.16 Special performance provisions applicable to water heaters for installation in recreational vehicles are outlined under 2.1.1-g and -i, 2.1.7, 2.1.12, 2.1.17 and 2.2-g.

2.1.17 Special performance provisions applicable to direct vent water heaters are outlined under 2.1.7, 2.1.8, 2.1.9, 2.19, 2.28, 2.33.2 and 2.34.

2.1.18 Special performance provisions applicable to water heaters for outdoor installation are outlined under 2.1.9, 2.20.1, 2.28 and 2.33.

2.2 TEST GASES

In conducting the performance tests specified herein, test gases with characteristics approximately as shown in Table VIII shall be used.

TABLE VIII
CHARACTERISTICS OF TEST GASES

	Heating Value (Btu/ft ³) (MJ/m ³)		Sp Gr (Air = 1.0)
Gas A (Natural)	1075	(40.1)	0.65
Gas B (Manufactured)	535	(19.9)	0.38
Gas C (Mixed)	800	(29.8)	0.50
Gas D (n-Butane)	3200	(119.2)	2.00
Gas E (Propane HD-5)	2500	(93.1)	1.55
Gas F (Propane-Air)	700	(26.1)	1.16
Gas G (Butane-Air)	1400	(52.2)	1.42
Gas H (Propane-Air)	1400	(52.2)	1.30

a. A water heater for use with natural gas shall have the tests specified herein conducted with test Gas A. Additional tests shall be conducted with test Gas G with no change whatever in burner equipment, test pressures, orifices or air shutter setting used for natural gas and shall comprise those tests specified in 2.5 and 2.6. Compliance with these supplemental tests does not imply that the appliance has been examined under this standard for use with LP gas-air mixtures.

b. An appliance for use with manufactured gas shall have the tests specified herein conducted with test Gas B.

c. An appliance for use with mixed gas shall have the tests specified herein conducted with test Gas C.

d. An appliance for use with natural, manufactured and mixed gases shall be tested with test Gases A and G, as specified in 2.2-a, and test Gas B.

The tests specified in 2.4, 2.5 and 2.6 shall also be conducted with test Gas C (1) when the appliance is equipped with different burners for natural and manufactured gas, or (2) when a third burner is supplied specifically for use with mixed gas. In the former case, the burner equipment employed for the mixed gas tests shall be that specified by the manufacturer.

e. An appliance for use with liquefied petroleum gases shall have the tests specified herein conducted with test Gas E. The tests specified in 2.5 and 2.6.7, 2.6.9 and 2.6.11 (or 2.7.3, 2.7.4, 2.7.5 and 2.7.6) shall also be conducted with test Gas D with no change whatever in burner equipment.

f. An appliance for use with LP gas-air mixtures shall have the tests specified herein conducted with test Gas H. The tests specified in 2.4.1, 2.5 and 2.6.7, 2.6.9 and 2.6.11 (or 2.7.3, 2.7.4, 2.7.5 and 2.7.6) shall also be conducted with test Gas F with no change in the appliance except for main burner and pilot orifices and air shutter adjustment.

g. An appliance for manufactured home (mobile home) or recreational vehicle installation convertible for use with natural gas and liquefied petroleum gases shall be tested as specified in 2.2-a and -e. Conversion from one gas to the other shall be made in accordance with the manufacturer's instructions.

h. When use with more than one type of gas is desired, the tests specified in 2.8 through 2.21, and 2.23, 2.24, 2.28, 2.33 and 2.34 need be conducted with only one test gas provided there are no changes in the appliance or input rating which, in the opinion of the testing agency, would affect the results of these tests.

2.3 TEST PRESSURES AND BURNER ADJUSTMENTS

2.3.1 Unless otherwise stated, each test specified herein shall consist of a series of three tests: one at normal inlet test pressure, one at reduced inlet test pressure and one at increased inlet test pressure, as shown in Table IX.

When the manifold pressure at the increased inlet test pressure is not greater than the manifold pressure at normal inlet test pressure, tests at the increased inlet test pressure need not be conducted. However, tests at normal inlet test pressure shall be conducted whenever tests at the increased inlet test pressure are specified.

TABLE IX
INLET TEST PRESSURES

Test Gas	Test Pressure-Inches Water Column (kPa)		
	Reduced	Normal	Increased
A	3.5 (0.87)	7.0 (1.74)	10.5 (2.61)
B	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)
C	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)
D	8.0 (1.99)	11.0 (2.74)	13.0 (3.23)
E	8.0 (1.99)	11.0 (2.74)	13.0 (3.23)
F	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)
G	3.5 (0.87)	7.0 (1.74)	10.5 (2.61)
H	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)

2.3.2 The inlet test pressures stated in 2.3.1 shall be the pressure immediately ahead of all controls. The regulator outlet pressure, at normal inlet test pressure, shall be approximately that recommended by the water heater manufacturer.

2.3.3 Burners shall be adjusted to their Btu ratings at normal inlet test pressure, unless otherwise specified herein. Burners shall be adjusted so they will be at the manufacturer's hourly Btu rating (± 2 percent) 15 minutes after being placed in operation from a room temperature start. The manifold pressure shall be within ± 0.2 inch of that printed on the rating plate. Primary air shall be set to give a good flame. No readjustment of hourly Btu input or primary air shall be made during a series of tests with any one test gas.

2.3.4 The minimum input rating for test purposes, on water heaters provided with controls which will reduce the input rating by automatic means, shall be 87 percent of the minimum input rating specified by the manufacturer. The manufacturer's specified minimum input rating shall not be less than 20 percent of the manufacturer's specified normal input rating.

2.4 COMBUSTION

2.4.1 A water heater shall not produce carbon monoxide in excess of 0.02 percent in the air-free products of combustion when the appliance is tested in a room with approximately a normal oxygen supply when operating at reduced inlet test pressure, and not in excess of 0.04 percent with the appliance adjusted to have a manifold pressure of 12.5 percent above that obtained during burner adjustment. (See 2.1.12.)

Method of Test

The appliance shall be installed as specified in 2.1.8 and the tank filled with water at 70 ± 2 F (21 ± 1 °C).

At the end of 15 minutes of operation at normal inlet test pressure two samples of the flue gases shall be secured at a point immediately preceding their discharge from the flue outlet of the appliance. The two samples shall be taken progressively one with the appliance adjusted to have a manifold pressure 12.5 percent above that obtained during the burner adjustment by changing the outlet pressure of the regulator, after 5 minutes of operation at that pressure when the regulator outlet pressure cannot be readily adjusted, this increase in manifold pressure may be obtained with the regulator removed or locked in its full open position and one at the reduced inlet test pressure after an additional 5 minutes of operation at that pressure.

These samples shall be analyzed for carbon dioxide and carbon monoxide. The samples shall be secured before the thermostat begins to reduce the gas rate.

This test shall then be repeated without any vent connector or venting arrangement connected to the appliance.

2.4.2 A water heater provided with a power burner or induced draft shall not produce a concentration of carbon monoxide in excess of 0.04 percent in the air-free products of combustion when operated at normal inlet test pressure and with reduced supply voltage.

Method of Test

With the appliance at room temperature the pilot shall be ignited and the supply voltage reduced to 85 percent of the appliance rating plate voltage. With the appliance operating at normal input rating and normal inlet test pressure after 15 minutes of operation a combustion sample shall be secured and analyzed for carbon monoxide.

2.4.3 A water heater for use with natural gas shall not produce carbon monoxide in the air-free products of combustion in excess of 0.04 percent when adjusted and operated in a room having approximately a normal oxygen supply with test Gas A at 4.0 inches water column (995 Pa) inlet test pressure.

Method of Test

When the gas pressure regulator outlet pressure at the 4.0 inches water column (995 Pa) inlet test pressure adjustment is not less than that obtained at normal inlet test pressure during conduct of the combustion tests specified in 2.4.1, this test need not be conducted.

The normal input shall be obtained at 4.0 inches water column (995 Pa) inlet test pressure, with test Gas A, by means of the orifice. Auxiliary adjustment means, if provided, shall be in the wide open position. A sample of the flue gases shall be secured with the appliance operating at

this adjustment pressure and in accordance with the method prescribed in 2.4.1 and analyzed.

2.4.4 A water heater for use with manufactured gas shall not produce carbon monoxide in excess of 0.04 percent in the air-free products of combustion when adjusted and operated in a room having approximately a normal oxygen supply with test Gas B at 3.0 inches water column (747 Pa) inlet test pressure.

Method of Test

When the gas pressure regulator outlet pressure at the 3.0 inches water column (747 Pa) inlet test pressure adjustment is not less than that obtained at normal inlet test pressure during conduct of the combustion tests specified in 2.4.1, this test need not be conducted.

The normal input shall be obtained at 3.0 inches water column (747 Pa) inlet test pressure with test Gas B, by means of the orifice. Auxiliary gas adjustment means, if provided, shall be in the wide open position. A sample of the flue gases shall be secured with the appliance operating at this adjustment pressure in accordance with the method prescribed in 2.4.1 and analyzed.

2.4.5 There shall be no leakage of flue gases around door cracks or any openings through which flue gas might pass through the jacket to the outside of any automatic storage water heater having an input rating of 5000 Btu per hour (1465 W) or more.

Method of Test

This test shall be conducted in conjunction with 2.24.5 with a stack attached as specified therein. A fuming or smoking material, such as titanium tetrachloride, shall be introduced into the combustion chamber in sufficient amount to give assurance that, if combustion products are discharged through door cracks or other openings, their presence will be revealed by the smoke. If no continuous discharge of smoke is in evidence, the appliance shall be considered as complying with this provision.

2.4.6 Under the conditions specified in the following Method of Test, a water heater shall not produce a concentration of carbon monoxide in excess of 0.04 percent in the air-free products of combustion.

Method of Test

Burners for use with natural, manufactured and mixed gases, or natural and mixed gases, shall be operated with test Gas A only.

Water at a temperature of 40 ± 2 F (4.5 ± 1 °C) and at a working pressure of not less than 40 psi (275.8 kPa) shall be supplied to the appliance through the inlet connection.

After the system has been filled, the outlet water valve shall be closed, and the inlet shall remain connected to the 40 F (4.5 °C) water supply.

The thermostat shall be adjusted to 130 ± 5 F (54.5 ± 3 °C) and the appliance shall be operated at normal inlet test pressure until it shuts off due to thermostat action.

Following this cycle, water shall be drawn from the outlet connection at a rate of 3 gallons (11.36 L) per minute until the water temperature at the outlet is reduced to 100 F (38 °C). The burner shall be allowed to operate by means of normal thermostat action.

The outlet connection shall be closed upon reaching 100 F (38 °C) outlet water temperature. Five minutes after closing the water outlet connection a sample of the flue products shall be collected and analyzed for carbon monoxide and carbon dioxide. This cycle shall be repeated.

2.5 BURNER AND PILOT OPERATING CHARACTERISTICS

2.5.1 Pilots and main burner flames shall not flash back during this or any of the other tests specified in this standard.

Method of Test

The appliance shall be operated for a period of 15 minutes at normal inlet test pressure. Then the main burner shall be turned off and back on with the main burner operating control. The test shall be repeated at the reduced inlet test pressure.

If the appliance is equipped with other than snap action main burner gas controls, this test shall be repeated with the gas rate to the main burner adjusted to deliver $\frac{1}{3}$ the normal input rate.

In the event the control system shuts off the main burner gas before the gas rate is adjusted to deliver $\frac{1}{3}$ the normal input rate, the test shall be conducted at the lowest input rate at which the control system will permit burner operation. In any event, the shutoff point of the control system shall not exceed 87 percent of the minimum input rate.

For any appliance including those equipped with automatic multi-rate or automatic modulating controls which provide for ignition and operation at a reduced input rate and act to reduce the input rate after ignition of the main burner gas, the test shall be conducted at 87 percent of the minimum input rate.

2.5.2 When the main burner gas is ignited, the flames shall carry across all ports and burn at all ports.

Method of Test

This test shall be conducted at the inlet test pressures specified under 2.3.1.

Starting with the appliance at room temperature and filled with 70 ± 2 F (21 ± 1 °C) water, at least 5 successive ignition tests shall be conducted with the main burner gas flow maintained for 30 seconds and interrupted for 30 seconds for each cycle.

Appliances provided with controls which will reduce the input rate by automatic means, shall also be tested when adjusted as specified in 2.3.4.

2.5.3 Burners shall not expel gas through air openings in mixer faces.

Method of Test

The appliance shall be operated at the inlet test pressures specified in 2.3.1 and at the input rate specified in 2.3.4.

A flame shall be played on the mixer face in such a manner that any gas expelled from the mixer head would be ignited.

If the appliance is equipped with other than snap action main burner controls, this test shall be repeated with the gas rate to the main burner adjusted to deliver $\frac{1}{3}$ the normal input rate.

In the event the control system shuts off the main burner gas before the gas rate is adjusted to deliver $\frac{1}{3}$ the normal input rate, the test shall be conducted at the lowest input rate at which the control system will permit burner operation.

2.5.4 Burners and pilots shall operate without depositing carbon during conduct of the tests specified in 2.5.

Under conditions of these tests, yellow-tipped flames are considered acceptable as long as carbon is not being deposited.

At the completion of all tests in 2.5, the combustion chamber shall be examined for evidence of carbon.

2.5.5 Main burner flames of a water heater shall not become extinguished during conduct of the following Method of Test.

Method of Test

Burners for use with natural, manufactured and mixed gases, or natural and mixed gases, shall be operated with test Gas A only.

Water at a temperature of 40 ± 2 F (4.5 ± 1 °C) and at a working pressure of not less than 40 psi (275.8 kPa) shall be supplied to the appliance through the inlet connection. After the system has been filled, the outlet water valve shall be closed.

The appliance shall be operated at the normal inlet test pressure until condensation of the flue gases within the combustion chamber ceases, or for a period of time sufficient to demonstrate that it would continue to operate in a normal manner.

2.5.6 When ignition is made in a normal manner, by means of the main burner operating control, flames shall not flash outside the combustion space.

2.5.7 Burner flames shall not become permanently extinguished when subjected to an external draft.

Method of Test

The appliance shall be operated for a period of 15 minutes at normal inlet test pressure.

A 3-mile-per-hour (1.34 m/s) wind shall then be directed for a period of 1 minute alternately against the front, sides and back of the appliance by means of a fan or blower. This test shall be applied with and without the main burner(s) in operation.

2.5.8 For water heaters provided with a power burner or induced draft, there shall be no back pressure at the burner mixer face and the burners shall effectively ignite without delayed ignition.

Method of Test

This test shall be conducted at the burner adjustment specified in 2.3.3 and under the following conditions:

- a. Normal inlet test pressure with the supply voltage adjusted to deliver 110 percent of the appliance rating plate voltage;
- b. Normal inlet test pressure with the supply voltage adjusted to deliver 85 percent of the appliance rating plate voltage;
- c. Reduced inlet test pressure with the supply voltage adjusted to deliver 85 percent of the appliance rating plate voltage; and
- d. Reduced inlet test pressure with the supply voltage adjusted to deliver 110 percent of the appliance rating plate voltage.

Under each of the above conditions it shall be determined there is no back pressure at the burner mixer face (see 2.5.3).

2.5.9 For water heaters equipped with Bunsen-type pilots, ignition of gas at the main burner(s) shall take place in a normal manner even though the pilot gas is burning at the orifice.

Method of Test

Pilot flashback shall be induced with an external flame if necessary. The pilot gas supply shall be reduced to an amount just sufficient to maintain the safety shutoff device in the open position. The main gas valve shall be opened and ignition observed.

2.5.10 Water heaters for use with natural gas shall comply with the provisions of 2.5 when operating with test Gases A and G, without any change in burner equipment, orifices or air shutter setting. (Note: 2.4.6 and 2.5.5 need not be repeated with test Gas G.)

2.5.11 Water heaters for flush-to-wall installation, including counter models, shall comply with all of the above provisions while installed in enclosures as specified in 2.1.8.

2.6 PILOTED IGNITION SYSTEMS

2.6.1 Pilot burners and safety shutoff devices shall comply with the applicable performance provisions of the Standard for Automatic Gas Ignition Systems and Components, ANSI Z21.20.

2.6.2 The time from initiation of gas flow to proof of supervised flame shall not exceed:

- a. 3 minutes for integral valve type automatic gas ignition systems;
- b. 5 minutes for electrical contactor type automatic gas ignition systems;
- c. 1½ minutes for an automatic gas ignition system requiring a continually applied manual force to assume the "on" position; and
- d. 1½ minutes for automatic gas ignition systems which operate every time the main burner(s) with which they are used are turned "on" and "off."

For purposes of this test, the control manufacturer's specified maximum flame-establishing period shall be used.

2.6.3 The pilot(s) shall effect safe ignition of gas at the main burner(s) after gas reaches the main burner port(s) and shall not become extinguished and remain extinguished when the gas to the main

burner(s) is turned on or off in a normal manner, either manually or by means of automatic devices. This provision does not apply to interrupted type pilots or to intermittent type pilots when the gas to the main burner(s) is turned off.

Method of Test

This test shall be conducted over the range of inlet test pressures specified in 2.3.1 for each type of gas selected. When natural gas is selected, this shall include the 4.0 inches water column (995 Pa) inlet test pressure adjustment with test Gas A specified in 2.4.3. This latter test need not be applied when the manifold pressure at the 4.0 inches water column (995 Pa) inlet test pressure adjustment is not less than that specified by the manufacturer for natural gas.

The pilot burner(s), main burner(s), and automatic igniter(s) shall be adjusted according to the manufacturer's instructions, and the gas turned off at the main burner(s).

Before timing the ignition, it shall be determined that all gas piping is filled with gas.

Gas shall be admitted to the main burner(s) by turning on fully, in a continuous movement, any manual means provided for main burner ignition. The period of time between the instant gas is admitted to the main burner(s) and ignition of the gas shall be recorded.

At least 25 successive ignition tests shall be conducted with the main burner gas flow maintained for 30 seconds and interrupted for 30 seconds for each cycle. Failure to effect safe ignition after gas reaches the main burner port(s) in any one instance, or continued extinction of the pilot, shall be considered as noncompliance with this provision.

These tests shall then be repeated using any automatic means provided for controlling main burner gas flow.

2.6.4 When an interrupted ignition source is provided, the time required for the main burner flame to be proved from the initiation of main gas flow shall not exceed 90 seconds when the water heater is operated at normal inlet test pressure.

For purposes of this test, the control manufacturer's specified maximum main burner flame-establishing period for the automatic gas ignition system shall be used.

2.6.5 The time required for the automatic gas ignition system to shut off the main gas supply following loss of supervised flame shall not exceed 3 minutes.

For purposes of this test, the control manufacturer's specified maximum flame failure response time shall be used.

Method of Test

The thermostat, if of the adjustable type, shall be set at the maximum temperature setting.

With the water at 70 ± 2 F (21 ± 1 °C), at the start of the test, the main burner(s) gas shall be lighted and permitted to burn for 1 hour at normal inlet test pressure, or until the thermostat starts to reduce the main gas supply.

The gas supply to the main burner(s) and water to the appliance shall then be shut off and the gas flow to a continuous or intermittent pilot immediately reestablished but not ignited. The combined flame failure response time and valve closing time shall not exceed 3 minutes. An interrupted pilot having a separate sensing device from that for the main burner flame shall also be tested by turning off all gas after the pilot has been proved but before the main burner gas is ignited. The gas flow to the interrupted pilot shall be immediately reestablished but not ignited. The combined flame failure response time and valve closing time shall not exceed 3 minutes.

2.6.6 When the automatic gas ignition system is designed to shut off the pilot gas supply also, the time and conditions specified in 2.6.5 shall apply.

2.6.7 The pilot shall effect ignition of the gas at the main burner(s) when the gas supply to the pilot is reduced to a point where the flame is just sufficient to keep the valve of the automatic gas ignition system open, or just above the point of flame extinction, whichever represents the higher pilot gas rate.

For purposes of this test, the control manufacturer's specified maximum flame failure response time shall be used.

A pilot which becomes extinguished after having completed main burner ignition is considered as complying with this provision. If the pilot becomes extinguished when the main burner gas is turned on and before igniting the main burner gas, the condition shall be deemed safe, but additional tests shall be made at increasing pilot rates to determine that no condition exists where the pilot will remain lighted without igniting the main burner gas.

The following tests shall be conducted at normal inlet test pressure:

- a. **Single-Flame Pilot Burners** (Pilot burners which produce a single flame with substantially uniform contour under turndown conditions.)

The pilot shall effect ignition of the gas within 4 seconds from the time gas is admitted to the main burner(s), without

excessive flame flashback or damage to the water heater, when the pilot gas supply is reduced to an amount just sufficient to keep the valve of the automatic gas ignition system open, or just above the point of flame extinction, whichever represents the higher pilot gas rate.

A flame can be considered as being equivalent to a substantially uniform contour flame if its deviation from uniform contour is occasioned by a flame baffle(s) or channel(s).

- b. **Multiflame Pilot Burners** (Pilot burners which produce a flame(s) with substantial variation in contour under turndown conditions.)

The pilot shall effect ignition of the gas within 4 seconds from the time gas is admitted to the main burner(s), without excessive flame flashback or damage to the appliance, when all the pilot flame ports except those for heating the thermal element are blocked, and the pilot gas supply is reduced to an amount just sufficient to keep the valve of the automatic gas ignition system open, or just above the point of flame extinction, whichever represents the higher pilot gas rate.

- c. **Pilot Burner and Thermal Element Assemblies Which Supply Electrical Energy for an Automatic Control System.**

When the thermal element is the only source of electric power for operation of the system, the tests under "a" and "b" above shall be conducted with the pilot adjusted to the minimum size (pull-in voltage) required to open the valve. This condition shall be based on the performance of the system when only the thermal element and valve are present. Under these conditions, the pilot shall effect ignition of the gas within 4 seconds after the gas reaches the main burner(s) without excessive flame flashback or damage to the appliance.

System components other than the valve shall be excluded during this test.

When a multiflame pilot burner is provided, the tests outlined under "b" above at increased pilot input ratings shall also be conducted.

- d. **Recycling Pilot Burners (Gas Ignited.)**

In the case of a pilot burner which operates every time the main gas burner is turned on or off, either manually or by automatic controls, the ignition flame shall provide ignition of the gas at the main burner(s) within 4 seconds from the time gas is admitted to the main burner(s), without excessive flame flashback or damage to the appliance, when the gas supply to the ignition flame is just sufficient to ignite the gas at the thermal heating ports.

When an escapement pilot is used in the control system, it shall be disconnected before applying this test.

2.6.8 Under the conditions of voltage variation and pilot rate reduction specified in the following Method of Test, an automatic pilot ignition system shall either (1) ignite the pilot burner gas within 30 seconds after gas reaches the pilot burner port(s), or (2) at voltages to the igniter of less than 85 percent of the appliance rating plate voltage, lock out within the control manufacturer's specified maximum lockout time. For purposes of this test, the control manufacturer's specified maximum lockout time shall be used.

Method of Test

These tests shall be conducted at normal inlet test pressure under the following voltage and pilot input rate conditions:

- a. **Undervoltage**

1. The voltage to the appliance shall be adjusted to 85 percent of the appliance rating plate voltage.
2. The ignition source circuit shall be separated from the other circuits of the ignition system and the appliance, and the voltage to this circuit adjusted to 70 percent of the appliance rating plate voltage. The voltage to the remaining circuits shall be adjusted to 85 percent of the appliance rating plate voltage. If separation of the circuits is not possible, the energy content to the ignition system shall be measured at 70 percent of the appliance rating plate voltage, and this energy level shall be used to conduct this test.

- b. **Overvoltage**

The voltage to the appliance shall be adjusted to 110 percent of the appliance rating plate voltage.

c. **Reduced Pilot Input Rate**

The pilot gas supply shall be reduced to an amount just sufficient to keep the valve of the safety shutoff device open or to an amount just above the point of flame extinction, whichever represents the higher pilot gas flow, and the appliance rating plate voltage shall be supplied to the appliance.

Under the conditions specified in "a," "b" and "c" above, ignition cycles shall be repeated 10 times.

In each case the pilot igniter shall either (1) ignite the pilot burner gas within 30 seconds after gas reaches the pilot burner port(s), or (2) at voltages to the igniter of less than 85 percent of the appliance rating plate voltage, lock out within the control manufacturer's specified maximum lockout time.

2.6.9 Any type of pilot equipped with an automatic igniter shall not cause excessive flame flashback or damage to the water heater.

For purposes of this test, the control manufacturer's specified maximum flame failure response time in combination with the control manufacturer's specified minimum recycle time shall be used.

Method of Test

The pilot igniter shall be rendered inoperative.

The appliance shall be instrumented with a sampling tube(s) to measure the gas-air ratio at various points in the appliance. This sampling tube(s) shall be connected to a gas-air analyzer coupled to a chart-type single-point recording potentiometer in order to produce a constant trace of the gas-air ratio at the sample point for sufficient time to allow a complete evaluation of the system. The gas-air ratio trace shall be developed with the appliance both hot and cold, and with all test gases for which the appliance is tested. Supplemental natural gas tests with test Gas G need not be conducted.

Unburned gas shall be allowed to flow into the appliance for a time equivalent to the control manufacturer's specified maximum flame failure response time. Immediately following shutoff of the gas supply, an ignition cycle shall be initiated and continued until the pilot igniter would be energized, as determined by the control manufacturer's specified minimum recycle time.

If the gas-air ratio at the time at which the pilot igniter would be energized does not exceed the lower explosive limit, the appliance shall be considered as complying with this provision. If this ratio is above the lower explosive limit, sufficient ignition tests shall be conducted between the time of energization of the ignition means and when the atmosphere within the appliance returns to below the

lower explosive limit to determine that the automatic igniter does not cause excessive flame flashback or damage to the appliance.

Appliances with control systems not providing complete gas shutoff, but having a purge period of 5 minutes or longer, shall be tested as specified above except the purge time shall be 4½ minutes. Pilot gas shall be allowed to flow during the purge period.

Appliances with control systems providing complete gas shutoff and a purge period of 5 minutes, or longer, shall be deemed to comply with this provision.

2.6.10 A pilot not provided with automatic shutoff when the presence of the ignition source is not proved shall not cause excessive flame flashback or damage to the water heater.

Method of Test

The pilot igniter shall be rendered inoperative. Main burner gas flow shall be shut off.

This test shall be conducted in a draft-free environment.

The appliance shall be instrumented with a sampling tube(s) to measure the gas-air ratio at various points in the appliance. This sampling tube(s) shall be connected to a gas-air analyzer coupled to a chart-type single-point recording potentiometer in order to produce a constant trace of the gas-air ratio at the sample point for sufficient time to allow a complete evaluation of the system. The gas-air ratio trace shall be developed with the appliance both hot and cold and with all test gases for which the appliance is tested. Supplemental natural gas tests with test Gas G need not be conducted.

Unburned pilot gas shall be allowed to flow into the appliance until equilibrium of the gas-air ratio is obtained. If the gas-air ratio during this time does not exceed the lower explosive limit, the appliance shall be considered as complying with this provision. If this ratio is above the lower explosive limit, sufficient ignition tests shall be conducted at any time up to 1 hour of pilot gas flow to determine that the unsupervised pilot system does not cause excessive flame flashback or damage to the appliance.

2.6.11 Flames shall travel freely to all pilot burner ports when the gas is ignited at any one port.

Method of Test

The average temperature of the water in the storage vessel shall be 10 ± 2 F (5.5 ± 1 °C) above room temperature. Inlet water temperature shall not be less than 10 F (5.5 °C) above room temperature.

The gas rate to the pilot shall be adjusted at normal inlet test pressure to the manufacturer's hourly Btu input rating, and the gas ignited. The gas pressure shall then be reduced to a point at which only sufficient gas is being consumed to cause the safety shutoff device to remain in the position required of it in service for turning on the gas supply.

The flames shall then be extinguished and the gas from the ports which serve to heat the thermal element of the safety shutoff device immediately reignited. The flames shall travel freely to all other ports on the pilot burner.

2.6.12 The temperatures developed on an automatic gas ignition system component shall not exceed those for which the component is designed.

Method of Test

Thermocouples shall be peened into or brazed to the following points which are applicable to the component provided:

- a. Pilot burner tip
- b. Pilot burner orifice fittings
- c. Electric igniter
- d. Flame sensor
- e. Surfaces of the hot and cold junction of thermoelectric types
- f. Valve body
- g. Electric switch
- h. Contact mechanism
- i. Magnetic assembly

The main burner(s) and pilot burner(s) shall be operated at normal inlet test pressure until equilibrium pilot temperatures have been attained, at which time the temperatures at the points listed above shall be recorded.

2.7 DIRECT IGNITION SYSTEMS

2.7.1 Direct ignition systems shall provide a lockout timing of not more than 60 seconds and shall comply with the applicable performance provisions of the Standard for Automatic Gas Ignition Systems and Components, ANSI Z21.20. For purposes of this test, the control manufacturer's specified maximum lockout time shall be used.

2.7.2 For systems which incorporate an Ignition Activation Period (see Part IV, Definitions) the period of time between deactivation of the ignition means and the maximum lockout time shall not exceed 4 seconds.

2.7.3 The ignition system shall effect ignition of the gas at the main burner(s) immediately after gas reaches the main burner port(s) when operated at appliance rating plate voltage.

Method of Test

While maintaining appliance rating plate voltage to the appliance, the ignition system shall be placed in operation and ignition observed.

The procedure described above shall be repeated 25 times and in each instance ignition shall occur immediately after gas reaches the main burner port(s).

2.7.4 Under the conditions of voltage variation specified in the following Method of Test, the direct ignition system shall either (1) ignite main burner gas within 4 seconds after gas reaches the main burner port(s), or (2) at voltages to the igniter of less than 85 percent of the appliance rating plate voltage, lock out within the control manufacturer's specified maximum lockout time. For purposes of this test, the control manufacturer's specified maximum lockout time for the ignition system shall be used.

Method of Test

The following voltages shall be used during conduct of this test:

a. Undervoltage

1. The voltage to the appliance shall be adjusted to 85 percent of the appliance rating plate voltage.
2. The ignition source circuit shall be separated from the other circuits of the ignition system and the appliance, and the voltage to this circuit adjusted to 70 percent of the appliance rating plate voltage. The voltage to the remaining circuits shall be adjusted to 85 percent of the appliance rating plate voltage. If separation of the circuits is not possible, the energy content to the ignition source shall be measured at 70 percent of the appliance rating plate voltage, and this energy level shall be used to conduct this test.

b. Overvoltage

The voltage to the appliance shall be adjusted to 110 percent of the appliance rating plate voltage.

Under the conditions of both undervoltage and overvoltage as specified in "a" and "b" above, ignition cycles shall be repeated 25 times.

In each case the direct ignition system shall either (1) ignite main burner gas within 4 seconds after gas reaches the main burner port(s), or (2) at voltages to the igniter of less than 85 percent of the appliance rating plate voltage,

lock out within the control manufacturer's specified maximum lockout time.

2.7.5 With the water heater at equilibrium temperatures while operating at normal inlet test pressure, the time required for the main burner gas supply to be shut off in the event of flame outage during an operational cycle shall not exceed 90 seconds.

If the ignition means is reactivated, it shall be reenergized in not more than 0.8 second following flame outage and the ignition means shall reignite the main burner gas without flame flashback or damage to the appliance. On appliances where all air for combustion is supplied by mechanical means, the ignition means may be reactivated after a purge (recycle time) period sufficient to provide a minimum of four air changes of the combustion chamber and flue passages. For purposes of this test, the control manufacturer's specified maximum flame failure response time shall be used.

If the ignition means is reactivated, the control manufacturer's specified maximum flame failure reignition time and minimum recycle time shall be used.

2.7.6 The construction of the water heater and the arrangement of the ignition system shall be such that in the event of a delay in ignition of the main burner gas such as might be caused by foreign debris or electrical shorting of the ignition means the appliance will vent itself without excessive flame flashback or damage.

For the purposes of this test, the control manufacturer's specified maximum lockout time shall be used. For systems which deactivate the ignition means prior to the end of the lockout time, the test shall be conducted using the control manufacturer's specified maximum ignition activation period timing.

Method of Test

With the appliance at room temperature, the appliance shall be placed into operation at normal inlet test pressure with the ignition means temporarily circumvented for varying intervals of time up to the control manufacturer's maximum specified lockout time or maximum specified ignition activation period, whichever is shorter. For recycling systems, attempts to ignite shall be made for varying intervals of time for each cycle throughout the total operating sequence up to lockout. The resulting ignition in each trial shall be observed for flame flashback or damage to the appliance.

2.7.7 Temperatures of automatic burner ignition and safety shutoff devices shall not exceed those for which the device is designed when tested in accordance with the Method of Test specified in 2.6.12.

2.8 HEAT REQUIRED TO SUPPLY DAILY QUOTA OF HOT WATER

An automatic storage water heater, except those covered by Federal energy acts* (see 1.1.2), shall be capable of supplying a daily quota, G, of water heated from room temperature through a temperature rise of 90 F (50 °C), and shall further be capable of maintaining the stored water at the ultimate temperature specified above during that portion of the 24 hours not required to heat the daily quota, with a total gas consumption in Btu not in excess of 1500 G.** This provision shall be deemed met when the total heat required, as determined by the following formula, does not exceed 1500 G (396.26 G):

$$75,000 \frac{G}{E_r} + 180 VS - 562,500 \frac{VSG}{qE_r}$$

$$\frac{19813 G}{E_r} + 47.55 VS - \frac{11505 VSG}{qE_r}$$

where

E_r = recovery efficiency, percent,

V = volume of stored water, U.S. gallons (L),

S = standby loss, percent per hr, expressed as a percentage of the total heat content of the stored water above room temperature,

q = manufacturer's input rating, Btu per hr (W), and

G = daily quota, U.S. gallons (L) of water heated through a temperature rise of 90 F (50 °C).

$$= \frac{qV}{48.06 V + 0.105 q \sqrt{V}}$$

$$\left(\frac{qV}{3.724 V + 0.067 q \sqrt{V}} \right)$$

* At the time of this printing, Federal energy acts regulate the recovery efficiency and standby loss of water heaters having a manufacturer's specified storage capacity of not less than 20 gallons (75.7 L) nor more than 100 gallons (378.5 L) having input ratings up to and including 75,000 Btu per hour (21 980 W), and which are not for recreational vehicle installation only.

** The heat required for the purpose specified above by an appliance with a recovery efficiency of 70 percent, a standby loss of 22.39 % - \sqrt{V} per hour of the heat content of the stored water above room temperature, and the same rating and storage capacity as the appliance under test and which is designated a "standard heater" for the purpose of the provision.

Method of Test

a. **Recovery Efficiency.** The appliance shall be installed following the instructions furnished by the manufacturer with thermometers in the cold water inlet line, the hot water outlet line, and in a line from the drain connection. The line from the drain connection shall be arranged to discharge into a container in order to weigh the water. Provision shall be made for shutting off the above lines. The gas rate shall be adjusted and maintained at normal inlet test pressure.

Before starting any tests, the setting of the thermostat shall first be obtained by starting the water in the system at $70 \pm 2 \text{ F}$ ($21 \pm 1 \text{ }^\circ\text{C}$) noting the maximum temperature of the water drawn from the hot water outlet immediately after the thermostat reduces the gas supply to a minimum. The temperature shall be $160 \pm 5 \text{ F}$ ($71 \pm 3 \text{ }^\circ\text{C}$).

When the thermostat reduces the gas supply to a minimum, the inlet water and main burner valves shall be closed and the water drained. After the system is emptied, the drain valve shall be closed, the inlet water valve opened, and the system filled at once with water at $70 \pm 2 \text{ F}$ ($21 \pm 1 \text{ }^\circ\text{C}$).

The meter reading shall be noted and the appliance again put into operation. When the thermostat reduces the gas supply to a minimum, the inlet water valve and gas valve shall be closed immediately, the meter reading taken, and the water in the storage vessel drained. The heat content of the water shall be determined by allowing the water to flow into a container and reading its temperature at 10-pound (4.5 kg) intervals, noting the total weight as well. During this test, the temperature and calorific value of the gas and barometric pressure shall be taken and recorded.

Efficiencies shall be computed by means of the following formula:

$$E_r = \frac{KW(\theta_2 - \theta_1)}{(CF \times Q \times H)} \times 100$$

where

E_r = recovery efficiency, percent,

K = 1.0 Btu per pound degree F (4184 J kg $^\circ\text{C}$),
nominal specific heat of water,

W = total weight of water drained, lbs (kg),

θ_1 = average temperature of inlet water, F ($^\circ\text{C}$),

θ_2 = average temperature of drained water, F ($^\circ\text{C}$),

CF = correction factor to correct observed gas volume to standard conditions of 30 inches mercury column (101.3 kPa) pressure at 60 F ($15.5 \text{ }^\circ\text{C}$),

Q = total gas consumed as metered, cu ft (m^3), and

H = total heating value of gas, Btu per cu ft (MJ m^3).

b. **Standby Loss.** For purposes of this test, the pilot or bypass consumption shall be within the limits specified by the manufacturer.

The appliance shall be installed following the instructions furnished by the manufacturer with thermometers in the cold water inlet line, the hot water outlet line, and in a line from the drain connection. The line from the drain connection shall be arranged to discharge into a container in order to weigh the water. Provision shall be made for shutting off the above lines. The gas rate shall be adjusted and maintained at normal inlet test pressure. The inlet water temperature for the purpose of this test shall be maintained at $70 \pm 2 \text{ F}$ ($21 \pm 1 \text{ }^\circ\text{C}$). The thermostat setting shall be the same as that employed during the efficiency test in "a" above.

The gas to the pilot or the bypass shall then be lighted and the gas to the main burner(s) turned on. The appliance shall be allowed to cycle a sufficient number of times to attain thermal equilibrium before beginning the test. The initial meter reading shall then be taken immediately after the thermostat reduces the main gas supply to a minimum and when the water temperature at the top of the storage vessel is constant, $\pm 2 \text{ F}$ ($\pm 1 \text{ }^\circ\text{C}$) in the case of a graduating thermostat. The temperature at the top of the storage vessel shall be $160 \pm 5 \text{ F}$ ($71 \pm 3 \text{ }^\circ\text{C}$). The duration of this test shall not be less than 24 hours nor less than 2 cycles. The final meter reading shall be taken when the water temperature, as recorded by the recording thermometer, corresponds to the initial reading.

In the case of a snap or quick-acting thermostat, the burner consumption shall also be taken from the time the thermostat opens until it closes for any cycle. The reason for this is to be able to compute the heat content of the stored water at the time the thermostat turns on.

The room temperature shall not vary more than $\pm 7.5 \text{ F}$ ($\pm 4 \text{ }^\circ\text{C}$) from the average during the test, temperature readings being taken by means of a recording thermometer and averaged at the end of the test. The calorific value of the gas, barometric pressure and gas temperature shall be taken at such intervals that a fair average may be obtained.

Immediately after the conclusion of the test, the inlet water valve shall be closed and the average temperature of the stored water determined by allowing the water to flow into a container and reading its temperature at 10-pound (4.5 kg) intervals, noting the total weight as well.

The average gas consumption, including pilot consumption, in Btu per hour, expressed as a percentage (S)

of the heat content of the stored water above room temperature, shall be determined by the formula:

$$S = \frac{(CF \times Q \cdot H)}{K_1 W (\theta_2 - \theta_1)} \times 100$$

where

S = standby loss, percent per hr. expressed as a percentage of the total heat content of the stored water above room temperature.

CF = correction factor to correct observed gas volume to standard conditions of 30 inches mercury column (101.3 kPa) pressure at 60 F (15.5 °C).

Q = total gas consumed as metered, cu ft (m³).

H = total heating value of gas, Btu per cu ft (MJ m³).

K = 1.0 Btu per pound degree F (4184 J kg·°C), nominal specific heat of water.

t = duration of test, hrs.

W = weight of stored water, lbs (kg).

θ_2 = average temperature of stored water, F (°C), and

θ = average room temperature, F (°C).

2.9 MANUALLY OPERATED GAS VALVES

Manually operated gas valves shall comply with the applicable performance provisions of the Standard for Manually Operated Gas Valves, ANSI Z21.15.

2.10 GAS APPLIANCE PRESSURE REGULATORS

Gas appliance pressure regulators shall comply with the applicable performance provisions of the Standard for Gas Appliance Pressure Regulators, ANSI Z21.18, and shall have a regulation capacity, as determined under that standard, at least equal to the manufacturer's hourly Btu input rating for the water heater at normal inlet test pressure.

2.11 AUTOMATIC VALVES

Automatic valves, when provided, shall comply with the applicable performance provisions of the Standard for Automatic Valves for Gas Appliances, ANSI Z21.21.

2.12 THERMOSTATIC CONTROL

2.12.1 Thermostats shall comply with the applicable performance provisions of the Standard for Gas Appliance Thermostats, ANSI Z21.23.

2.12.2 The thermostat shall operate normally at all the test gas pressures specified in this standard. It shall be checked for normal operation during all tests.

2.12.3 Dials of thermostats provided with temperature markings shall be accurately calibrated.

Method of Test

A mercury thermometer graduated to 1 F (0.5 °C) or a calibrated thermocouple shall be placed in the storage vessel so the water temperature 1 inch (25.4 mm) from the outlet connection may be determined. The system shall be filled with water at 70 ± 2 F (21 ± 1 °C). The thermostat shall be set at the 140 F (60 °C) setting, and the appliance operated at normal inlet test pressure until the gas supply is reduced to a minimum or, in the case of a snap-acting thermostat, until the main gas supply is shut off. The water temperature at the outlet connection shall be observed, and if this temperature is not 140 ± 5 F (60 ± 3 °C), adjustment shall be made and the above procedure repeated until a water temperature within the limits specified is obtained.

The temperature of the water shall then be decreased to 70 ± 2 F (21 ± 1 °C), and the thermostat dial set at the lowest numbered position on the dial. The gas shall again be ignited and the outlet temperature at which the main gas supply is reduced to a minimum, or is shut off, observed. The outlet water temperature shall be within ± 10 F (± 5.5 °C) of the temperature indicated by the dial setting. This procedure shall be repeated with the thermostat set to the maximum position at which it can be set by the user. At this setting, the outlet water temperature shall be within ± 10 F (± 5.5 °C) of the temperature specified by the appliance manufacturer for that setting.

2.13 STORAGE HEATER TEMPERATURE LIMITS

When a separate nonadjustable thermostat in the upper part of the water heater is provided by the manufacturer to limit the water temperature in the top part of the tank, in addition to the thermostat used to control the operation of the appliance, both thermostats shall be considered as a single thermostat for test purposes under this section.

2.13.1 When water heaters are intended to deliver water at a temperature not in excess of 160 F (71 °C), the outlet water temperature shall not rise more than 30 F (16.5 °C) above the initial water temperature, and in no case shall the outlet water temperature exceed 190 F (88 °C) when tested as specified in the following Method of Test.

Method of Test

The appliance supplied for test shall be equipped with thermostat calibrated between 155 and 160 F (68 and 71 °C) at the thermostat level. The temperature adjustment means on thermostats provided with adjustable features for consumer use shall be set against the high stop, and the thermostat shall not be recalibrated during any part of this test. Other types of thermostats shall be tested as received.

The system shall be filled with water at 65 ± 5 F (18.5 ± 3 °C). A quick-acting valve shall be installed on the outlet connection of the storage vessel. The minimum cross-sectional area through this valve shall be equal to or greater than that of a ¼-inch (6.4 mm) nipple. A flow restricting device shall be connected to the outlet of this valve. The flow restricting device shall be adjusted or constructed so as to maintain a flow rate of 3 gallons per minute (11.36 L/min.) during test draw periods. A mercury thermometer graduated to 1 F (0.5 °C) or a suitable thermocouple shall be placed in the outlet flow stream as close to the outlet connection of the storage vessel as practical. A suitable thermocouple shall also be located in the storage vessel at the thermostat level. A water pressure regulator shall be located between the inlet connection to the storage vessel and the water supply line and adjusted so that, at a steady flow rate of 3 gallons per minute (11.36 L/min.), the pressure at the inlet connection will be 40 pounds per square inch (275.8 kPa). During the test, inlet water temperature shall be maintained at 65 ± 5 F (18.5 ± 3 °C).

The appliance shall be operated at normal inlet test pressure with the test gas for which the highest rating is requested until the thermostat reduces the gas supply to the burner(s) to a minimum. The water temperature at the thermostat level shall be within the limits of 155-160 F (68-71 °C). Water shall then be immediately drawn at the specified draw rate until the thermostat functions, and the maximum outlet temperature shall be recorded as the maximum initial temperature. This operation shall be repeated until a constant outlet water temperature is attained. When this condition has been reached, the maximum outlet water temperature shall be recorded. The outlet water temperature shall not increase more than 30 F (16.5 °C) above its maximum initial temperature, nor exceed 190 F (88 °C).

2.13.2 When water heaters are intended to deliver outlet water at a temperature in excess of 160 F (71 °C), the outlet water temperature shall not rise more than 20 F (11 °C) above the initial water temperature, and in no case shall the outlet water temperature exceed 200 F (93.5 °C) when tested as specified in the following Method of Test. (Also see 2.15.3 and 2.15.4.)

Method of Test

The appliance supplied for test shall be equipped with thermostat calibrated between 175 and 180 F (79.5 and

82 °C) at the thermostat level. The temperature adjustment means on thermostats provided with adjustable features for consumer use shall be set against the high stop, and it shall not be recalibrated during any part of this test. Other types of thermostats shall be tested as received.

The system shall be filled with water at 65 ± 5 F (18.5 ± 3 °C). A quick-acting valve shall be installed on the outlet connection of the storage vessel. The minimum cross-sectional area through this valve shall be equal to or greater than that of a ¼-inch (6.4 mm) nipple. A flow restricting device shall be connected to the outlet of this valve. The flow restricting device shall be adjusted or constructed so as to maintain a flow rate of 3 gallons per minute (11.36 L/min.) during test draw periods. A mercury thermometer graduated to 1 F (0.5 °C) or a suitable thermocouple shall be placed in the outlet flow stream as close to the outlet connection of the storage vessel as practical. A suitable thermocouple shall also be located in the storage vessel at the thermostat level. A water pressure regulator shall be located between the inlet connection to the storage vessel and the water supply line and adjusted so that, at a steady flow rate of 3 gallons per minute (11.36 L/min.), the pressure at the inlet connection will be 40 pounds per square inch (275.8 kPa).

During test, inlet water temperature shall be maintained at 65 ± 5 F (18.5 ± 3 °C).

The appliance shall be operated at normal inlet test pressure with the test gas for which the highest rating is requested until the thermostat reduces the gas supply to the burner(s) to a minimum. The water temperature at the thermostat level shall be within the limits of 175-180 F (79.5-82 °C). Water shall then be immediately drawn at the specified draw rate until the thermostat functions, and the maximum outlet temperature shall be recorded as the maximum initial temperature. This operation shall be repeated until a constant outlet water temperature is attained. When this condition has been reached, the maximum outlet water temperature shall be recorded. The outlet water temperature shall not increase more than 20 F (11 °C) above its maximum initial temperature, nor exceed 200 F (93.5 °C).

2.14 QUANTITY AND TEMPERATURE OF HOT WATER

A water heater shall be capable of delivering, as water above 120 F (49 °C), 60 percent of the theoretical degree-gallon capacity of the tank above 120 F (49 °C) in a continuous drawoff of 85 percent or less of the actual storage vessel capacity, with the thermostat used to control the operation of the appliance adjusted to give a top-of-tank temperature of 150 ± 2 F (65.5 ± 1 °C).

The theoretical degree-gallon capacity of the tank above 120 F (49 °C) shall be calculated by use of the following equation:

$$DG = C (T - 120)$$

where

DG = actual tank degree-gallon (degree-liter) capacity above 120 F (49 °C),

C = actual tank capacity in gallons (L),

T = actual top-of-tank temperature, F (°C).

Method of Test

This test shall be conducted at normal inlet test pressure

The appliance shall be installed and adjusted as specified in 2.8 a except that the hot water connection shall be made from the regular hot water outlet, and the thermometer in this line shall be as close to the storage vessel as is practicable. A valve capable of adjustment to the desired draw rate shall be installed in the hot water outlet line

A thermocouple insulated to withstand immersion in high temperature water shall be installed 2 inches (50.8 mm) below the top of the tank to determine the temperature of the water at the top of the tank. The thermostat used to control the operation of the appliance shall be adjusted to reduce the gas supply to a minimum when the temperature in the top of the tank reaches 150 ± 2 F (65.5 ± 1 °C). The capacity of the storage vessel shall be determined as specified in 2.29

The appliance shall be connected to a source capable of supplying water at a temperature of 70 ± 2 F (21 ± 1 °C) and at a pressure of 40 psi (275.8 kPa). The system shall be filled with water at the specified temperature and operated until the thermostat reduces the gas supply to a minimum. After 10 minutes, a quantity of water equal to 85 percent of the actual storage vessel capacity of the appliance shall be drawn from the hot water outlet, with water being supplied through the cold water inlet at a constant temperature of 70 ± 2 F (21 ± 1 °C) and at a pressure of 40 psi (275.8 kPa). The valve in the hot water outlet of an appliance with an actual tank capacity above 18.0 gallons (68.14 L) shall be adjusted to provide a uniform rate of draw equal to 3 gallons per minute (11.36 L/min). For an appliance with an actual tank capacity of 18.0 gallons (68.14 L) or less, this valve shall be adjusted to provide a uniform rate of draw equal to $\frac{1}{4}$ the actual tank capacity [to the nearest gallon (L)] per minute

The temperature of water withdrawn shall be read at a point as close to the storage vessel as possible and

recorded immediately at the start of the draw and at 10-pound (4.5 kg) intervals thereafter. A curve with outlet water temperature as ordinate and percent of actual tank capacity as abscissa shall be prepared from the data obtained. The area under that portion of the delivery curve above 120 F (49 °C) and within 85 percent of actual storage vessel capacity shall be determined as percent of total area representing actual storage vessel capacity multiplied by the difference between 120 F (49 °C) and the top of tank temperature

2.15 TEMPERATURE LIMITING SYSTEMS

2.15.1 Automatic gas shutoff devices shall comply with the applicable performance provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22.

2.15.2 Temperature relief valves and temperature relief elements of combination valves, when provided, shall comply with the applicable performance provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22.

2.15.3 Automatic gas shutoff devices shall not be actuated during the tests specified in 2.13.

2.15.4 An automatic gas shutoff system shall operate to shut off the gas to all burners, including the pilot burner(s), before the stored water temperature in the top 6 inches (152 mm) of the tank exceeds 210 F (99 °C) when tested as specified in the following Method of Test.

An automatic gas shutoff system of the manual reset type shall be manually resettable at a water temperature not lower than 120 F (49 °C).

Method of Test

When a separate nonadjustable thermostat in the upper part of the appliance is provided by the manufacturer to limit the water temperature in the top part of the tank in addition to the thermostat used to control the operation of the appliance, both thermostats shall be considered as a single thermostat for test purposes

The appliance shall be set up for test as specified in 2.13.1 or 2.13.2, as applicable. In addition, a suitable thermocouple shall be centrally located in the storage vessel at a point 6 inches (152 mm) below the top of the tank and another thermocouple placed in the storage vessel at the water temperature within 1 inch (25.4 mm) of the temperature sensitive element of the automatic gas shutoff system can be determined

The appliance shall be operated as specified in 2.13.1, 2.13.2, as applicable. When a condition of constant outlet water temperature has been attained, the closing action of the thermostat(s) shall be nullified by blocking in the full open position or by other suitable means. The appliance shall be continued in operation until the automatic gas shutoff system functions or until the water temperature as indicated by the thermocouple 6 inches (152 mm) below the top of the tank exceeds 210 F (99 °C), whichever occurs first. The temperature indicated by the thermocouple located adjacent to the temperature sensitive element of the automatic gas shutoff system shall also be recorded.

If the system is of the manual reset type, the water temperature indicated by the thermocouple adjacent to the temperature sensitive element of the system shall be adjusted to 120 F (49 °C). The automatic gas shutoff system shall then be manually resettable to permit gas flow to the appliance.

2.15.5 The electromotive force produced by a hot thermocouple or generator for a circuit that includes a temperature sensitive switch of an automatic gas shutoff system shall be as specified in the following Method of Test.

Method of Test

- a. For nominal 30 millivolt or less open-circuit single-couple generators operating a safety shutoff device

The appliance shall be operated as specified in 2.15.4 through one complete cycle of automatic gas shutoff operation. Throughout this test the closed-circuit voltage across the shutoff valve terminals shall be measured by means of a suitable millivoltmeter. During the heat-up period the minimum closed-circuit voltage reading shall be recorded.

The minimum closed-circuit voltage recorded shall be at least two times the maximum closed-circuit drop-out voltage for the device as specified by the control manufacturer. The maximum closed-circuit drop-out voltage specified by the control manufacturer shall be the maximum resulting from the control manufacturer's tolerances.

- b. For greater than nominal 30 millivolt open-circuit generators operating a safety shutoff device

The appliance shall be operated as specified in 2.15.4 through one complete cycle of automatic gas shutoff operation. Throughout this test the closed-circuit voltage across the shutoff valve terminals shall be measured by means of a suitable millivoltmeter. During the heat-up period the minimum closed-circuit voltage reading shall be recorded.

The minimum closed-circuit voltage recorded shall be at least one and one-half (1½) times the maximum closed-

circuit drop-out voltage for the device as specified by the control manufacturer. The maximum closed-circuit drop-out voltage specified by the control manufacturer shall be the maximum resulting from the control manufacturer's tolerances.

2.16 PRESSURE RELIEF VALVES

Pressure relief valves and pressure relief elements of combination valves, when supplied, shall comply with the applicable performance provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22.

2.17 VACUUM RELIEF VALVES

Vacuum relief valves, when provided, shall comply with the applicable performance provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22.

2.18 EVALUATION OF BURN HAZARD POTENTIAL OF EXTERIOR SURFACES

The temperatures of exterior surfaces of the water heater, when tested as specified in the following Method of Test, shall not exceed the temperatures listed in Table X.

Method of Test

The appliance shall be installed in accordance with the manufacturer's installation instructions and connected to a source capable of supplying water at a temperature of 70 ± 2 F (21 ± 1 °C) at a pressure of 40 psi (275.8 kPa). A water outlet supply system, as specified in 2.12.3, and a vent pipe, as specified in 2.24.5, shall be installed. The thermostat shall be calibrated as specified in 2.12.3.

Room temperature shall be within the range of 68-86 F (20-30 °C). The maximum temperature specified is based on a 77 F (25 °C) room temperature. When the room temperature is other than 77 F (25 °C), the allowable temperature shall be increased or decreased 1 degree for each degree of room temperature greater or less than 77 F (25 °C).

With the thermostat set to its maximum temperature position, the appliance shall be operated at normal input rate until the thermostat is satisfied and, after 15 additional minutes, a quantity of water equal to 30 percent of the rated tank capacity shall be drawn from the hot water outlet at a uniform rate as specified in 2.14.

Burn hazard potential shall be determined for all surfaces that can be contacted by the probe. Surface temperatures shall not be taken on the (a) vent pipe, (b) draft hood, (c) heater casings exterior to the structure in which installed and vent terminals of direct vent water heaters (see 1.31.35), (d) water fittings or (e) leg surfaces which are recessed $\frac{3}{8}$ inch (9.5 mm) or more from the external jacket diameter.

Surface temperatures shall be measured using the probe illustrated in Figure 3. For each measurement, the probe is to be at the ambient temperature, and then is to be heated for 15 seconds to approximately the temperature of the surface under consideration. The probe is then to be applied to the surface under consideration with a 5-pound (22.2 N) force for 10 seconds. The probe is to be moved from the preheat position to the surface as quickly as possible, and is to be applied so the tip will fully contact the surface. The tip is considered to be the disc and the flat surface of the cork surrounding the disc. The surface temperatures obtained shall not exceed those specified in Table X.

TABLE X
MAXIMUM SURFACE TEMPERATURES, F (°C)*

Bare or painted metal	152 (66.5)
Porcelain Enamel	160 (71)
Glass	172 (78)
Plastic**	182 (83.5)

* Temperatures are based on a 77 F (25 °C) room temperature. When the room temperature is other than 77 F (25 °C), the temperatures are to be increased or decreased 1 degree for each degree of room temperature greater or less than 77 F (25 °C).

** Includes plastic with a metal plating not more than 0.005 inch (0.127 mm) thick and metal with a plastic or vinyl covering not less than 0.005 inch (0.127 mm) thick.

2.19 WALL, FLOOR AND CEILING TEMPERATURES

The temperature of walls, ceiling and floor adjacent to or in contact with the water heater shall not exceed room temperature by more than 90 F (50 °C).

On an appliance for use only in installations where either the walls or floors are noncombustible, the temperatures on these parts need not comply with this provision (see 1.31.11).

Method of Test

The appliance shall be installed as specified in 2.1.8

When vent arrangement Style I (Figure 2) will not accommodate the manufacturer's specified ceiling clearances for an appliance with vertical flue outlet, vent arrangement Style IA (Figure 4) shall be used for the conduct of this test.

When vent arrangement Style II (Figure 2) will not accommodate the manufacturer's specified clearances from the back wall of the enclosure for an appliance with horizontal flue outlet, vent arrangement Style IIA (Figure 4) shall be used for the conduct of this test.

Wall and ceiling temperatures shall be determined by means of a potentiometer and bead-type thermocouples. The thermocouples shall be made by contact welding No. 24 AWG (0.20 mm²) iron-constantan thermocouple wire and clipping off the free ends beyond the junction. The junction and $\frac{3}{8}$ inch (9.5 mm) of the lead shall be exposed on the test surface, the remainder of the lead extending through the wall. Thermocouples shall be secured to the wall surface by staples over the insulated portion of the leads and held in thermal contact with the surface by a radiation-transparent adhesive tape finished in dull black.

Thermocouples shall be placed at horizontal and vertical intervals of 6 inches (152 mm) on the wall and ceiling surfaces. Additional thermocouples may be located at any other points deemed necessary by the testing agency.

Floor temperatures shall be determined by means of No. 24 AWG (0.20 mm²) iron-constantan thermocouples the junctions of which are copper discs $\frac{1}{32}$ inch (8.7 mm) in diameter and 0.022 inch (0.559 mm) thick, to which the thermocouple wires are silver-soldered $\frac{1}{8}$ inch (3.2 mm) apart. The surface of the copper discs shall be finished with clear varnish. The discs shall be embedded so their surfaces are flush with the surface of the floor at intervals of no more than 3 inches (76.2 mm). A thermocouple shall also be placed under the legs or base of the appliance.

For a direct vent appliance, the junctions shall be placed flush with the surface of the appliance casing. For structural elements having a free surface in the stud space enclosing the appliance or vent - air intake pipe, or an exposed wall, floor and ceiling surface, the thermocouples shall be held in thermal contact with the wood surface by a radiation-transparent adhesive tape finished in dull black.

With the outlet water temperature regulated to deliver outlet water at a constant temperature of 160 ± 5 F (71 ± 3 °C) [or 180 ± 2 F (82 ± 3 °C) for an appliance intended to deliver outlet water above 160 F (71 °C)] and with the main burner(s) operated at maximum input, the appliance shall be operated at increased inlet test pressure until equilibrium temperature conditions are attained.

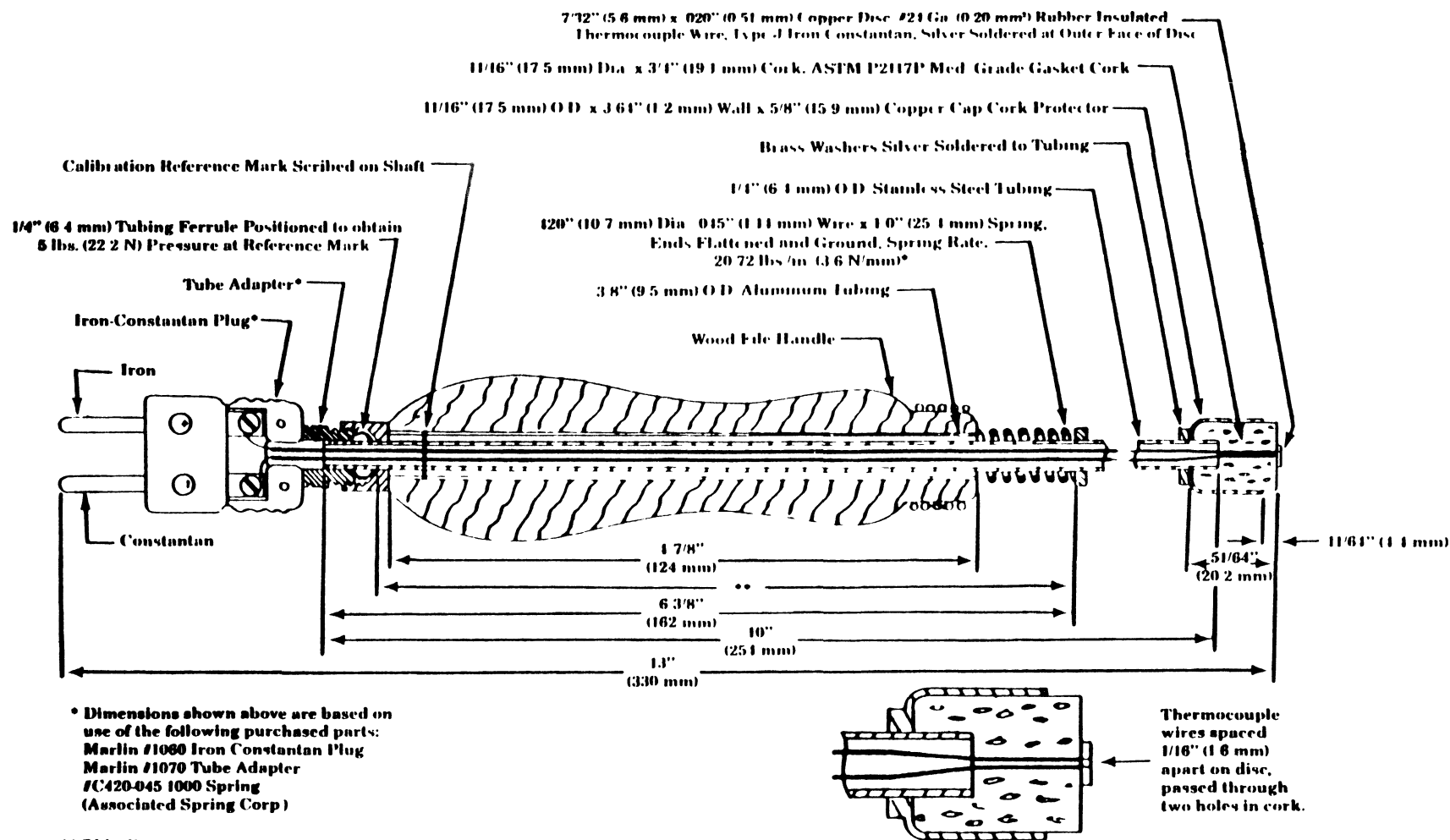


Figure 3. Temperature-Measuring and Accessibility Probe

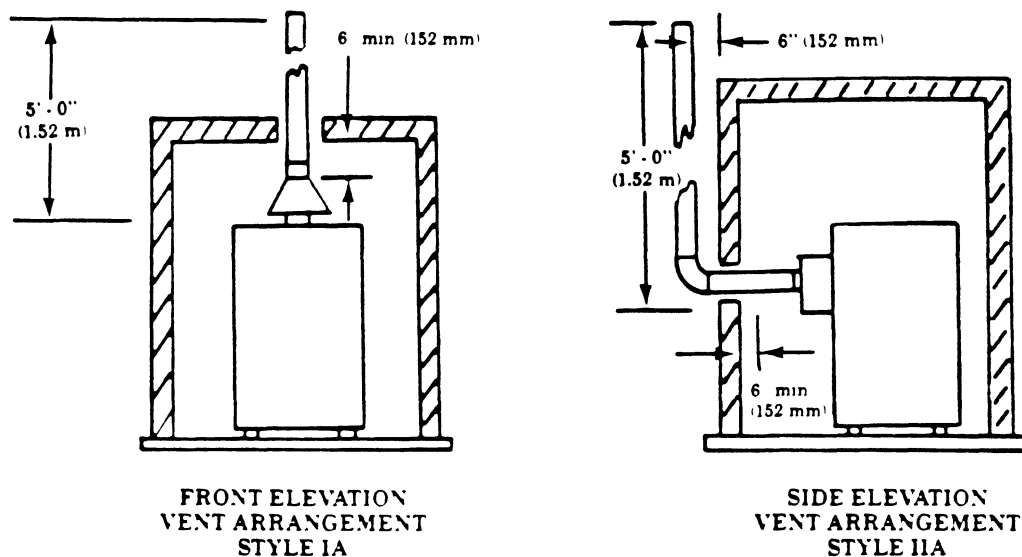


Figure 4. Alternate Vent Arrangement for Wall, Floor and Ceiling Temperature Tests

The temperature indicated by each thermocouple shall then be read and when compared with room temperature, shall not be more than 90 F (50 °C) above room temperature

An additional test shall be conducted on an appliance of other than the direct vent type with the appliance operated at normal inlet test pressure and the water flow rate as specified above. The outlet of the vent connector shall be progressively blocked until the flue gas temperature attains equilibrium, as measured under 2.20, after which the wall, floor and ceiling temperatures shall be recorded and shall not be more than 90 F (50 °C) above room temperature

2.20 FLUE GAS TEMPERATURE

2.20.1 The average temperature of the flue gases shall not exceed 480 F (266.5 °C) above room temperature. This provision does not apply to water heaters for outdoor installation incorporating integral venting systems.

Method of Test

This test shall be conducted at normal inlet test pressure. The flow of water through the appliance shall be regulated to deliver outlet water at the maximum setting of the thermostat. A sample of the flue gases shall be secured ahead of the draft hood and analyzed for carbon dioxide

The draft hood relief opening shall then be blocked. A 2-foot (610 mm) long vent pipe shall be attached vertically to the outlet of a vertically discharging draft hood. If the draft hood discharges horizontally, an elbow and a 2-foot (610 mm) vent pipe shall be used. The draft hood, elbow and vent pipe shall be insulated to prevent heat loss with 1 inch (25.4 mm) of glass fiber insulation. A grid of 10 thermocouples in parallel shall be installed in the vent pipe in a plane 18 inches (457 mm) from the inlet. Thermocouples shall be bead-type iron-constantan, No. 24 AWG (0.20 mm²), and shall be positioned in the grid so each thermocouple is in an equal area of the vent pipe. The length of all thermocouple leads shall be equal before paralleling. The outlet of the vent pipe shall be equipped with an adjustable restrictor.

The vent pipe outlet shall be restricted until the carbon dioxide concentration in a sample of the flue gases is the same as determined under conditions specified above. The average temperature of the flue gases shall be determined and shall not exceed 480 F (266.5 °C) above room temperature.

2.20.2 For water heaters having unconventional venting means supplied with the appliance by the manufacturer, the intent of 2.20.1 may be deemed met if the flue gas temperature and construction of the appliance are such as to preclude any fire hazard, as determined by the testing agency, when the appliance is installed in accordance with the manufacturer's printed instructions.

2.21 TEMPERATURE OF MANUALLY OPERATED PARTS

2.21.1 The temperature of exterior access door handles, drain valve handles and control parts and surfaces normally handled by the user in making adjustments of water temperature, operating main and pilot gas supply valves, or in resetting the safety shutoff device shall not exceed room temperature by more than 60 F (33.5 °C) for metallic parts or 80 F (44.5 °C) for nonmetallic parts.

Method of Test

The appliance shall be installed and adjusted as specified in 2.19 except that counter-type appliances shall have a vent pipe attached to the draft hood outlet as specified by 2.24.5 and this vent pipe shall not be blocked.

The appliance shall be operated at normal inlet test pressure for 1 hour. At the end of this time temperatures of parts listed above shall be measured. Room temperature shall be measured at a point opposite the access door not exposed to direct radiation. Temperatures shall be determined with a No. 24 AWG (0.20 mm²) iron-constantan thermocouple having the junction brazed into the face of a copper plate $\frac{7}{32}$ inch (5.6 mm) in diameter and 0.024 inch (0.61 mm) thick. The temperature of parts listed above shall not exceed room temperature by more than 60 F (33.5 °C) for metallic parts or 80 F (44.5 °C) for nonmetallic parts.

2.21.2 No part of the top working surface of a flush counter type water heater shall exceed room temperature by more than 30 F (16.5 °C) and no part of its backsplash shall exceed room temperature by more than 60 F (33.5 °C) when the appliance is tested in accordance with 2.21.1.

2.22 BURNER AND FLAME SPREADER TEMPERATURES

Metal used in the construction of a main burner(s) or a flame spreader, its support, or baffles located in the combustion chamber above the burner port level which serve as flame spreaders shall be suitable for the temperature developed during the following Method of Test and in accordance with Table XI.

Method of Test

This test shall be conducted at normal inlet test pressure using appropriate equipment, as specified by the manufacturer, with test gases as follows:

Burner and Flame Spreader for Use With

Test Gas

Natural Gas	A
Manufactured Gas	B
Mixed Gas	C
Natural, Manufactured and Mixed Gases	B
Natural and Mixed Gases	C
Liquefied Petroleum Gases	E
LP Gas-Air Mixtures	H

Thermocouples shall be securely fastened by peening, welding or other suitable means to the main burner(s) at probable high temperature points and to the metal at the outer edges and at other probable high temperature points on the flame spreader, its support, or baffles located in the combustion chamber which serve as flame spreaders. The appliance shall be placed in operation and the burner(s) adjusted, if adjustment means are provided, to give a hard flame. The control system shall be modified as necessary to permit continuous operation of the burner(s) so equilibrium temperatures are attained. When equilibrium conditions are attained, the temperatures as indicated by the thermocouples shall be recorded.

The burner(s) shall then be adjusted, if adjustment means are provided, to give a soft flame and continued in operation until equilibrium conditions are attained. Temperatures as indicated by the thermocouples shall be compared with the previously recorded temperatures.

The temperature developed on any part of the main burner(s) and flame spreader, its support, or baffles in the combustion chamber which serve as flame spreaders shall not be in excess of that permitted for the metal employed as specified in Table XI.

TABLE XI

MAXIMUM BURNER AND FLAME SPREADER TEMPERATURES

<u>Metal</u>	<u>Maximum Temperature Rise Above Room Temperature, F (°C)</u>
Gray Cast Iron	930 (516.5)
Chrome Alloy Cast Iron, 0.5 to 1.0% Cr, 0.2 to 0.5% Ni or Cu	1230 (683.5)
Ductile (Nodular) Cast Iron	1230 (683.5)
Chrome Alloy Steel, 5% Cr, 0.45 to 0.65% Mo, 1.0% Si	1280 (711)
AISI Type 430	1325 (736)
AISI Type 442	1550 (861)
AISI Type 446	1640 (911)
AISI Type 309C	1730 (961)

2.23 FLUE COLLARS

A flue collar on a water heater equipped with a detachable draft hood and having an input rating of 5,000 Btu per hour (1 465 W) or less shall be constructed so incomplete combustion will not result when the draft hood is removed and a flat object is placed over the flue outlet. This provision shall be deemed met when a concentration of carbon monoxide not in excess of 0.04 percent is present in an air-free sample of the flue gases when the appliance is tested in a room having approximately a normal oxygen supply.

Method of Test

When use with one gas is desired, this test shall be conducted with the appropriate gas as specified in 2.2.

When use with more than one gas is desired and the appliance input ratings are not identical for the different gases, this test shall be conducted at the specified input ratings for the individual gases. The number of tests conducted shall be at the discretion of the testing agency.

When use with more than one gas is desired and the appliance input rating is identical for the various gases, this test shall be conducted in accordance with the following:

- a. If the gases selected include liquefied petroleum gases or LP gas-air mixtures, use test Gas E or H.
- b. If the gases selected are natural and mixed, or natural, manufactured and mixed, use test Gas A.
- c. If the gases selected are mixed and manufactured, use test Gas C.

This test shall be conducted at normal inlet test pressure with the draft hood removed. The appliance shall be filled with water at $70 \pm 2^\circ\text{F}$ ($21 \pm 1^\circ\text{C}$) and placed in operation. A flat plate sufficiently large to cover the flue outlet shall then be placed over the flue collar, provided that it will remain there without being fastened in place. Either immediately before the thermostat acts to reduce the gas flow or at the end of 15 minutes operation, whichever occurs first, a sample of the flue gases shall be secured from the flue passage at a point immediately preceding their discharge from the appliance and analyzed.

2.24 DRAFT HOODS

Draft hoods provided on water heaters shall comply with the following provisions when the appliance is installed as specified in 2.1.8.

For an appliance not of the direct vent type for manufactured home (mobile home) installation, the venting system as supplied or specified in the manufacturer's instructions shall be used and shall be terminated at the top of the enclosure. The vent cap, if provided, shall be removed for these tests.

When use with one gas is desired, these tests shall be conducted with the appropriate gas as specified in 2.2.

When use with more than one gas is desired and the appliance input ratings are not identical for the different gases, these tests shall be conducted at the specified input ratings for the individual gases. The number of tests conducted shall be at the discretion of the testing agency.

When use with more than one gas is desired and the appliance input rating is identical for the various gases, these tests shall be conducted in accordance with the following:

- a. If the gases selected include liquefied petroleum gases or LP gas-air mixtures, use test Gas E or H.
- b. If the gases selected are natural and mixed, or natural, manufactured and mixed, use test Gas A.
- c. If the gases selected are mixed and manufactured, use test Gas C.

2.24.1 With the outlet of the draft hood blocked, the concentration of carbon monoxide in an air-free sample of the flue gases shall not exceed 0.03 percent when the water heater is tested in an atmosphere having a normal oxygen supply.

Method of Test

The appliance shall be operated at normal inlet test pressure for 15 minutes. (Also see 2.1.12.) Appliances equipped with throttling thermostats shall be operated until the input is reduced 5 percent or for 15 minutes, whichever occurs first. The outlet of the draft hood shall then be blocked and a sample of the flue gases shall be secured and analyzed as specified in 2.4.1.

2.24.2 Total downdraft pressures ranging from zero to 0.05 inch water column (13 Pa) imposed at the outlet of the draft hood shall not extinguish the main burner flames nor cause them to flash back, lift, float, burn outside the water heater, nor produce a concentration of carbon monoxide in an air-free sample of the flue gases in excess of 0.04 percent when the appliance is tested in an atmosphere having a normal oxygen supply.

Method of Test

The appliance shall be operated at normal inlet test pressure for at least 15 minutes. A straight section of vent pipe of suitable diameter and of a length at least equal to 10 pipe diameters shall be attached directly to the outlet of the draft hood and connected to a blower.

The total draft pressure shall be measured with a pitot tube* and a differential gage which may be read directly 0.005 inch water column (1.24 Pa) pressure. The pitot tube shall be inserted in the straight section of vent pipe at a point midway between its ends, so (1) the head of the tube is coincident with the axis of the vent pipe, and (2) the impact opening of the pitot tube faces the flow stream.

The draft in the vent pipe shall be varied from the minimum total pressure to the maximum value specified above, and the effect on the main burner flames noted. Sufficient combustion samples shall be secured to verify satisfactory combustion over the entire range of downdraft pressures.

2.24.3 Downdrafts imposed as specified in 2.24.2 shall not extinguish the pilot nor cause it to flash back when it is operated separately from the main burner(s).

2.24.4 A chimney action, consisting of static updraft and velocity updraft numerically totaling between 0.06 and 0.07 inch water column (15 and 17 Pa) pressure, applied to the outlet of the draft hood, shall not cause a fractional increase in the volume of the flue gases greater than twice the numerical sum of the pressure head and 5 times the velocity head, expressed in inches water column.

Method of Test

The appliance shall be operated at normal inlet test pressure for at least 15 minutes.

A straight length of vent pipe of suitable diameter and of a length at least equal to 10 pipe diameters shall be attached directly to the outlet of the draft hood and connected to a blower.

The pressure and velocity heads shall be measured with a pitot tube and a differential gage which may be read directly to 0.005 inch water column (1.24 Pa) pressure. The pitot tube shall be inserted in the straight section of vent pipe at a point midway between its ends, so (1) the head of the tube is coincident with the axis of the vent pipe, and (2) the impact opening of the pitot tube faces the flow stream.

*The pitot tube shall be of a recognized standard type or one calibrated by comparison with a standard type under conditions of air and flue gas flow comparable to those prevailing under draft conditions specified herein.

An updraft shall be imposed at the outlet of the draft hood such that the numerical sum of the pressure head and velocity head is between 0.06 and 0.07 inch water column (15 and 17 Pa). Under this condition, a sample of the flue gases shall be taken ahead of the draft hood and analyzed for carbon dioxide as specified in 2.4.1. The ratio of the carbon dioxide concentration for normal operation, as determined under 2.4.1, to that under updraft, as determined above, shall not be more than $1 + 2(h_p + 5h_v)$ where " h_p " is the pressure head and " h_v " is the velocity head.*

2.24.5 Flue gases shall not issue from the relief opening(s) of a draft hood:

- a. Having a vertical outlet when an elbow, a 2-foot (610 mm) length of vent pipe extending horizontally, a second elbow and a sufficient length of vertical vent pipe are attached to provide a total height of 5 feet (1.52 m) measured from the highest point of the draft hood relief opening(s) to the top of the vertical vent pipe, or
- b. Having a horizontal outlet when a 2-foot (610 mm) length of vent pipe extending horizontally, an elbow and a sufficient length of vertical vent pipe are attached to provide a total height of 5 feet (1.52 m) measured from the highest point of the draft hood relief opening(s) to the top of the vertical vent pipe. The horizontal section shall be pitched upward away from the water heater 1/4 inch to the foot (21 mm to the meter).

On appliances not of the direct vent type for installation in manufactured homes (mobile homes), flue gases shall not issue from the relief opening(s) of a draft hood having a vertical outlet when a sufficient length of vertical vent pipe is attached to provide a total height of 6 feet 6 inches (1.98 m) measured from the floor level, or from the relief opening(s) of a draft hood having a horizontal outlet when an elbow and a sufficient length of vertical vent pipe are attached to provide a total height of 6 feet 6 inches (1.98 m) measured from the floor level.

Ninety-degree (1.57 rad) sheet-metal elbows with inlet and outlet connections of the same nominal size as the outlet collar of the draft hood, with no abrupt bends and with a reasonably smooth inner contour, shall be used.

A test shall also be conducted on an appliance not of the direct vent type for installation in manufactured homes (mobile homes) whereby the flue gases shall not issue from the relief opening of the draft

*This formula considers friction, e.g., for a 45-ft. (13.72 m), 9-in. (229 mm) diameter chimney: $H_p - 5h_v = 0.13$ and $1 - 2(h_p - 5h_v) = 1.25$ (approx.). The same proportion holds for other values in the neighborhood of $h_p - 5h_v = 0.13$.

hood when the appliance is installed as specified in 2.1.8 with the venting system supplied or specified in the manufacturer's installation instructions in place (see 2.1.9).

In addition, these tests shall be repeated on appliances which reduce the input rating by automatic means at the minimum input rating specified in 2.1.14 and on appliances not of the direct vent type for installation in manufactured homes (mobile homes) at the increased input rate specified in 2.1.12.

Method of Test

The appliance shall be operated at normal inlet test pressure with sections of vent pipe or venting system corresponding to the above specifications attached to the outlet of the draft hood. (Also see 2.1.12.) Immediately after 15 minutes of operation, a fuming or smoking material, such as titanium tetrachloride, shall be introduced ahead of the draft hood so as to form a dense smoke. A beam of light shall be directed across the relief opening(s). This provision shall be deemed met when no smoke can be observed escaping from the relief opening(s).

2.24.6 A draft hood shall be sufficiently rigid in construction and supported on the water heater so it will withstand a load equivalent to that specified in the following Method of Test without becoming distorted and without alteration of its position with respect to the appliance.

Method of Test

A vertical or horizontal-to-vertical type draft hood shall be installed on the appliance in its normal operating position. When special means are provided for bolting or otherwise securing the draft hood to the flue outlet, such means shall be employed. A vertical compression load equal to 5 pounds per inch (0.09 kg/mm) of nominal outlet diameter shall then be applied without impact to the draft hood outlet. This load shall not cause distortion of any part of the draft hood or alteration of its position relative to the appliance.

A horizontal draft hood shall be installed on the appliance in its normal operating position. When special means are provided for bolting or otherwise securing the draft hood to the flue outlet, such means shall be employed. A 10-foot (3.05 m) length of vent pipe, made of sheet steel not less than 0.0195* inch (0.495 mm) thick, of suitable diameter shall then be attached in a horizontal position to the outlet connection of the draft hood, the other end of the length of pipe being supported at a point not more than 1 inch (25.4 mm) from its extremity. This load shall not result in distortion of any part of the draft hood or alteration of its position relative to the appliance.

* This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

2.25 AUTOMATIC VENT DAMPER DEVICES

Whenever the use of air above room temperature is specified and required for use in conducting the following performance tests, flue gases from a water heater or burner assembly, mixed with air to obtain the specified temperature, shall be used.

2.25.1 Strength

A vent damper device shall be sufficiently rigid in construction to withstand a load equivalent to the following without impairment of operation or significant distortion.

Method of Test

The vent damper device shall be installed on the appliance as specified in the manufacturer's installation instructions. The vent damper device shall then be operated for 10 cycles before any load is imposed to ascertain that the damper is operating properly.

a. A vent damper device having a vertical outlet shall have a vertical compression load, equal to 5 pounds per inch (0.09 kg/mm) of nominal outlet diameter, applied without impact to the outlet. With this load imposed, the vent damper device shall be operated for 10 cycles, shall operate properly, and shall exhibit no significant distortion upon visual examination.

b. A vent damper device having a horizontal outlet shall have a 10-foot (3.05 m) length of vent pipe, made of sheet steel not less than 0.0195* inch (0.495 mm) thick, of suitable diameter attached in a horizontal position to the outlet, the other end of the vent pipe being supported at a point not more than 1 inch (25.4 mm) from its extremity. With this load imposed, the vent damper device shall be operated for 10 cycles, shall operate properly, and shall exhibit no significant distortion upon visual examination.

2.25.2 Operation Under Variable Voltage or Variable Motive Power

a. An electrically operated vent damper device shall function properly and shall not adversely affect the operation of the appliance control system when the electrical supply voltage to the water heater is varied over a range of 85 to 110 percent of the voltage marked on the appliance rating plate.

Method of Test

The vent damper device shall be installed on the appliance as specified in the manufacturer's installation instructions.

* This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

The supply voltage to the appliance shall be adjusted 85 percent of the voltage marked on the appliance rating plate and, with the appliance at room temperature, the appliance control system shall be operated, by a switch in the thermostat circuit, to allow the main burner to alternately operate and turn off. This procedure shall be repeated 10 times, and during each cycle the vent damper device and main burner automatic gas valve shall function properly. The damper shall be open whenever the gas is admitted to the main burner.

This procedure shall be repeated with the supply voltage to the appliance adjusted to 110 percent of the voltage marked on the appliance rating plate.

b. A mechanically actuated vent damper device shall function properly when the motive power is varied over a range of 75 to 125 percent of the range of motive power marked on the vent damper device (see 1.31.34-d).

Method of Test

At room temperature, damper operation shall be observed when the motive power to the vent damper device is varied over a range of 75 and 125 percent of the range of motive power. The damper shall function properly for 10 cycles under each of these conditions.

2.25.3 Damper Force of a Thermally Actuated Vent Damper Device

This test shall be conducted before conduct of 15.5.

The damper of a thermally actuated vent damper device shall be capable of exerting a force of at least 2 ounces (57 gram-force) when moving in both the direction to open the damper and the direction to close the damper.

Method of Test

The vent damper device shall be installed in the position(s) specified in the manufacturer's installation instructions in a simulated venting system capable of alternately delivering to the vent damper device a supply of room temperature air and a supply of air at a temperature of 575 ± 25 F (301.5 ± 14 °C).

The damper force shall be measured using a strain gage or equivalent instrument coupled to the damper at the location that undergoes the greatest amount of movement as the damper goes from the closed to the open position.

The vent damper device shall be at room temperature, with the damper in the closed position. Air at a temperature of 575 ± 25 F (301.5 ± 14 °C) shall then be passed through the vent damper device. The force exerted

by the damper to move from its closed position toward the open position shall be measured and shall be at least 2 ounces (57 gram-force).

The strain gage shall then be coupled to the damper in the opposite direction and room temperature air passed through the vent damper device. The force exerted by the damper to move from its open position toward the closed position shall be measured and shall be at least 2 ounces (57 gram-force).

2.25.4 Exposure to Temperature Extremes

The vent damper device shall function properly and not be damaged after exposure to high and low temperature extremes.

Method of Test

a. The vent damper device shall be installed in a simulated venting system in the position(s) specified in the manufacturer's installation instructions. The damper shall be opened in a normal manner and maintained in this position for a period of 24 hours with the air at a temperature of 575 ± 25 F (301.5 ± 14 °C) continually passing through the vent damper device.

At the end of this period, room temperature air shall be introduced until the vent damper device has been brought to room temperature, and the vent damper device shall then be operated for 10 cycles to determine that it functions properly and has not become damaged.

b. The vent damper device, with the damper in the closed position, shall be maintained in an ambient temperature of 32 ± 5 F (0 ± 3 °C) for a period of 24 hours.

At the end of this period, the vent damper device shall be operated for 10 cycles to determine that it functions properly and has not become damaged. Electrically operated and mechanically actuated vent damper devices shall be subjected to the ambient temperature of 32 ± 5 F (0 ± 3 °C) while they are operated for these 10 cycles.

c. In addition, a thermally actuated vent damper device shall be maintained in an ambient temperature of 725 ± 25 F (385 ± 14 °C) for a period of 2 hours.

At the end of this period, room temperature air shall be introduced until the vent damper device has been brought to room temperature, and the vent damper device shall then be operated for 10 cycles to determine that it functions properly and has not become damaged.

2.25.5 Continued Operation

A vent damper device shall withstand 100,000 cycles of opening and closing the damper without any mechanical failure, impairment of operation, or damage.

Method of Test

The vent damper device shall be installed in the position(s) specified in the manufacturer's installation instructions in a simulated venting system capable of alternately delivering to the vent damper device a supply of room temperature air and a supply of air at a temperature of 575 ± 25 F (301.5 ± 14 °C).

The following cycling sequence, as applicable, shall be repeated until a total of 100,000 cycles of opening and closing of the damper have been completed, after which the vent damper device shall function properly and not be warped, bent, broken or otherwise damaged.

a. Electrically operated and mechanically actuated vent damper devices:

A control system which will actuate the damper of the vent damper device to alternately open and close shall be connected to the vent damper device and the air delivery means.

The damper shall be caused to assume its open position, and a supply of air at 575 ± 25 F (301.5 ± 14 °C) shall be passed through the vent damper device for at least 5 seconds. This temperature shall be measured in the air stream at the outlet of the vent damper device.

The source of heat for the air supply shall then be shut off and the damper caused to assume its closed position for at least 5 seconds. The damper shall then be caused to assume its open position until the air passing through the vent damper device attains a temperature of 175 ± 25 F (79.5 ± 14 °C).

The damper shall then be caused to assume its closed position for at least 5 seconds, after which the damper shall be caused to assume its open position and the source of heat for the air supply turned on.

b. Thermally actuated vent damper devices:

The damper shall be allowed to assume its open position by passing a supply of air at 575 ± 25 F (301.5 ± 14 °C) through the vent damper device. This temperature shall be measured in the air stream at the outlet of the vent damper device.

After the damper has been in the open position for at least 5 seconds, the source of heat for the air supply shall be shut off and room temperature air passed through the vent damper device.

After the damper has been in the closed position for at least 5 seconds, the source of heat for the air supply shall again be turned on.

2.26 AUTOMATIC FLUE DAMPER DEVICES

Whenever the use of air above room temperature is specified and required for use in conducting the following performance tests, flue gases from a water heater or burner assembly, mixed with air to obtain the specified temperature, shall be used.

2.26.1 Strength

A flue damper device shall be sufficiently rigid in construction to withstand a load equivalent to the following without impairment of operation or significant distortion.

Method of Test

The flue damper device shall be installed on the appliance as specified in the appliance manufacturer's installation instructions. The flue damper device shall then be operated for 10 cycles before any load is imposed to ascertain that the damper is operating properly.

a. A flue damper device having a vertical outlet shall have a vertical compression load, equal to 5 pounds per inch (0.09 kg/mm) of nominal outlet diameter, applied without impact to the outlet. With this load imposed, the flue damper device shall be operated for 10 cycles, shall operate properly and shall exhibit no significant distortion upon visual examination.

b. A flue damper device having a horizontal outlet shall have a 10-foot (3.05 m) length of vent pipe, made of sheet steel not less than 0.0195" inch (0.495 mm) thick, of suitable diameter attached in a horizontal position to the outlet, the other end of the vent pipe being supported at a point not more than 1 inch (25.4 mm) from its extremity. With this load imposed, the flue damper device shall be operated for 10 cycles, shall be operated properly and shall exhibit no significant distortion upon visual examination.

2.26.2 Operation Under Variable Voltage or Variable Motive Power

a. An electrically operated flue damper device shall function properly and shall not adversely affect the operation of the appliance control system when the electrical supply voltage to the water heater is varied over a range of 85 to 110 percent of the voltage marked on the appliance rating plate.

Method of Test

The flue damper device shall be installed on the appliance as specified in the manufacturer's installation instructions.

* This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

The supply voltage to the appliance shall be adjusted 5 percent of the voltage marked on the appliance rating plate and, with the appliance at room temperature, the appliance control system shall be operated by a switch in thermostat circuit to allow the main burner to alternately operate and turn off. This procedure shall be repeated 10 times, and during each cycle the flue damper device and main burner automatic gas valve shall function properly. The damper shall be open whenever the gas is admitted to the main burner.

This procedure shall be repeated with the supply voltage to the appliance adjusted to 110 percent of the voltage marked on the appliance rating plate.

b. **A mechanically actuated flue damper device shall function properly when the motive power is varied from 75 to 125 percent of the range of motive power marked on the flue damper device (see 2.26.3-c).**

Method of Test

At room temperature, damper operation shall be varied when the motive power to the flue damper device is varied from 75 to 125 percent of the range of motive power. The flue damper device shall function properly for cycles under each of these conditions.

2.26.3 Flue Damper Failure

The main burner shall not operate, or shall shut off, if the damper is in other than the open position, the damper is closed to a point where normal combustion is affected.

Method of Test

Tests shall be conducted with test Gases A and E. Inlet temperature shall be 70 ± 5 F (21 ± 3 °C). The thermostat shall be set at maximum temperature. The flue damper device interlock specified in 1.27.11 (not the lock switch or means specified in 1.27.12) and, if necessary, the sensing device of the ignition system, shall be bypassed to allow main burner operation.

With the damper in the open position the appliance shall be placed in operation, at which time the damper shall be closed slowly to the point just before the main burner shuts down. The level of carbon monoxide (CO) shall exceed 0.02 percent air free.

2.26.4 Exposure to Temperature Extremes

All components of a flue damper device, installed on a water heater, shall function properly and not be damaged after exposure to high and low temperature extremes.

Method of Test

a. The flue damper device shall be installed on the appliance or in a simulated flue system in the position(s) specified in the appliance manufacturer's installation instructions. The damper shall be opened in a normal manner and maintained in this position for a period of 24 hours with air at a temperature of 725 ± 25 F (385 ± 14 °C) continually passing through the flue damper device.

At the end of this period, room temperature air shall be introduced until the flue damper device has been brought to room temperature, and the flue damper device shall then be operated for 10 cycles to determine that it functions properly and has not become damaged.

b. The flue damper device, with the damper in the closed position, shall be maintained in an ambient temperature of 32 ± 5 F (0 ± 3 °C) for a period of 24 hours.

At the end of this period and while subjected to this temperature, the flue damper device shall be operated for 10 cycles to determine that all components function properly and have not become damaged.

2.26.5 Continued Operation

A flue damper device shall withstand 100,000 cycles of opening and closing the damper without any mechanical failure, impairment of operation or damage.

Method of Test

The flue damper device shall be installed in the position(s) specified in the appliance manufacturer's installation instructions on the appliance or in a simulated flue system capable of alternately delivering to the flue damper device a supply of room temperature air and a supply of air at a temperature of 725 ± 25 F (385 ± 14 °C).

A control system which will actuate the flue damper device to assume its open and closed damper positions shall be connected to the flue damper device and to the air delivery means.

The damper shall be caused to assume its open position, and a supply of air at 725 ± 25 F (385 ± 14 °C) shall be passed through the flue damper device for at least 5 seconds. This temperature shall be measured in the air stream at the outlet of the flue damper device.

The source of heat for the air supply shall then be shut off and the damper caused to assume its closed position for at least 5 seconds. The damper shall then be caused to assume its open position until the air passing through the flue damper device attains a temperature of 175 ± 25 F (79.5 ± 14 °C).

The damper shall then be caused to assume its closed position for at least 5 seconds, after which the damper shall be caused to assume its open position and the source of heat for the air supply turned on.

This cycling sequence shall be repeated until a total of 100,000 cycles of opening and closing of the damper have been completed, after which all components of the flue damper device shall function properly and not be warped, bent, broken or otherwise damaged.

2.26.6 When equipped with a flue damper device and a continuous pilot, the outlet water temperature of a water heater intended to deliver water at a temperature not in excess of 160 F (71 °C) shall not rise more than 30 F (16.5 °C) above the initial temperature when tested as specified in the following Method of Test.

Method of Test

The appliance supplied for test shall be equipped with a thermostat calibrated between 155 and 160 F (68 and 71 °C) at the thermostat level. The temperature adjustment means on thermostats provided with adjustable features for consumer use shall be set against the high stop, and the thermostat shall not be recalibrated during any part of this test. Other types of thermostats shall be tested as received.

The room temperature shall not vary more than ± 7.5 F (± 4 °C) from the average during the test, temperature readings being taken by means of a recording thermometer and averaged at the end of the test. The calorific value of the gas, barometric pressure and gas temperature shall be taken at such intervals that a fair average may be obtained.

With the thermostat set to its maximum temperature position, the appliance shall be operated at normal inlet test pressure and normal input rate until the thermostat is satisfied, and an equilibrium temperature between 155 and 160 F (68 and 71 °C) measured in the top 6 inches (152 mm) of the tank is reached.

With the flue damper in the closed position, the water temperature in the top 6 inches (152 mm) of the tank shall be continuously monitored until such time as the thermostat functions to turn on main burner gas with no water being drawn off. At no time shall the water temperature rise more than 30 F (16.5 °C) above the initial temperature.

2.26.7 When equipped with a flue damper device and a continuous pilot, the outlet water temperature of a water heater intended to deliver water at a temperature in excess of 160 F (71 °C) shall not rise more than 20 F (11 °C) above the initial temperature when tested as specified in the following Method of Test.

Method of Test

The appliance supplied for test shall be equipped with a thermostat calibrated between 175 and 180 F (79.5 and 82 °C) (see 1.30.17) at the thermostat level. The temperature adjustment means on thermostats provided with adjustable features for consumer use shall be set against the high stop and the thermostat shall not be recalibrated during any part of this test. Other types of thermostats shall be tested as received.

The room temperature shall not vary more than ± 7.5 F (± 4 °C) from the average during the test, temperature readings being taken by means of a recording thermometer and averaged at the end of the test. The calorific value of the gas, barometric pressure and gas temperature shall be taken at such intervals that a fair average may be obtained.

With the thermostat set to its maximum temperature position, the appliance shall be operated at normal inlet test pressure and normal input rate until the thermostat is satisfied, and an equilibrium temperature between 175 and 180 F (79.5 and 82 °C) measured in the top 6 inches (152 mm) of the tank is reached.

With the flue damper in the closed position, the water temperature in the top 6 inches (152 mm) of the tank shall be continuously monitored until such time as the thermostat functions to turn on main burner gas with no water being drawn off. At no time shall the water temperature rise more than 20 F (11 °C) above the initial temperature.

2.27 DRAFT TESTS FOR WATER HEATERS EQUIPPED WITH POWER BURNERS

The construction of a water heater equipped with a power burner or operating under forced or induced draft shall be such that its performance is not impaired by chimney drafts or chimney stoppage. This provision shall be deemed met when the appliance complies with the conditions specified below. An appliance for outdoor installation with the venting system provided as a part of the appliance need not comply with the provisions of this section.

When use with one gas is desired, these tests shall be conducted with the appropriate gas as specified in 2.2.

When use with more than one gas is desired and the appliance input ratings are not identical for the different gases, these tests shall be conducted at the specified input ratings for the individual gases. The number of tests conducted shall be at the discretion of the testing agency.

When use with more than one gas is desired and appliance input rating is identical for the various gases, these tests shall be conducted in accordance with the following:

- a. If the gases selected include liquefied petroleum gases or LP gas-air mixtures, use test Gas E or H.
- b. If the gases selected are natural and mixed, or natural, manufactured and mixed, use test Gas A.
- c. If the gases selected are mixed and manufactured, use test Gas C.

2.27.1 With the flue outlet or outlet of the draft diverting device, if one is provided, blocked to any degree up to and including complete closure, the concentration of carbon monoxide in an air-free sample of the flue gases shall not exceed 0.04 percent when the water heater is tested in an atmosphere having a normal oxygen supply. Should outage occur, the gas shall not be forced into the combustion chamber on reopening the flue outlet.

Method of Test

The appliance shall be operated at normal inlet test pressure for at least 15 minutes. When the appliance incorporates a control to automatically shut off the main supply under blocked flue conditions, the area of the outlet shall be gradually decreased to the lowest point which the control will remain in its open position. A sample of the flue gases shall then be secured and analyzed as specified by 2.4.1.

When a draft diverting device is supplied, its outlet shall be completely closed off and a sample of the flue gases secured and analyzed as specified by 2.4.1.

In case of outage, the blocked condition shall be maintained for 3 minutes to allow for operation of safety devices, and then removed and observation made.

2.27.2 Total downdraft pressures ranging from 0 to 0.05 inch water column (13 Pa) imposed at the outlet or outlet of the draft diverting device, if one is provided, shall not extinguish the main burner, nor cause them to flash back, lift, float, burn side the water heater, nor produce a concentration of carbon monoxide in an air-free sample of the flue gases in excess of 0.04 percent when the appliance is tested in an atmosphere having a normal oxygen supply.

Method of Test

A straight section of vent pipe of suitable diameter and length at least equal to 10 pipe diameters shall be

attached directly to the flue outlet or the outlet of the draft diverting device and connected to the outlet of a blower.

The total draft pressure shall be measured with a pitot tube and a differential gage which may be read directly to 0.005 inch water column (1.24 Pa) pressure. The pitot tube shall be inserted in the straight section of vent pipe at a point midway between its ends, so (1) the head of the tube is coincident with the axis of the vent pipe, and (2) the impact opening of the pitot tube faces the flow stream.

The total downdraft pressure shall be adjusted at 0.05 inch water column (13 Pa). The appliance shall then be allowed to operate for at least 15 minutes. A sample of the flue gases shall be secured and analyzed as specified by 2.4.1. The total downdraft pressure shall then be varied from zero to 0.05 inch water column (13 Pa) and the effect noted.

2.27.3 Downdrafts imposed as stated by 2.27.2 shall not extinguish the pilot nor cause it to flash back when it is operated separately from the main burner(s).

2.27.4 A chimney action, consisting of a static updraft and velocity updraft numerically totaling between 0.06 and 0.07 inch water column (15 and 17 Pa) pressure, applied to the flue outlet or to the outlet of the draft diverting device, if one is provided, shall not cause a fractional increase in the volume of flue gases greater than twice the numerical sum of the pressure head and 5 times the velocity head expressed in inches water column pressure. Furthermore, the concentration of carbon monoxide in an air-free sample of the flue products shall not exceed 0.04 percent under these conditions when the water heater is tested in an atmosphere having a normal oxygen supply.

Method of Test

A straight length of vent pipe of suitable diameter and of a length at least equal to 10 pipe diameters shall be attached directly to the flue outlet or the outlet of the draft diverting device and connected to the inlet of a blower.

The pressure and velocity heads shall be measured with a pitot tube and a differential gage which may be read directly to 0.005 inch water column (1.24 Pa) pressure. The pitot tube shall be inserted in the straight section of vent pipe at a point midway between its ends, so (1) the head of the tube is coincident with the axis of the vent pipe, and (2) the impact opening of the pitot tube faces the flow stream.

An updraft shall be imposed at the flue outlet, or at the outlet of the draft diverting device, such that the numerical sum of the pressure head and velocity head shall be between 0.06 and 0.07 inch water column (15 and 17 Pa). The appliance shall then be operated at normal inlet test pressure for at least 15 minutes.

Under this condition a sample of the flue gases shall be taken at the flue outlet and ahead of the draft diverting device, if one is provided, and analyzed for carbon dioxide and carbon monoxide. The ratio of carbon dioxide concentration for normal operation, as in the combustion test, to that under updraft, as above shall not be more than $1 - 2(h_p - 5h_v)$ where " h_p " is the pressure head and " h_v " is the velocity head, nor shall the concentration of carbon monoxide exceed the value specified above.

2.27.5 Flue gases shall not issue from the relief opening(s) of a draft diverting device, if one is provided, when tested as specified in 2.24.5.

2.28 WIND TEST

The provisions of 2.28.1 and 2.28.2 are applicable to (a) water heaters for outdoor installation, (b) water heaters for installation in manufactured homes (mobile homes), and (c) direct vent water heaters.

The appliance shall be installed as specified in 2.1.8.

These tests shall be conducted with test Gas A when the gases for which the appliance is for use include natural gas. Otherwise, the test gas shall be selected by the testing agency. Tests shall be conducted at normal inlet test pressure, unless otherwise specified herein.

At the discretion of the testing agency, the wind tests may be repeated with the wind directed from other directions.

2.28.1 The pilot(s) shall be capable of being ignited in accordance with the manufacturer's instructions and shall not become extinguished when the water heater is placed in operation in a normal manner while exposed to a wind of 10 miles per hour (4.47 m/s).

Method of Test

A 10-mile-per-hour (4.47 m/s) wind [0.04 inch water column (10 Pa) static pressure], measured in a vertical plane 18 inches (457 mm) from the windward surface of the appliance, shall be directed over the following:

- a. The outer surface of an outdoor type appliance and the outlet of the draft hood or integral venting system;
- b. The combustion and ventilation openings of the test enclosure and the venting system for an appliance for installation in a manufactured home (mobile home) other than of the direct vent type; and

- c. The area of the air intake and vent terminal of a direct vent appliance.

With the access door open or the access panel removed for lighting as specified by the manufacturer, the pilot shall be ignited in accordance with the manufacturer's lighting instructions outlined on the instruction plate (see 1.31.4). After the pilot is ignited, the access door shall be closed or the access panel replaced and the main burner(s) placed in operation.

The pilot shall be capable of being ignited and shall not become extinguished when the main burner(s) is operated.

2.28.2 The gas to the main burner(s) shall ignite from the pilot without excessive delay and the pilot(s) and main burner(s) shall not become extinguished when the water heater installation is exposed to a wind of 40 miles per hour (17.88 m/s).

Method of Test

For this test all doors and access panels shall be in the closed position.

A 40-mile-per-hour (17.88 m/s) wind [0.66 inch water column (164 Pa) static pressure], measured in accordance with the test method specified in 2.28.1, shall be directed at the surfaces specified therein. While operating under the above wind conditions, the pilot(s) when operating alone, and the pilot(s) and main burner(s) when operating simultaneously, shall not become extinguished during a 5-minute period.

The main burner valve shall then be shut off. After a period of at least 30 seconds the main burner valve shall be turned on and the main burner gas shall ignite from the pilot without excessive delay.

2.28.3 Water heaters of the direct vent type shall not produce a concentration of carbon monoxide in excess of 0.04 percent in an air-free sample of the flue gases when exposed to winds from zero to 40 miles per hour (17.88 m/s).

This provision does not apply to a direct vent appliance in which:

- a. The combustion system is water-backed;
- b. The entire appliance is enclosed in its own housing designed so there are no air openings to the interior of the structure, and with all piping entering the combustion system gasketed; and
- c. All access to the combustion system of the appliance is from the exterior of the structure.

Method of Test

runner and primary air adjustments shall be made in accordance with the provisions of 2.3.3. Any adjustments in the deposit of carbon shall not be acceptable.

The appliance shall be operated until an equilibrium is obtained, ascertained by a constant flue gas temperature. Sufficient flue gas samples shall be secured and analyzed to determine that the carbon monoxide concentration is not in excess of the allowable limit when winds are up to 40 miles per hour (17.88 m/s) (zero to 0.66 inch column (164 Pa) static pressure), measured in accordance with the test method specified in 2.28.1, are taken at the surfaces specified therein.

2.28.4 The operating characteristics of a water heater of the direct vent type shall not be affected by the conditions specified in 2.28.3.

This provision does not apply to a direct vent heater in which:

- a. The combustion system is water-backed;
- b. The entire appliance is enclosed in its own housing designed so there are no air openings to the interior of the structure and with all piping entering the combustion system gasketed; and
- c. All access to the combustion system of the appliance is from the exterior of the structure.

Method of Test

runner and primary air adjustments shall be made in accordance with the provisions of 2.3.3.

The appliance shall be operated until an equilibrium is obtained, ascertained by a constant flue gas temperature, under a still air condition. A flue gas sample then be secured and analyzed for carbon dioxide.

The appliance shall then be adjusted to provide the desired manifold pressure as specified in 2.4.1, and, after a purge period of at least 2 minutes, another flue gas sample shall be secured under a still air condition and analyzed for carbon dioxide.

The appliance shall be readjusted to operate at normal test pressure and operated until an equilibrium condition is attained, as ascertained by a constant flue gas temperature or by an outlet water temperature maintained at $\pm 2^\circ\text{F}$ ($54.5 \pm 1^\circ\text{C}$) for 15 minutes. The wind conditions specified in 2.28.3 shall then be imposed and flue gas samples at various wind conditions secured and analyzed to determine the carbon dioxide concentration. The appliance subjected to any of the wind conditions

specified in 2.28.3 shall not exceed by more than 0.3 percent the carbon dioxide concentration produced by the appliance when operated at increased manifold pressure under a still air condition, and shall not be less than 50 percent of the carbon dioxide concentration produced by the appliance when operated at normal inlet test pressure under a still air condition.

2.29 CAPACITIES OF STORAGE VESSELS

The storage vessel capacity shall be within ± 5.0 percent of the manufacturer's rated capacity.

Method of Test

The storage capacity shall be determined by weighing the system when dry and empty and reweighing it when full or by filling the system with water, the weight of which has been predetermined. The capacity shall then be computed in gallons and compared with the manufacturer's rated capacity.

2.30 HYDROSTATIC TEST

Unless the storage vessel of a water heater is marked with an appropriate ASME symbol and a working pressure no less than the marked maximum working pressure of the water heater, the storage vessel shall withstand a hydrostatic test pressure of two times the manufacturers rated maximum working pressure, but not less than 300 psi (2.07 MPa), without developing leakage or permanent deformation.

Method of Test

The storage vessel shall be connected to a water supply through a pump system incorporating a calibrated pressure gage graduated in increments of not more than 5 psi (34.5 kPa), a check valve, and shutoff valves. All tapped openings in the storage vessel shall be closed by use of threaded fittings. If the storage vessel is equipped with a pressure relief device, the device shall be removed and the opening plugged. The storage vessel and system shall be filled with water at 70 F (21 °C) and at atmospheric pressure, care being exercised to avoid any pocketing of air.

Before starting the test, such measurements of the storage vessel as are necessary to reveal permanent deformation resulting from the hydrostatic pressure test shall be taken. These observations shall include circumferential measurements at intervals along the vessel of not more than 12 inches (305 mm) by a method permitting readings to be made directly to 0.001 inch (0.025 mm). Extensometers reading to 0.001 inch (0.025 mm) shall be placed with the movable spindles against top and bottom heads.

Hydrostatic pressure in the system shall be gradually raised by means of the pump until the required hydrostatic or the rated test pressure is reached. This pressure shall be maintained for 30 minutes. At the end of this time, the pressure in the system shall be reduced to atmospheric and the measurements originally taken repeated. Circumference measurements shall not vary by more than 0.2 percent of the corresponding measurement taken prior to the application of the test pressure. Top or bottom head deflections as shown by the extensometers shall not exceed 0.5 percent of tank diameter. At no time during the application of the hydrostatic pressure test shall any leakage of water from the storage vessel be evidenced.

2.31 NONMETALLIC DIP TUBES

2.31.1 Nonmetallic dip tubes shall have a linear deformation not in excess of $\frac{1}{2}$ inch (12.7 mm), a total lateral deformation not in excess of $1\frac{1}{2}$ inches (38.1 mm) and shall undergo no weight loss when tested as specified in the following Method of Test.

Method of Test

Twelve samples of dip tubes, cut to the same length, shall be submitted for this test. The length and weight of each tube shall be determined and recorded. The samples shall be suspended as they would be in service for 48 hours in water maintained at 200 F (93.5 °C). These samples shall then be cooled to room temperature, surface water removed, and the length and weight determined and compared with the original results. Any weight loss shall be considered as evidence of failure.

Lateral deformation shall be determined by installing one end of the tube in a fixture (as it would be by a tank inlet fixture) and measuring the distance between the position of the center line of the free end and the extended center line of the fixture. Total lateral deformation shall be within the limits of a circle having a radius of $1\frac{1}{2}$ inches (38.1 mm) measured from the extended center line of the fixture.

2.31.2 Nonmetallic dip tubes shall not impart odor, taste or color to the water.

Method of Test

Four 1-inch (25.4 mm) sample lengths of nonmetallic dip tubes shall be placed in a 500 milliliter Erlenmeyer flask, with 250 milliliters of distilled water. The flask shall be closed with a metallic cap (not rubber or cork) provided with a small vent hole, and maintained at 170 F (76.5 °C) for 24 hours.

At the end of the 24-hour period the flask shall be removed from the heat source, cooled to convenient handling temperature and immediately checked for odor and taste. The tube sections shall be removed from the flask

and the water examined for color. At least two observers shall independently check for odor, taste and color.

2.31.3 Nonmetallic dip tubes shall not deform more than $\frac{1}{4}$ inch (6.4 mm) in 5 minutes when subjected to transverse loading under a weight of 870 grams while being maintained at a temperature of 225 +5 -0 F (107 +3 -0 °C).

Method of Test

A 2-inch (50.8 mm) sample shall be cut from each of 10 dip tubes submitted for test.

The scale on the test apparatus shown in Figure 5 shall be set at zero with a sample of tube to be tested in place in the "V" trough beneath the pressure block. The sample shall then be removed and the test apparatus placed in a 1-liter glass beaker filled with a suitable liquid, for example: ethylene glycol, glycerin, etc., to a depth sufficient to cover the pressure block when at the zero scale setting. The glass beaker shall then be placed over a hot plate and heated until the temperature of the liquid and test apparatus, as determined by a thermometer placed in the beaker with its bulb on the base of the test apparatus, has reached 225 +5 -0 F (107 +3 -0 °C). The temperature shall then be held constant for the duration of the test.

The pressure block shall then be raised and a sample of the dip tube to be tested placed in the "V" trough below the block. The block shall then be lowered without impact onto the dip tube sample and the time recorded. After 5 minutes, during which time rate of travel and distance of travel of the indicator on the scale is recorded, the test sample shall be removed and the above test repeated on the remaining test samples. The average deformation of all samples shall not exceed $\frac{1}{4}$ inch (6.4 mm) and the rate of deformation shall be slow and uniform. Immediate deformation of any test sample upon application of the test load shall be considered as noncompliance of the lot submitted for test.

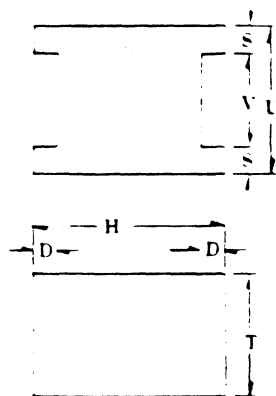
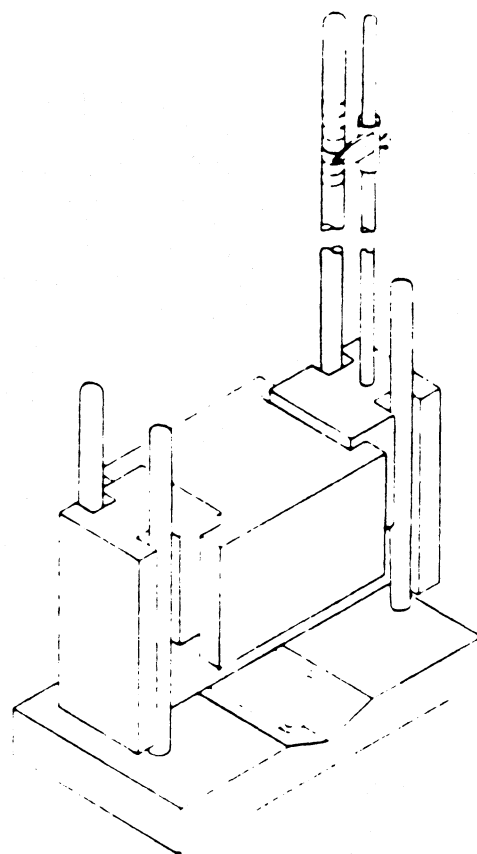
2.31.4 Nonmetallic dip tubes shall not collapse, as evidenced by a reduction in internal diameter in excess of $\frac{1}{8}$ inch (3.2 mm), after immersion in water at a temperature of 225 +5 -0 F (107 +3 -0 °C), under the following Method of Test.

Method of Test

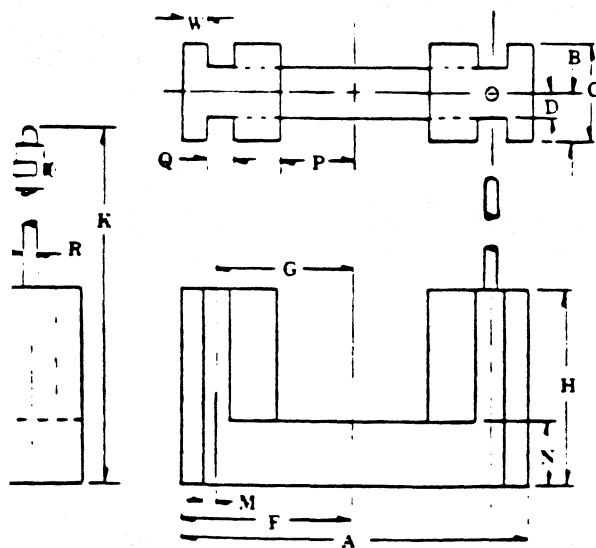
The internal diameter of the dip tube shall be determined.

The dip tube shall be installed in the hot water outlet of the test appliance. A quick-acting valve shall be installed at the outlet connection of the storage vessel. The minimum cross-sectional area through this valve shall be equal to or greater than that of a $\frac{1}{4}$ -inch (6.4 mm) nipple. A flow restricting device adjusted or constructed so as to maintain a flow rate of 5 gallons per minute (18.9 L/min)

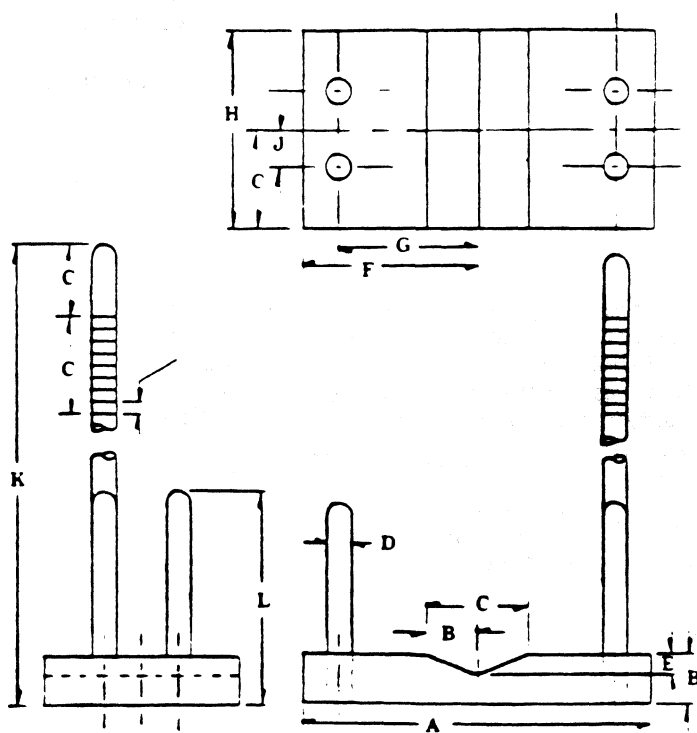
Dim.	In.	mm	Dim.	In.	mm
A	3 ¹ / ₁₆	90.5	M	5 ¹ / ₁₆	3.6
B	1 ¹ / ₂	12.7	N	5 ¹ / ₁₆	15.9
C	1	25.4	P	25 ¹ / ₃₂	19.8
D	1 ¹ / ₄	6.4	Q	9 ¹ / ₃₂	7.1
E	3 ¹ / ₁₆	4.8	R	1 ¹ / ₈	3.2
F	125 ¹ / ₃₂	45.2	S	7 ¹ / ₃₂	5.6
G	115 ¹ / ₃₂	35.7	T	1 ¹ / ₄	31.8
H	2	50.8	U	1 ¹ / ₂	38.1
J	25 ¹ / ₁₆	9.9	V	21 ¹ / ₃₂	24.6
K	10	254.0	W	15 ¹ / ₁₆	6.0
L	3 ¹ / ₂	88.9			



Weight



Pressure Block



Base

Figure 5. Nonmetallic Dip Tube Heat Deformation Tester

during the test period shall be connected to the inlet of the appliance. A mercury thermometer graduated to 1 F (0.5 °C), or a suitable thermocouple, shall be installed in the storage vessel within the top 6 inches (152 mm) of the tank. A water pressure regulator shall be located between the inlet connection to the storage vessel and the water supply line and adjusted so that, at a steady flow rate of 5 gallons per minute (18.9 L min), the pressure at the inlet connection will be 40 psi (275.8 kPa).

The storage vessel shall be filled and the test appliance placed in operation, with the thermostat, if any, bypassed. When the temperature indicated by the thermometer or thermocouple in the top of the storage vessel is 225 ± 5 °F (107 ± 3 °C), the quick-acting valve shall be opened and water allowed to flow until the outlet water temperature is the same as the inlet water temperature.

The dip tube shall then be removed from the test appliance and examined. Any indication of reduction in internal diameter in excess of 1/8 inch (3.2 mm) from the original diameter shall be considered as noncompliance with this provision.

2.32 BURNER DURABILITY

The design and materials used in the construction of a water heater burner shall be such that the burner will not sag, distort, melt, damage any protective coating sufficient to expose the base metal, exhibit appreciable corrosion, or show leakage of gas during any of the tests specified herein, or when the burner is operating with the flame burning within the mixer tube or burner head.

Method of Test

This test shall be conducted at the increased inlet test pressure.

The gas to the burner shall be ignited in such a manner that it burns within the mixer tube or burner head and shall continue to burn there for 30 minutes. If the flame cannot be maintained within the mixer tube or burner head, the gas rate to the burner shall be reduced to a point where it can be so maintained.

At the end of this test, as well as the conclusion of all performance tests specified herein, the burner shall be carefully examined for evidence of sagging, distortion, melting, appreciable corrosion, damage to protective coating sufficient to expose the base metal, or leakage of gas.

2.33 RAIN TESTS

2.33.1 A water heater for outdoor installation shall be constructed so it will function normally with

the pilot(s) and main burner(s) in operation when subjected to a simulated rainstorm.

Method of Test

The appliance shall be placed on the test platform of the rain test apparatus described in Figures 6 and 7 in the position with respect to the spray heads deemed most critical by the testing agency. Appliances equipped with a draft hood shall be connected to a vent pipe which is of sufficient height to prevent water from entering the vent during test.

The appliance shall be adjusted at normal inlet test pressure and the pilot(s) placed in operation.

The rain test apparatus shall then be placed in operation and each spray head adjusted by means of the control valve to operate at 5 psig (34.5 kPa). The spray head unit shall be adjusted to varying elevations and horizontal distances from the test platform to determine the most critical location. The exposure at the position deemed most critical by the testing agency shall be maintained throughout the test.

After adjustment of the spray head unit, the rain test apparatus shall be operated for a period of 15 minutes. The main burner(s) shall then be placed in operation and the rain test apparatus operated for an additional 15 minutes.

The above test procedure shall be repeated with the appliance located in any other position(s) with respect to the spray heads deemed necessary by the testing agency.

The appliance shall function normally during exposure to the simulated rainstorm. Upon completion of exposure to the simulated rainstorm, there shall be no evidence of damage or malfunctioning of any part of the appliance, nor evidence of water from the simulated rainstorm retained in any part of the appliance.

2.33.2 Vent and vent-air intake terminals of direct vent water heaters shall be constructed so no water will accumulate in the appliance when subjected to a simulated rainstorm.

Method of Test

The vent or vent-air intake terminal shall be secured to a suitable watertight container and placed on the test platform of the rain test apparatus described in Figures 6 and 7, in the position, with respect to the spray heads, deemed most critical by the testing agency.

The rain test apparatus shall then be placed in operation and the spray heads adjusted as specified under 2.33.1.

After adjustment of the spray head unit, the rain test apparatus shall be operated for a period of 30 minutes.

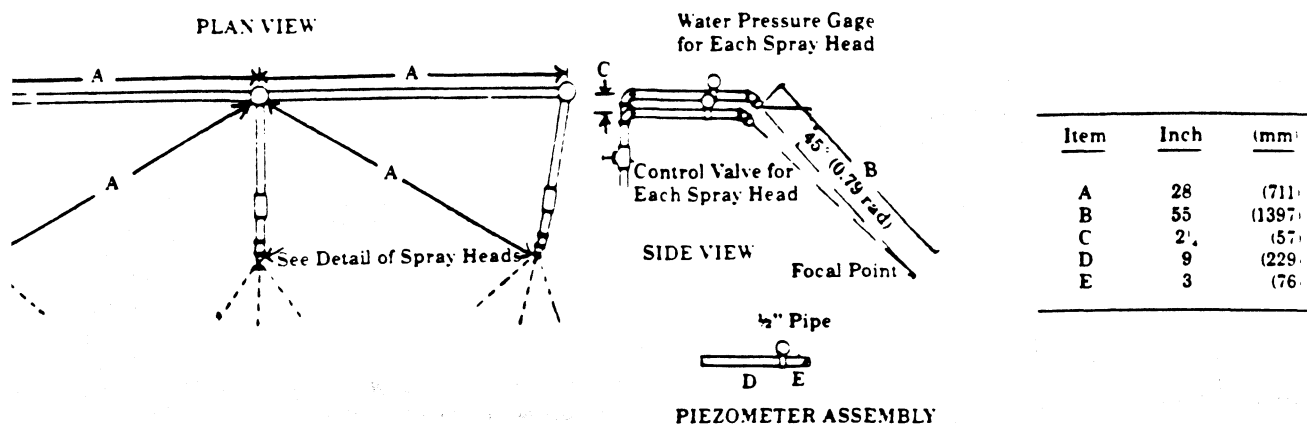
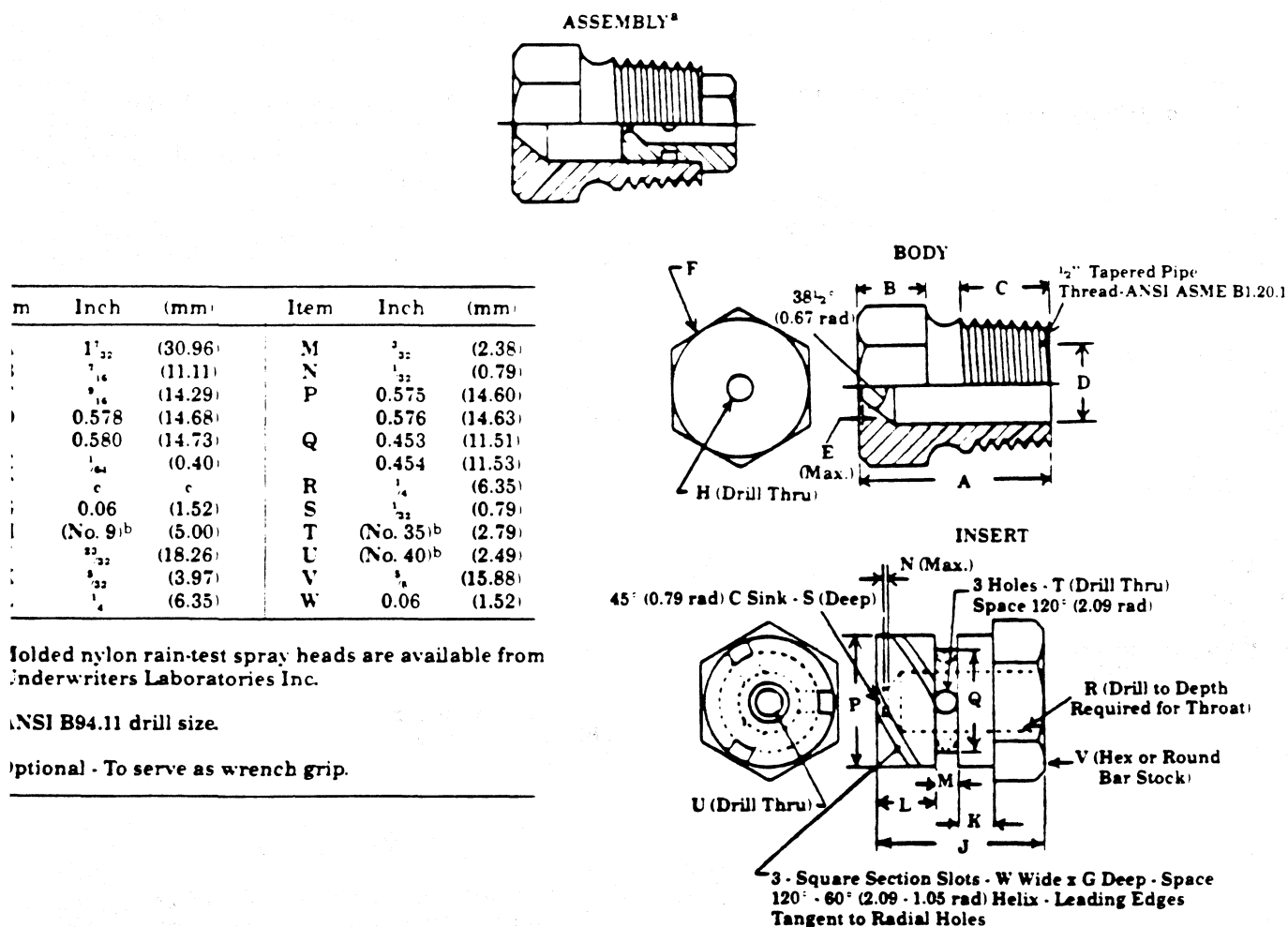


Figure 6. Arrangement of Spray Heads and Associated Piping for Simulated Rainstorm Test



folded nylon rain-test spray heads are available from Underwriters Laboratories Inc.

ANSI B94.11 drill size.

optional - To serve as wrench grip.

Figure 7. Spray Head Assembly and Details of Construction

The above test procedure shall be repeated with the terminal located in any other position(s) with respect to the spray heads deemed necessary by the testing agency.

Upon completion of exposure to the simulated rainstorm, there shall be no appreciable amount of water accumulated in the appliance.

2.34 DIRECT VENT SYSTEMS

2.34.1 The vent-air intake terminal of a direct vent system shall be sufficiently rigid in construction and supported so it will withstand a load of 150 pounds (68.0 kg) without extensive damage or alteration of its position with respect to the water heater. Following application of this load, the appliance shall comply with the combustion test specified in the following Method of Test.

Method of Test

A vertical suspension load of 150 pounds (68.0 kg) shall be evenly distributed without impact over the vent-air intake terminal.

The load shall then be removed and shall not have caused substantial distortion of any part of the vent-air intake terminal or alteration of its position relative to the appliance so that the appliance would not operate satisfactorily.

The appliance shall then be operated at normal inlet test pressure until equilibrium conditions are attained. A sample of the flue gases shall then be secured and analyzed as outlined in 2.4.1 before the thermostat begins to reduce the gas rate. The concentration of carbon monoxide, based on an air-free sample of the flue gases, shall not exceed 0.04 percent.

2.34.2 The vent-air intake terminal of a direct vent system shall be sufficiently rigid in construction so as not to become damaged to the extent that it would be unsafe for use when subjected to impact in accordance with the following Method of Test. Following impact of the vent-air intake terminal, the water heater shall comply with the combustion test as specified in the following Method of Test.

Method of Test

The impact shall be produced by a pendulum consisting of a cloth bag, filled with sand, weighing 25 pounds (11.3 kg) suspended from a steel cable or rope. The bag shall be formed from a flat section of burlap, canvas or suitable material. A suitable plastic liner may be used to prevent sand loss. All sides and corners of the cloth shall be drawn up as tightly as possible around the sand and the excess material tied as close as possible at the top of the bag. The bag shall have an at-rest position not more than

1 inch (25.4 mm) from the edge of the bag to the nearest edge of the vent-air intake terminal. The point of impact shall be opposite the center of gravity of the bag. The distance of swing [angle 45 degrees (0.79 rad)] shall be measured as the angle between the pendulum arm with the bag at its at-rest position and pendulum arm at its elevated position. The length of the pendulum is that distance measured from the point of rotation to the center of gravity of the bag.

On the horizontal vent-air intake terminal, one impact shall be made at each of the following points, as shown in Figure 8A:

- a. The center of the vertical front surface of the vent-air intake terminal;
- b. The leading edge on the left side of the vent-air intake terminal, pendulum rotated left at an angle 45 degrees (0.79 rad) from the point described in "a"; and
- c. The leading edge on the right side of the vent-air intake terminal, pendulum rotated right at an angle 45 degrees (0.79 rad) from the point described in "a."

On a vertical vent and vent-air intake terminal, one impact shall be made on the top cap, as described in Figure 8B, at the point deemed most critical by the testing agency. At the option of the testing agency, additional impact tests may be conducted at other points.

Following each impact, the appliance shall be operated at normal inlet test pressure until equilibrium conditions are attained. A sample of the flue gases shall then be secured and analyzed as prescribed in 2.4.1 before the thermostat begins to reduce the gas rate. In each case, the concentration of carbon monoxide, based on an air-free sample of the flue gases, shall not exceed 0.04 percent.

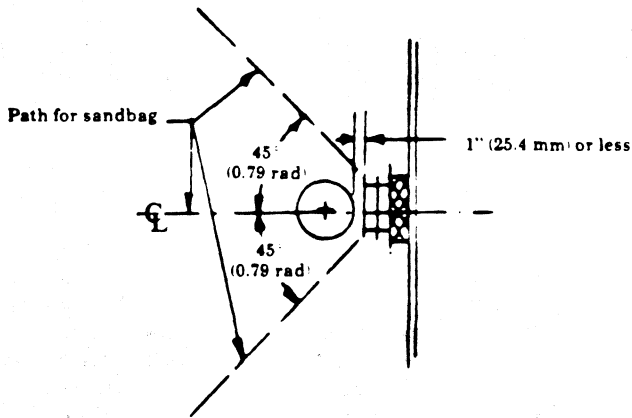
At the option of the manufacturer, the vent-air intake terminal may be replaced following each impact and combustion test.

2.34.3 Joints in direct vent systems shall be tight. This provision shall be deemed met if leakage from the system is not in excess of the limits specified in the following Method of Test.

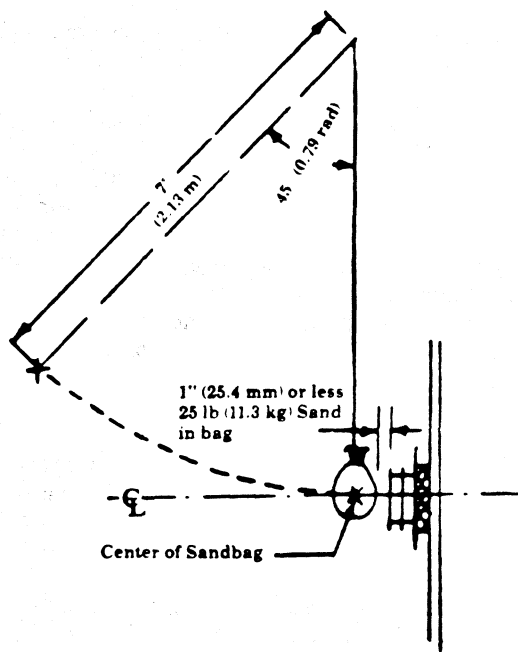
Method of Test

The vent-air intake terminal(s) shall be removed and the air intake system sealed at the burner port level.

The entire system, including the combustion air and flue gas connections between the appliance and the vent-air intake terminal(s), shall be assembled and the joints in the vent-air intake system sealed in accordance with the manufacturer's instructions.

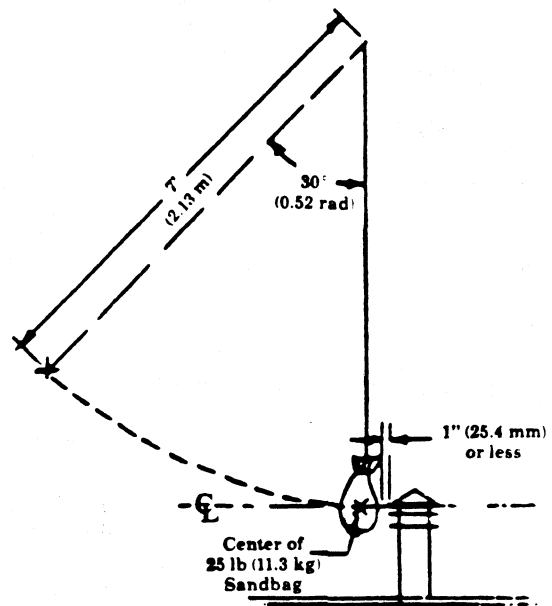


TOP VIEW



SIDE VIEW

A. HORIZONTAL CAPS



SIDE VIEW

B. VERTICAL CAPS

Figure 8. Arrangement of Sandbag and Vent-Air Intake Terminal for Impact Test

Both the flue outlet and the air inlet shall then be sealed at the point of connection to the vent-air intake terminal(s). The sealing means shall include fittings for supplying air to both the air inlet and combustion chamber sides of the system and provisions for measuring the internal pressure in each side of the system.

The internal system pressure shall be determined by connecting the means for determining internal pressure to a water-filled manometer which may be read directly to 0.01 inch water column (2 Pa).

A suitable supply of clean air shall be permitted to flow through a wet test meter and into the portion of the direct vent system being pressurized through the air supply fitting. The air supply fitting to the portion of the system not being pressurized shall be open.

The meter pressure shall be adjusted to produce an internal air pressure of 0.1 inch water column (25 Pa) above the normal operating system pressure (atmosphere for other than forced or induced draft systems) in the portion of the system being pressurized and the leakage rate noted in cubic feet per hour (cm³/s) for both the air inlet and combustion chamber portions of the direct vent system.

At the manufacturer's option, internal air pressures of less than 0.1 inch water column (25 Pa) above the normal operating pressure may be used if it is demonstrated that the system pressures will be less than 0.1 inch water column (25 Pa). Under this option, the test pressure for the air inlet section and for the combustion air section of the system shall be the maximum pressure measured for the respective section when the vent-air intake terminal is subjected to winds, as described in the Method of Test of 2.28.3.

Compliance with this provision shall be deemed met if leakage from the combustion chamber portion of the system does not exceed 2.0 percent of the products of combustion and leakage from the air inlet portion of the system does not exceed 8.0 percent of the products of combustion. These values shall be determined by the following appropriate formulae*:

$$\begin{aligned} L_c &= .02 \times V \times I \\ L_a &= .08 \times V \times I \end{aligned}$$

where

L_c = allowable leakage rate from combustion chamber portion of direct vent system, cu ft per hr,

L_a = allowable leakage rate from air inlet portion of direct vent system, cu ft per hr,

* These formulae may be simplified to read $L_c = 0.3 I$ and $L_a = 1.2 I$.

V = 15 cu ft of flue products (based on the formation of approximately 10 cu ft of dry flue products, plus 5 cu ft of excess air, when 1,000 Btu of fuel gas is burned), and

I = appliance input rate, in thousands of Btu per hr.

[Note: Allowable leakage rates in cubic centimeters per second (cm³/s) for appliances rated in watts (W) can be determined by multiplying the input rating in kilowatts (kW): (1) by 8.05 for combustion chamber-vent sections and (2) by 32.2 for air intake sections.]

2.34.4 When a direct vent water heater is tested as specified in 2.20, surfaces of vent pipes and radiation shields exposed to flue gases outlined under 1.3.9 shall not exceed those temperatures indicated by Table XII when tested at equilibrium. Vent pipes fabricated from aluminum shall not attain temperatures in excess of 630 F (350 °C) above room temperature.

Method of Test

This test shall be conducted at normal inlet test pressure following the conduct of 2.20.

With the appliance in normal operation, the surfaces of vent pipes and radiation shields exposed to flue gases outlined under 1.3.9 shall be explored to determine approximately the regions of maximum temperatures. When these locations have been determined, the gas supply shall be shut off and the appliance allowed to cool to room temperature. At least five No. 24 AWG (0.20 mm²) bead-type thermocouples shall then be silver-soldered to the surface of sheet-metal elements, or peened into holes drilled in cast-iron elements, adjacent to the hottest locations, as previously determined.

The appliance shall then be placed in operation and temperature readings obtained by means of the thermocouples, individually connected to a potentiometer. Temperature readings shall then be recorded at 15-minute intervals until equilibrium conditions have been attained as indicated by temperature changes of not more than ± 5 F (± 3 °C) between readings. When equilibrium conditions have been attained, the maximum temperature recorded shall not exceed the temperature indicated by Table XII.

2.35 MARKING MATERIAL ADHESION AND LEGIBILITY

Marking material recognized as complying with the Standard for Marking and Labeling Systems, ANSI/UL 969, are exempt from this test.

TABLE XII

MAXIMUM VENT PIPE AND RADIATION
SHIELD TEMPERATURES*

<u>Metal</u>	<u>Maximum Temperature Rise Above Inlet Air Temperature, F (°C)</u>
Carbon Steel	830 (461)
Cast Iron	830 (461)
Some-Alloy Cast Iron, 0.5 to 1% Cr, 0.2 to 0.5% Cu or Ni	1010 (561)
Carbon Steel Coated with Enamel	1030 (572)
Aluminum-Coated Steel in which the bond between the steel and the aluminum is an iron- aluminum alloy	1030 (572)
Chromium-Coated Low Carbon Steel in which the chromium is fused into the surface of the steel to form an iron-chromium alloy	1080 (600)
Type 409	1080 (600)
Type 410	1100 (611)
Type 430	1100 (611)
Type 321	1330 (739)
Type 309C	1360 (755.5)
Type 347	1370 (761)

*The maximum usage temperature of materials not shown shall not exceed 90 percent of scaling temperature, or the temperature at stress to induce rupture in 1,000 hours at a load of 6,000 psi (41.4 MPa) for an 0.0304 inch (0.772 mm) thick sample, whichever is the lower temperature. Temperatures shown have been determined on this basis.)

The adhesive quality of Class IIA-3, IIA-4, IIIA-1 and IIIA-2 marking materials and legibility of all Class II and III marking materials (see 1.31.1) shall not be adversely affected when the marking materials are exposed to heat and moisture as specified in the following Method of Test.

Method of Test

a. Adhesive type marking materials shall be applied to a sample test panel having the particular type of finish used on the appliance in production. Two samples of marking material shall be applied to the panel. Test samples shall be applied with firm pressure, unless the manufacturer's application instructions specify otherwise. Each sample shall be allowed to set for 24 hours at room temperature.

Each sample of marking material shall exhibit:

1. Good adhesion and no curling at edges;
2. No illegible or defaced printing when rubbed with thumb or finger pressure; and
3. Good adhesion when a dull metal blade (as the back of a pocketknife blade) is held at 90 degrees (1.57 rad) to the applied marking and scraped across the edges of the marking.

b. Nonadhesive type marking materials shall exhibit no illegible or defaced printing when rubbed with thumb or finger pressure. Two samples of marking material shall be tested.

c. Samples of both adhesive and nonadhesive type marking materials shall then be placed in an oven for a period of 2 weeks with the oven temperature maintained at 50 F (10 °C) above the temperature of the surface upon which the marking will be applied or 250 F (121 °C), whichever is greater.

Following the oven test, adhesion and legibility of the samples shall be checked again as specified in "a" or "b" above.

Samples shall then be immersed in water for a period of 24 hours, after which adhesion and legibility shall be rechecked as specified in "a" or "b" above.

Good adhesion and legibility qualities shall be obtained for all samples under the above specified test conditions.

Final acceptance of marking materials shall be based on the suitability of the marking material on the appliance.

EXHIBIT A

OUTLINE OF LIGHTING INSTRUCTIONS FOR APPLIANCES EQUIPPED WITH CONTINUOUS PILOTS

The following is a guide to aid in the writing of the lighting instructions label for an appliance equipped with a continuous pilot. The statements in quotes are to be worded as shown. For purposes of this Exhibit, the word "knob" is used. An actual label shall use the word knob, button, lever, etc., as appropriate. If the action necessary to operate the control is other than stated below, modification of the sentence(s) is acceptable.

A sample of this label is shown in Figure A.

Section 1

"FOR YOUR SAFETY READ BEFORE LIGHTING"

The following warning shall be indented and boxed at the top of this section:

"WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life"

"A. This appliance has a pilot which must be lighted by hand. When lighting the pilot, follow these instructions exactly."

"B. **BEFORE LIGHTING** smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department."

"C. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion."

"D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water."

Section 2

"LIGHTING INSTRUCTIONS"

1. **"STOP! Read the safety information above (to the left) on this label."**
2. For an appliance equipped with or for use with an adjustable thermostat:

"Set the thermostat to lowest setting."

3. For an appliance which utilizes an external electrical supply:

"Turn off all electric power to the appliance."

4. For an appliance which requires removal of a panel(s) or other part to gain access to the gas control, instructions for gaining access to the gas control.

5. Instructions, with an illustration, for turning the gas control manual valve to the full OFF position.*

6. **"Wait five (5) minutes** to clear out any gas. If you then smell gas, STOP! Follow "B" in the safety information above (to the left) on this label. If you don't smell gas, go to next step."**

7. For an appliance which requires removal of a part(s) to gain access to the pilot, instructions for gaining access to the pilot.

8. Instructions for locating the pilot. Illustration of the pilot is required.

9. Instructions for putting the gas control into the PILOT position.*

10. Step by step instructions for lighting the pilot.

An indented statement relative to maloperation of the control such as:

- If the knob does not pop up when released, stop and immediately call your service technician or gas supplier.

* Wherever rotation is required, the following words and symbols shall be used to indicate direction



** The manufacturer may specify a longer time

- "If the pilot will not stay lit after several tries, turn the gas control knob to "OFF" and call your service technician or gas supplier."*

If applicable, instructions to replace the pilot access panel(s).

Instructions for turning the gas control manual valve to the ON position.*

If applicable, instructions to replace the gas control access panel(s) or other part(s).

If applicable:

"Turn on all electric power to the appliance."

If applicable:

"Set thermostat to desired setting."

Section 3

"TO TURN OFF GAS TO APPLIANCE"

1. If applicable:
"Set the thermostat to lowest setting."
2. If applicable:
"Turn off all electric power to the appliance if service is to be performed."
3. If applicable, instructions for gaining access to the gas control.
4. Instructions for turning the gas control manual valve to the full OFF position.*
5. If applicable, instructions to replace the gas control access panel(s).

Every rotation is required, the following words and symbols shall be used to indicate direction:

clockwise



counterclockwise



FOR YOUR SAFETY READ BEFORE LIGHTING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

A. This appliance has a pilot which must be lighted by hand. When lighting the pilot, follow these instructions exactly.

B. **BEFORE LIGHTING** smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

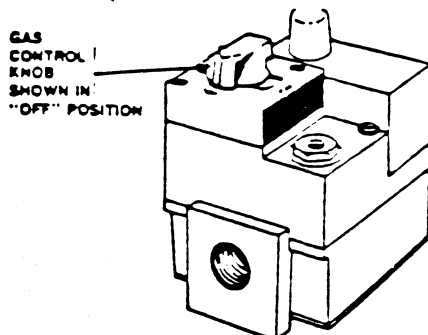
• If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

LIGHTING INSTRUCTIONS

1. STOP! Read the safety information above on this label.
2. Set the thermostat to lowest setting.
3. Turn off all electric power to the appliance.
4. Remove control access panel.
5. Push in gas control knob slightly and turn clockwise to "OFF."



NOTE: Knob cannot be turned from "PILOT" to "OFF" unless knob is pushed in slightly. Do not force.

6. Wait five (5) minutes to clear out any gas. If you then smell gas, STOP! Follow "B" in the safety information above on this label. If you don't smell gas, go to next step.
7. Remove the pilot access panel located below and behind the gas control unit.

8. Find pilot - follow metal tube from gas control. The pilot is between the two burner tubes behind the pilot access panel.



9. Turn knob on gas control counterclockwise to "PILOT."
10. Push in control knob all the way and hold in. Immediately light the pilot with a match. Continue to hold the control knob in for about one (1) minute after the pilot is lit. Release knob and it will pop back up. Pilot should remain lit. If it goes out, repeat steps 5 through 10.

- If knob does not pop up when released, stop and immediately call your service technician or gas supplier.
- If the pilot will not stay lit after several tries, turn the gas control knob to "OFF" and call your service technician or gas supplier.

11. Replace pilot access panel.
12. Turn gas control knob counterclockwise to "ON."
13. Replace control access panel.
14. Turn on all electric power to the appliance.
15. Set thermostat to desired setting.

TO TURN OFF GAS TO APPLIANCE

1. Set the thermostat to lowest setting.
2. Turn off all electric power to the appliance if service is to be performed.
3. Remove control access panel.

4. Push in gas control knob slightly and turn clockwise to "OFF." Do not force.
5. Replace control access panel.

Figure A. Sample Lighting Instructions Label for an Appliance Equipped with a Continuous Pilot

EXHIBIT B

OUTLINE OF OPERATING INSTRUCTIONS FOR APPLIANCES EQUIPPED WITH INTERMITTENT PILOT OR INTERRUPTED PILOT SYSTEMS

The following is a guide to aid in the writing of the operating instructions label for an appliance equipped with an intermittent pilot or interrupted pilot system. The statements/quotes are to be worded as shown. For purposes of this exhibit the word "knob" is used. An actual label shall use the word knob, button, lever, etc., as appropriate. If the action necessary to operate the control is other than stated below, modification of the sentence(s) is acceptable.

A sample of this label is shown in Figure B.

Section 1

"OR YOUR SAFETY READ BEFORE OPERATING"

The following warning shall be indented and boxed at the beginning of this section:

"WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life."

This appliance is equipped with an ignition device which automatically lights the pilot. Do not try to light the pilot by hand.

BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department."

Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it; call a qualified service technician. Force or attempted repair may result in a fire or explosion."

Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water."

Section 2

"OPERATING INSTRUCTIONS"

- 1 "STOP! Read the safety information above (to the left) on this label."
- 2 For an appliance equipped with or for use with an adjustable thermostat:
"Set the thermostat to lowest setting."
- 3 For an appliance which utilizes an external electrical supply:
"Turn off all electric power to the appliance."
- 4 Instructions not to attempt to light the pilot by hand.
- 5 For an appliance which requires removal of a panel(s) or other part to gain access to the gas control, instructions for gaining access to the gas control.
- 6 Instructions with an illustration for turning the gas control manual valve to the full OFF position*.
- 7 "Wait five (5) minutes** to clear out any gas. If you then smell gas, STOP! Follow "B" in the safety information above (to the left) on this label. If you don't smell gas, go to next step."
- 8 Instructions for turning the gas control manual valve to the ON position*.
- 9 If applicable, instructions to replace the gas control access panel(s) or other part(s).
- 10 If applicable:
"Turn on all electric power to the appliance."
- 11 If applicable:
"Set thermostat to desired setting."
- 12 Instructions as to what to do next if the appliance fails to operate after following the above steps, and the following:

* Wherever rotation is required, the following words and symbols shall be used to indicate direction:

clockwise

counterclockwise

** The manufacturer may specify a longer time.

"If the appliance will not operate, follow the instructions
"To Turn Off Gas To Appliance" and call your service
technician or gas supplier."

Section 3

"TO TURN OFF GAS TO APPLIANCE"

1. If applicable:

"Set the thermostat to lowest setting."

2. If applicable:

"Turn off all electric power to the appliance if service is
to be performed."

3. If applicable, instructions for gaining access to the gas
control.

4. Instructions for turning the gas control manual valve to
the full OFF position.*

5. If applicable, instructions to replace the gas control
access panel(s).

* Wherever rotation is required, the following words and symbols shall be used to indicate
direction

clockwise



counterclockwise



FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

This appliance is equipped with an ignition device which automatically lights the pilot. Do not try to light the pilot by hand.

BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

- If you cannot reach your gas supplier, call the fire department.

- C. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.
- D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

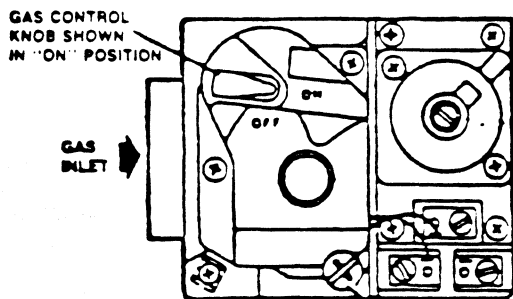
OPERATING INSTRUCTIONS

STOP! Read the safety information above on this label.

Set the thermostat to lowest setting.

Turn off all electric power to the appliance.

This appliance is equipped with an ignition device which automatically lights the pilot. Do not try to light the pilot by hand.



5. Remove control access panel.

6. Push in gas control knob slightly and turn clockwise to "OFF."

NOTE: Knob cannot be turned to "OFF" unless knob is pushed in slightly. Do not force.

7. Wait five (5) minutes to clear out any gas. If you then smell gas, **STOP!** Follow "B" in the safety information above on this label. If you don't smell gas, go to next step.

8. Turn gas control knob counterclockwise to "ON."

9. Replace control access panel.

10. Turn on all electric power to the appliance.

11. Set thermostat to desired setting.

12. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

Set the thermostat to lowest setting.

Turn off all electric power to the appliance if service is to be performed.

Remove control access panel.

4. Push in gas control knob slightly and turn clockwise to "OFF." Do not force.

5. Replace control access panel.

EXHIBIT C

OUTLINE OF OPERATING INSTRUCTIONS FOR APPLIANCES EQUIPPED WITH DIRECT IGNITION SYSTEMS

The following is a guide to aid in the writing of the operating instructions label for an appliance equipped with a direct ignition system. The statements in quotes are to be worded as shown. For purposes of this Exhibit, the word 'knob' is used. An actual label shall use the word knob, button, lever, etc. as appropriate. If the action necessary to operate the control is other than stated below, modification of the sentence(s) is acceptable.

A sample of this label is shown in Figure C.

Section 1

"FOR YOUR SAFETY READ BEFORE OPERATING"

The following warning shall be indented and boxed at the top of this section.

"WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life."

"A This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand."

"B BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor."

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department."

"C Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it; call a qualified service technician. Force or attempted repair may result in a fire or explosion."

"D Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water."

Section 2

"OPERATING INSTRUCTIONS"

- 1 "STOP! Read the safety information above (to the left on this label)."
- 2 For an appliance equipped with or for use with an adjustable thermostat:
"Set the thermostat to lowest setting."
- 3 For an appliance which utilizes an external electrical supply:
"Turn off all electric power to the appliance."
- 4 Instructions not to attempt to light the burner by hand.
- 5 For an appliance which requires removal of a panel(s) or other part to gain access to the gas control, instructions for gaining access to the gas control.
- 6 Instructions, with an illustration, for turning the gas control manual valve to the full OFF position*.
- 7 "Wait five (5) minutes** to clear out any gas. If you then smell gas, STOP! Follow 'B' in the safety information above (to the left) on this label. If you don't smell gas, go to next step."
- 8 Instructions for turning the gas control manual valve to the ON position*.
- 9 If applicable, instructions to replace the gas control access panel(s) or other part(s).
- 10 If applicable:
"Turn on all electric power to the appliance."
- 11 If applicable:
"Set thermostat to desired setting."
- 12 Instructions as to what to do next if the appliance fails to operate after following the above steps, and the following:

* Wherever rotation is required, the following words and symbols shall be used to indicate direction.

clockwise

counterclockwise

** The manufacturer may specify a longer time.

"If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier."

ion 3

"TURN OFF GAS TO APPLIANCE"

If applicable:

"Set the thermostat to lowest setting."

2. If applicable:

"Turn off all electric power to the appliance if service is to be performed."

3. If applicable, instructions for gaining access to the gas control.

4. Instructions for turning the gas control manual valve to the full OFF position.*

5. If applicable, instructions to replace the gas control access panel(s).

* Wherever rotation is required, the following words and symbols shall be used to indicate direction:



FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

A. This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.

B. **BEFORE OPERATING** smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.

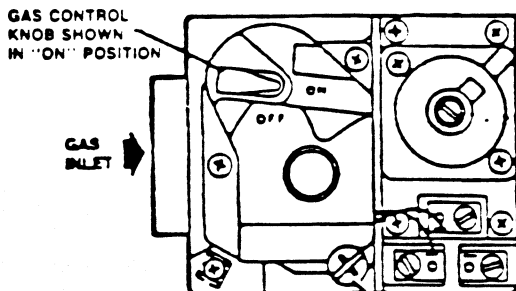
• If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

OPERATING INSTRUCTIONS

1. **STOP!** Read the safety information above on this label.
2. Set the thermostat to lowest setting.
3. Turn off all electric power to the appliance.
4. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.



5. Remove control access panel.

6. Push in gas control knob slightly and turn clockwise to "OFF."

NOTE: Knob cannot be turned to "OFF" unless knob is pushed in slightly. Do not force.

7. Wait five (5) minutes to clear out any gas. If you then smell gas, **STOP!** Follow "B" in the safety information above on this label. If you don't smell gas, go to next step.

8. Turn gas control knob counterclockwise to "ON."

9. Replace control access panel.

10. Turn on all electric power to the appliance.

11. Set thermostat to desired setting.

12. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

1. Set the thermostat to lowest setting.
2. Turn off all electric power to the appliance if service is to be performed.
3. Remove control access panel.

4. Push in gas control knob slightly and turn clockwise to "OFF." Do not force.

5. Replace control access panel.

Figure C. Sample Operating Instructions Label for an Appliance Equipped with a Direct Ignition System

EXHIBIT D

LIST OF REFERENCE STANDARDS

(Sources for reference standards given in this Exhibit are denoted by superscript numbers.)

- NSI A119.2 NFPA 501C-1987, *Recreational Vehicles*^{2,8}
- NSI B18.2.1-1981, *Square and Hex Bolts and Screws (Inch Series)*²
- NSI B18.6.2-1972 (R1983), *Slotted Head Cap Screws, Square Head Set Screws and Slotted Headless Set Screws*²
- NSI B18.6.3-1972 (R1983), *Slotted and Recessed Head, Machine Screws and Machine Screw Nuts*²
- NSI B18.6.4-1981, *Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws (Inch Series)*²
- NSI C101.1-1986, *Leakage Current for Appliances*²
- NSI Y14.15-1966 (R1988), *Electrical and Electronic Diagrams*²
- NSI Z21.15-1979, and Addenda, Z21.15a-1981 and Z21.15b-1984, *Manually Operated Gas Valves*^{1,2}
- NSI Z21.18-1987, and Addenda, Z21.18a-1989, *Gas Appliance Pressure Regulators*^{1,2}
- NSI Z21.20-1985, and Addenda, Z21.20a-1987 and Z21.20b-1988, *Automatic Gas Ignition Systems and Components*^{1,2}
- NSI Z21.21-1987, and Addenda, Z21.21a-1989, *Automatic Valves for Gas Appliances*^{1,2}
- NSI Z21.22-1986, *Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems*^{1,2}
- NSI Z21.23-1980, and Addenda, Z21.23a-1985 and Z21.23b-1988, *Gas Appliance Thermostats*^{1,2}
- NSI Z21.35-1989, *Pilot Gas Filters*^{1,2}
- NSI Z223.1 NFPA 54-1988, *National Fuel Gas Code*^{1,2,8}
- NSI ASME B1.1-1989, *Unified Inch Screw Threads (UN and UNR Thread Form)*^{2,5}
- NSI ASME B1.20.1-1983, *Pipe Threads. General Purpose (Inch)*^{2,5}
- NSI ASME B18.2.2-1987, *Square and Hex Nuts (Inch Series)*^{2,5}
- NSI ASME B36.10M-1985, *Welded and Seamless Wrought Steel Pipe*^{2,5}
- NSI ASME PTC 19.3-1974 (R1985), *Performance Test Codes, Supplement on Instruments and Apparatus, Part 3, Temperature Measurement*^{2,5}
- NSI/IEEE 315-1975 and Supplement 315A-1986, *Graphic Symbols for Electrical and Electronic Diagrams (Including Reference Designation Class Designation Letters)*^{2,7}
- NSI/NFPA 70-1990, *National Electrical Code*^{2,8}
- NSI/SAE J554b-1981, *Electric Fuses (Cartridge Type)*^{2,10}
- NSI UL 62-1985, *Flexible Cord and Fixture Wire*^{2,11}

ANSI UL 969-1982, Marking and Labeling Systems^{2,11}

ASTM A90-81, Methods of Test for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles³

ASTM A525-87, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process³

ASTM B487-85, Method for Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section³

ASTM B499-88, Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals³

ASTM B504-88, Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method³

Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280⁶

National Sanitation Foundation Standard 14 for Plastics Piping System Components and Related Materials - 1965, reviewed December 1988⁹

UL 275-1986, Automotive Glass-Tube Fuses¹¹

Sources for Reference Standards:

1. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.
2. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
3. American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, Georgia 30329.
5. American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.
6. Department of Housing and Urban Development, Washington, D.C. 20410.
7. Institute of Electrical and Electronic Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.
8. National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.
9. National Sanitation Foundation, 3475 Plymouth Road, Ann Arbor, Michigan 48106.
10. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096-0001.
11. Underwriters Laboratories Inc., Publication Stock, 333 Pfingsten Rd., Northbrook, Illinois 60062.

PART III

MANUFACTURING AND PRODUCTION TESTS

The following manufacturing and production tests are intended to provide the means for certifying agencies to uniformly apply quality control standards to all water heaters certified as complying with the standard.

3.1 The manufacturer shall check, inspect and test the components and the assemblies of each water heater in the following manner:

- a. Inspect raw materials and purchased components using a sampling plan mutually acceptable to the manufacturer and the certifying agency.
- b. Inspect each vessel to determine its water holding integrity by application of a pressure test or other means mutually acceptable to the manufacturer and the certifying agency.
- c. Test fire each burner and manifold and control assembly for proper burner and gas valve operation and verify the gastightness of the manifold and control assembly. This test shall be conducted on completely assembled appliances, when practicable.
- d. Test each appliance to determine that electrical components function properly. This test shall be conducted on completely assembled appliances, or when not practicable, subassemblies shall be tested separately, or when components are to be wired in the field, written assurance from the component manufacturers that operational tests have been conducted on their devices shall be kept on file.
- e. Conduct dielectric withstand tests on each factory assembled appliance incorporating high-voltage electrical circuits. If the appliance employs solid-state components which can be damaged by the dielectric potential, the test may be conducted before these components are electrically connected. The tests shall consist of the application of the 60 hertz potential between high-voltage current-carrying parts and the casing, frame and similar noncurrent-carrying parts of the appliance

with any switch contacts both open and closed. The test potential shall be in accordance with the dielectric withstand test specified in 1.28.40 applied for 1 minute, or a potential of 120 percent of that value applied for 1 second.

3.2 Using a sampling plan mutually agreeable to the manufacturer and the certifying agency, completely assembled water heaters shall be tested to determine satisfactory operation with respect to:

- a. Burner operating characteristics;
- b. Ignition systems and pilot safety shutoff devices;
- c. Combustion;
- d. Storage heater temperature limits;
- e. Flue loss; and
- f. Dielectric withstand with solid-state components connected (if not tested under 3.1-e).

Under this sampling plan, the frequency of conducting the tests specified in "a" through "f" above need not be the same.

If appliances are not shipped assembled from the factory, the manufacturer shall periodically assemble an appliance from production to check the compatibility of the subassemblies. The appliance shall be capable of ready assembly. It is suggested that one appliance be so checked for each 100 appliances produced, but not less than one for each week's production.

The manufacturer's test method(s) shall be capable of relating back to the test(s) specified in the standard.

The results of these tests shall be recorded and maintained by the manufacturer for review by the certifying agency.

3.3 Using a sampling plan mutually acceptable to the manufacturer and the certifying agency, storage vessels shall be hydrostatically tested as specified in 2.30.

PART IV

DEFINITIONS

AIR SHUTTER. An adjustable device for varying the size of the primary air inlet(s).

APPLIANCES-AUTOMATICALLY CONTROLLED. Appliances equipped with automatic devices which:

1. Accomplish complete "turn-on" or "shutoff" of the gas to the main burner(s); or
2. Graduate the gas supply to the burner(s) but do not effect complete shutoff of the gas.

AUTOMATIC FLUE DAMPER DEVICE. A device, in the flue outlet or in the inlet of, or upstream of the draft hood of an individual automatically operated gas-fired appliance, which is designed to automatically open the flue outlet during appliance operation and to automatically close off the flue outlet when the appliance is in a standby condition.

1. Electrically Operated. An automatic flue damper device that employs electrical energy to control the device.
2. Mechanically Actuated. An automatic flue damper device dependent for operation upon the direct application or transmission of mechanical energy without employing any type of energy conversion.

AUTOMATIC GAS IGNITION SYSTEM. A system designed to ignite and reignite an appliance burner(s). Such systems shall:

1. Automatically ignite gas at the main burner, or gas at the pilot burner so the pilot can ignite the main burner;
2. Prove the presence of either the ignition source, the main burner flame, or both; and
3. Automatically act to shut off the gas supply to the main burner or to the pilot burner and the main burner, when the supervised flame or ignition source is not proved.

AUTOMATIC GAS IGNITION SYSTEM TIMINGS.

1. Flame-Establishing Period. The period of time between initiation of gas flow and proof of the supervised flame or between the proof of

supervised flame and initiation of gas flow. This may be applicable to proof of ignition source, proof of main burner flame, or both.

2. Flame Failure Reignition Time. The period of time between loss of the supervised ignition source or the supervised main burner flame and a reignition attempt. During this time period the main burner gas supply is not shut off.
3. Flame Failure Response Time. The period of time between loss of the supervised ignition source or the supervised main burner flame and the action to shut off the gas supply.
4. Ignition Activation Period. The period of time between energizing the main gas valve and deactivation of the ignition means prior to the lockout time.
5. Lockout Time. The period of time between initiation of the lighting procedure and the action to shut off the gas flow in the event of failure to establish proof of the supervised ignition source or the supervised main burner flame. Reinitiating the lighting procedure requires a manual operation.
6. Recycle Time. The period of time between shutoff of the gas supply following loss of the supervised ignition source or the supervised main burner flame and reactivation of the ignition means.

AUTOMATIC GAS SHUTOFF DEVICE. A device constructed so the attainment of a water temperature in a hot water supply system in excess of some predetermined limit acts in such a way as to cause the gas to the system to be shut off.

AUTOMATIC GAS SHUTOFF SYSTEM. A system consisting of an automatic gas shutoff device and an automatic gas shutoff valve constructed so the attainment of a water temperature in excess of some predetermined limit acts in such a way as to cause the gas to the main burner(s) of the appliance to be shut off. It may also shut off the gas to the pilot burner.

AUTOMATIC GAS SHUTOFF VALVE. A valve used in conjunction with an automatic gas shutoff device to shut off the gas supply to a gas-fired water heating system. It may be constructed integrally with the gas shutoff device, or be a separate assembly.

AUTOMATIC VENT DAMPER DEVICE. A device intended for installation in the venting system, upstream of or downstream of the appliance draft hood, of an individual automatically operated gas-fired appliance and which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

1. **Electrically Operated.** An automatic vent damper device that employs electrical energy to control the device.
2. **Mechanically Actuated.** An automatic vent damper device dependent for operation upon the direct application or transmission of mechanical energy without employing any type of energy conversion.
3. **Thermally Actuated.** An automatic vent damper device dependent for operation exclusively upon the direct conversion of the thermal energy of the vent gases into mechanical energy.

BAFFLE. An object placed in an appliance to change the direction of or retard the flow of air, gas, or mixtures or flue gases.

BTU. Abbreviation for British Thermal Unit. The quantity of heat required to raise the temperature of one pound of water 1 F.

BURNER. A device for the final conveyance of a gas, or a mixture of gas and air, to the combustion zone.

1. **Injection (Bunsen) Burner.** A burner employing the energy of a jet of gas to inject air for combustion into the burner and mix it with the gas.
 - a. **Atmospheric Injection Burner.** A burner in which air at atmospheric pressure is injected into the burner by a jet of gas.
2. **Power Burner.** A burner in which either gas or air, or both, are supplied at pressures exceeding, for gas, the line pressure, and for air, atmospheric pressure; this added pressure being applied at the burner.
 - a. **Premixing Burner.** A power burner in which all or nearly all of the air for combustion is mixed with the gas as primary air.
3. **Pressure Burner.** A burner which is supplied with a gas-air mixture under pressure (usually

from 0.5 to 14.0 inches water column and occasionally higher).

4. **Yellow-Flame Burner.** A burner in which secondary air only is depended on for the combustion of the gas.

BURNER HEAD. That portion of the burner beyond the outlet end of the mixer tube which contains the ports.

CHIMNEY. (See also "Gas Vent," "Vent" and "Venting System.") One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere.

- a. **Factory-Built Chimney.** A chimney composed of listed factory-built components assembled in accordance with the terms of their listing to form the completed chimney.
- b. **Masonry Chimney.** A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units or reinforced portland cement concrete, lined with suitable chimney flue liners.
- c. **Metal Chimney.** A field-constructed chimney of metal.

CIRCUIT.

1. **High-Tension.** A circuit involving a potential of more than 600 volts supplied by a step-up transformer or by a suitable combination of devices which will increase line voltage to over 600 volts.
2. **High-Voltage.** A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.
3. **Low-Voltage.** A circuit involving a potential of not more than 30 volts.
4. **Thermoelectric.** A circuit which receives its electrical energy by a conversion of heat to electricity by means of a thermocouple or thermopile.

COMBUSTIBLE MATERIAL. As pertaining to materials adjacent to or in contact with heat producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts, shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that are capable of being ignited and burned. Such material shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered.

COMBUSTION. The rapid oxidation of fuel gases accompanied by the production of heat, or heat and light.

COMBUSTION CHAMBER. The entire appliance volume within which combustion occurs.

COMBUSTION PRODUCTS. Constituents resulting from the combustion of a fuel gas with the oxygen of the air, including the inerts, but excluding excess air.

CONDENSATE (CONDENSATION). The liquid which separates from a gas (including flue gases) due to a reduction in temperature.

CONDENSATION SHEDS. Devices placed in an appliance to direct the flow of condensate.

CONTROLS. Devices designed to regulate the gas, air, water or electrical supplies to a gas appliance. These may be manual, semi-automatic or automatic.

CUBIC FOOT OF GAS. The amount of gas which would occupy 1 cubic foot when at a temperature of 60 F, if saturated with water vapor, and under a pressure equivalent to that of 30 inches mercury column.

DAMPER. The valve or plate which controls the flow through an automatic vent damper device.

DRAFT HOOD. A device placed in, and made a part of, the vent connector from an appliance, or in the appliance itself, which is designed to:

1. Provide for ready escape of the flue gases in the event of no draft, back draft, or stoppage beyond the draft hood;
2. Prevent a back draft from entering the appliance; and
3. Neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

DRIP PAN. A receptacle located below the burner(s) for the purpose of collecting water condensed from the flue gases.

ELECTRICAL DIAGRAMS.

1. **Connection.** A diagram which shows the connections of an installation or its component devices or parts. It may cover internal or external connections, or both, and contains such detail as is needed to make or trace connections that are involved. The Connection

Diagram usually shows general physical arrangement of the component devices or parts.

2. **Schematic.** A diagram which shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The Schematic Diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape or location of the component device or parts.

- a. **Ladder Form of Schematic.** A diagram drawn in the form of a vertical ladder. The outer vertical lines represent the electrical supply conductors. The horizontal steps represent each individual circuit with all component devices.

ELECTRICAL ENCLOSURE. A case enclosing electrical equipment and wiring which is designed expressly to prevent:

1. A person from accidentally contacting uninsulated live parts;
2. Burning or molten materials from contacting adjacent combustible materials or falling onto combustible materials;
3. Conductive or combustible materials from dropping onto uninsulated live parts; and
4. Mechanical abuse of electrical equipment not intended to withstand normal use without such additional enclosure.

EXCESS AIR. Air which passes through the combustion chamber and the appliance flues in excess of that which is required for complete combustion.

FLAME CHECK. A gauze, grid or any other portion of the burner assembly used to avert flash back.

FLUE, APPLIANCE. The passage(s) within an appliance through which combustion products pass from the combustion chamber of the appliance to the draft hood inlet opening on an appliance equipped with a draft hood or to the outlet of the appliance on an appliance not equipped with a draft hood.

FLUE COLLAR. That portion of an appliance designed for the attachment of the draft hood or vent connector.

FLUE GASES. Products of combustion plus excess air in appliance flues or heat exchangers.

FLUE LOSSES. The sensible heat and latent heat above room temperature of the flue gases leaving appliance.

FLUE OUTLET. The opening provided in an appliance for the escape of the flue gases.

GAS VENT. A passageway, vertical or nearly so, composed of listed factory-built components assembled in accordance with the terms of listing for conveying vent gases from gas appliances or their connectors to the outside atmosphere.

HEATING SURFACE. All surfaces which transmit heat from the flames or flue gases to the medium to be heated.

HEATING VALUE. The number of British Thermal Units produced by the combustion at constant pressure of 1 cubic foot of gas, when the ducts of combustion are cooled to the initial temperature of the gas and air, when the water vapor formed during combustion is condensed, and when the necessary corrections have been applied.

HOT WATER STORAGE TANK. A tank used to store water that is heated indirectly by a circulating burner heater or by steam or hot water circulating through coils or other heat exchange methods internal or external to the tank.

IGNITER. A device which utilizes electrical energy to ignite gas at a main burner or pilot burner.

IGNITION DEVICE. A device for igniting gas at a burner. It may be a pilot or an igniter.

IGNITION DEVICE, DIRECT. An igniter designed to ignite gas at a main burner.

IGNITION SOURCE.

1. Continuous. An ignition source which, once placed in operation, is intended to remain ignited or energized continuously until manually interrupted.
2. Intermittent/Continuous. An ignition source which is ignited or energized upon appliance user initiation of the operational cycle and which remains continuously ignited or energized during the appliance use cycle. The ignition source is extinguished or deenergized when the appliance use cycle is completed.
3. Intermittent. An ignition source which is automatically ignited or energized when an appliance is called on to operate and which remains continuously ignited or energized during each period of main burner operation.

The ignition source is automatically extinguished or deenergized when each main burner operating cycle is completed.

4. Intermittent/Interrupted. An ignition source which is ignited or energized upon appliance user initiation of the operational cycle and which is extinguished or deenergized after the appliance use cycle has been initiated.
5. Interrupted. An ignition source which is automatically ignited or energized when an appliance is called on to operate and which remains ignited or energized during the main burner Flame-Establishing Period. The ignition source is automatically extinguished or deenergized when each main burner Flame-Establishing Period is completed.

IID. (See Intermittent Ignition System.)

INPUT RATING. The gas-burning capacity of an appliance in Btu per hour as specified by the manufacturer based on sea level operation.

INTERLOCK. A control to prove the physical state of a required condition, and to furnish that proof to the safety shutoff device circuit.

INTERMITTENT IGNITION SYSTEM. A system in which the ignition source is automatically shut off when the appliance is in an off or standby condition.

JACKET. The outer casing or shell of the appliance or storage vessel.

LIQUEFIED PETROLEUM GASES. The terms "Liquefied Petroleum Gases," "LPG" and "LP Gas" as used in this standard shall mean and include any material which is composed predominantly of any of the following hydrocarbons, or mixtures of them: propane, propylene, butanes (normal butane or isobutane) and butylenes.

LP GAS-AIR MIXTURE. Liquefied petroleum gases distributed at relatively low pressures and normal atmospheric temperatures which have been diluted with air to produce desired heating value and utilization characteristics.

MANIFOLD. The conduit of an appliance which supplies gas to the individual burners.

MANUFACTURED HOME (MOBILE HOME). A structure, transportable in one or more sections, which, in the traveling mode, is 8 body feet or more in width, 40 body feet or more in length or, when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without permanent foundation

when connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein.

MAXIMUM GAS SUPPLY PRESSURE. The maximum gas supply pressure to the appliance, based on the pressure rating of the appliance control or component having the lowest rated operating pressure.

MAXIMUM REGULATION CAPACITY. The high limit of flow below which are found acceptable regulating characteristics.

MIXER. The combination of mixer head, mixer throat and mixer tube.

1. **Mixer Head.** The portion of an injection (Bunsen) type burner, usually enlarged, into which primary air flows to mix with the gas stream.
2. **Mixer Throat.** The portion of the mixer which has the smallest cross-sectional area and which lies between the mixer head and the mixer tube.
3. **Mixer Tube.** The portion of the mixer which lies between the throat and the burner head.

MIXER FACE. The air inlet end of the mixer head.

MOBILE HOME. (See Manufactured Home.)

NEEDLE, ADJUSTABLE. A tapered projection coaxial with and movable with respect to an orifice, the position of which is fixed, to regulate the flow of gas.

NEEDLE, FIXED. A tapered projection, the position of which is fixed, coaxial with an orifice which can be moved with respect to it, to regulate the flow of gas.

NONCOMBUSTIBLE MATERIAL. For the purpose of this standard, 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.

NORMAL BUTANE (n-BUTANE), TECHNICAL GRADE. A liquefied petroleum gas composed of a minimum of 95 percent n-butane (C_4H_{10}) which may contain other impurities such as isobutane, butylenes and propane not in excess of 5 percent.

NORMAL INLET TEST PRESSURES. Those pressures specified for testing purposes at which

adjustment of burner ratings and primary air adjustments are made.

ORIFICE. The opening in an orifice spud or other device whereby the flow of gas is limited and through which the gas is discharged.

ORIFICE SPUD. A removable plug or cap containing an orifice which permits adjustment of the flow of gas by substitution of a spud with a different size orifice.

PILOT. A small gas flame utilized to ignite gas at a main burner(s).

PILOT SHUTOFF DEVICE. A device capable of shutting off the pilot gas that is not intended for frequent usage. It may also be capable of adjusting pilot gas flow.

PORT. Any opening in a burner head through which gas or a gas-air mixture is discharged for ignition.

PRIMARY AIR. The air which, when introduced into a burner, mixes with the gas before it reaches the port(s).

PRIMARY AIR INLET. The opening(s) through which primary air is admitted into a burner.

PROPANE HD-5. A special grade of liquefied petroleum gas composed of a minimum of 90 percent liquid volume of propane (C_3H_8) and a maximum of 5 percent liquid volume of propylene (C_3H_6).

RACEWAY. A channel for holding wires, cables or bus bars, which is designed expressly for, and used solely for, this purpose. Raceways may be of metal or insulating material and the term includes metal conduit, flexible metal conduit, and wireways.

RECOVERY RATING. As used in this standard, the quantity of water obtained by dividing the manufacturer's input rating in Btu per hour by 1179 Btu per gallon. This is based on a 100 F temperature rise, 70 percent thermal efficiency and a nominal specific heat for water of 8.25 Btu per gallon per degree F.

RECREATIONAL VEHICLE. A vehicular type unit primarily designed as temporary living quarters for recreational, camping, or travel use, which either has its own motive power or is mounted on or drawn by another vehicle. The basic entities are as follows:

1. **Camping Trailer.** A vehicular portable unit mounted on wheels and constructed with collapsible partial side walls which fold for towing by another vehicle and unfold at the camp site.

2. **Motor Home.** A vehicular unit built on or permanently attached to a self-propelled motor vehicle chassis, or on a chassis cab or van which is an integral part of the completed vehicle.
3. **Travel Trailer.** A vehicular portable unit, mounted on wheels, of such a size or weight as not to require special highway movement permits when drawn by a motorized vehicle and having a living area of less than 220 square feet, excluding built-in equipment (such as wardrobes, closets, cabinets, kitchen units or fixtures) and bath and toilet rooms.
4. **Truck Camper.** A portable unit consisting of a roof, floor and sides, designed to be loaded onto and unloaded from the bed of a pickup truck.

REGULATOR, GAS APPLIANCE PRESSURE. Device for controlling a selected gas pressure.

1. **Adjustable.**
 - a. **Spring Type, Limited Adjustment.** A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable over a range of not more than ± 15 percent of the outlet pressure at the midpoint of the adjustment range.
 - b. **Spring Type, Standard Adjustment.** A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable.
2. **Convertible.** A regulator whose adjustment means can be positioned from one predetermined outlet pressure setting to another predetermined outlet pressure setting with no intermediate pressure settings and without addition, deletion or substitution of parts.
3. **Nonadjustable.**
 - a. **Spring Type, Nonadjustable.** A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is not adjustable.
 - b. **Weight Type.** A regulator in which the regulating force acting upon the diaphragm is derived from a weight or combination of weights.

RELIEF VALVE. A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature or vacuum in the hot water supply system.

1. **Pressure Relief Valve.** A valve which automatically opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.
2. **Combination Temperature and Pressure Relief Valve.** A valve which automatically opens and closes a relief vent, depending on whether the temperature or pressure is above or below a predetermined value.
3. **Vacuum Relief Valve.** A valve which automatically opens and closes a vent for relieving a vacuum within the hot water supply system depending on whether the vacuum is above or below a predetermined value.

SAFETY CIRCUIT. A circuit or portion thereof involving one or more safety controls in which failure due to grounding, opening or shorting of any part of the circuit can cause unsafe operation of the controlled appliance.

SAFETY SHUTOFF DEVICE. A device that will shut off the gas supply to the controlled burner(s) in the event the source of ignition fails. This device may interrupt the flow of gas to the main burner(s) only, or to the pilot and main burner(s) under its supervision.

SECONDARY AIR. The air externally supplied to the flame at the point of combustion.

SPECIFIC GRAVITY. As applied to gas, the ratio of the weight of a given volume to that of the same volume of air, both measured at the same temperature and pressure.

STORAGE VESSEL. Container provided for storage of hot water under pressure.

TEMPERATURE LIMITING DEVICE. The following devices are considered as being temperature limiting devices:

1. Automatic gas shutoff systems.
2. Temperature relief valves or combination temperature and pressure relief valves.

THERMOSTAT.

1. **Electric Switch Type.** A device which senses changes in temperature and controls

electrically, by means of separate components, the flow of gas to the burner(s) to maintain selected temperatures.

2. **Integral Gas Valve Type.** An automatic device, actuated by temperature changes, designed to control the gas supply to the burner(s), in order to maintain temperatures between predetermined limits, and in which the thermal actuating element is an integral part of the device.

a. **Graduating Thermostat.** A thermostat in which the motion of the valve is approximately in direct proportion to the effective motion of the thermal element induced by temperature change.

b. **Snap-Acting Thermostat.** A thermostat in which the thermostatic valve travels instantly from the closed to an open position, and vice versa.

TOOLS, SPECIAL. Those tools that are not available on the open retail market.

VALVE.

1. **Automatic.** An automatic or semi-automatic device consisting essentially of a valve and operator that controls the gas supply to the burner(s) during normal operation of an appliance. The operator may be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other means.

2. **Burner.** A manually or mechanically operated valve which permits control of the flow of gas.

3. **Diaphragm Type Automatic.** A device consisting essentially of an automatic valve actuated by means of the application of gas pressure upon a flexible diaphragm.

4. **Electric Type Automatic.** A device actuated by electrical energy for controlling the gas supply.

5. **Manual Main Shutoff.** A manually operated valve in the gas line for the purpose of completely turning on or shutting off the gas supply to the appliance, except to the pilot(s) which may be provided with independent shutoff valves.

6. **Safety Shutoff.** A valve that is automatically closed by the safety control system or by an

emergency device. Such valve may be of the automatic or manually opened type.

7. **Semi-Automatic.** A valve that is opened manually and closed automatically, or vice versa.

VENT. A passageway, vertical or nearly so, used to convey flue gases from gas utilization equipment, or their vent connectors, to the outside atmosphere.

VENT-AIR INTAKE TERMINAL. The device used with a direct vent water heater which is located on the outside of the structure through which the air for combustion is taken from the outside atmosphere and from which products of combustion are discharged.

1. **Vent Terminal.** The fitting at the end of the vent pipe that directs the flue products into the outside atmosphere.

2. **Air-Intake Terminal.** The fitting at the inlet of the air intake pipe that allows entrance of the outside atmosphere to the air intake pipe.

VENT CONNECTOR. That portion of the venting system which connects the gas appliance to the gas vent, chimney or single-wall metal pipe.

VENT GASES. Products of combustion from fuel-gas burning appliances plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.

VENTING SYSTEM. A continuous open passageway from the flue collar or draft hood of a gas-burning appliance to the outside atmosphere for the purpose of removing flue or vent gases. NOTE: A venting system is usually composed of a vent or a chimney and vent connector(s), if used, assembled to form the open passageway.

VENT LIMITER. A means which limits the flow of air or gas from the atmospheric diaphragm chamber of a gas pressure regulator to the atmosphere. This may be either a limiting orifice or a limiting device.

WATER HEATER. A closed vessel, in which water is heated by the combustion of fuels, electricity or any other source and is withdrawn for use external to the vessel at pressures not exceeding 160 psig, including the apparatus by which heat is generated and all controls and devices necessary to prevent water temperatures from exceeding 210 F.

1. **Counter Type.**
 - a. **Concealed Type.** A water heater which is for flush installation beneath a counter top 36 inches high, wherein the entire heater is concealed.
 - b. **Flush Type.** A water heater which is primarily for installation in conjunction with or adjacent to a counter 36 inches high, wherein the front and top of the heater casing are exposed.
 - c. **Recessed Type.** A water heater which is for installation beneath a counter 36 inches high, wherein the front of the heater casing is exposed.
2. **Direct Vent.** A system consisting of (a) a water heater for indoor installation, (b) combustion air connections between the water heater and the outside atmosphere, (c) flue gas connections between the water heater and the vent cap, and (d) vent cap for installation outdoors, supplied by the manufacturer and constructed so that all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere.
3. **Automatic Storage.** A water heater that heats and stores water within the appliance at a thermostatically controlled temperature for delivery on demand, and which has an input rating of less than 4,000 Btu per hour per gallon of stored water.

APPENDIX A

PERTINENT REFERENCES TO ANSI Y14.15

(This Appendix is informative and is not part of the standard)

The following sections of ANSI Y14.15 are most pertinent to wiring diagrams for gas appliances and accessories.

15-2.2	Schematic Diagrams
15-2.3	Connection Diagrams
15-2.4	Interconnection Diagrams
15-3.6.1	Representation of Contacts
15-3.7	Abbreviations
15-3.11	Wire Colors
15-9.2.5	Circuit Arrangements
15-10.3.1	Views - Conn. Diagrams
15-10.3.2	Wiring Views
15-10.3.3	Device Representation

APPENDIX B

WIRE COLOR DESIGNATIONS

(This Appendix is informative and is not part of the standard.)

<u>WIRE COLOR</u>	<u>DESIGNATION SPECIFIED IN 15-3.11 OF ANSI Y14.15</u>
Black	BK
Brown	BR
Red	R
Orange	O
Yellow	Y
Green	G
Blue	BL
Violet (Purple)	V (PR)
Gray (Slate)	GY (S)
White	W

APPENDIX C

RECOMMENDED WIRE COLOR USAGE

(This Appendix is informative and is not part of the standard.)

Line Voltage Conductors

	<u>Single Phase</u>			<u>Three Phase</u>		<u>Three Phase Single Phase</u>	
	120v	240v	*120v 240v	208v		208v 120v*	240v 208v*
	208v	480v		240v		240v 277v*	
	277v			480v			
					(Alternative)		(Alternative)
L ₁ (Hot)	Black	Black	Black	Black	Black	Black	Black
L ₂ (Neutral)	White	.	White	.	.	White	White
L ₃ (Hot)	.	Red	Red	Black	Red	Black	Red
L ₄ (Hot)	.	.	.	Black	Blue	Black	Blue

The equipment grounding conductor shall be Green,
Green with Yellow stripe(s), or bare.

*120v, 208v, 277v circuits. - use Black & White

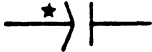


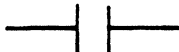
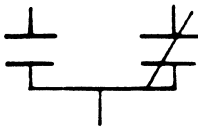

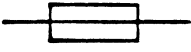







Line Voltage Component Leads

Capacitors		Brown
Single Phase Multi-Speed Motors	Common (208v, 240v, 480v)	Purple
	Common (120v, 277v) (Neutral)	White
	High Speed	Black
	Low Speed	Red
	Medium Speed	Blue

APPENDIX D

PREFERRED GRAPHIC SYMBOLS OF COMMONLY USED ITEMS, EXTRACTED FROM ANSI IEEE STANDARD 315, GRAPHIC SYMBOLS FOR ELECTRICAL AND ELECTRONICS DIAGRAMS, AND ABBREVIATIONS FOR THESE ITEMS

(This Appendix is informative and is not part of the standard)

<u>EM DESCRIPTION</u>	<u>ABBREVIATION</u>	<u>SYMBOL</u>	<u>IEEE STANDARD 315 SECTION REFERENCE</u>
Capacitor (*Closest to Grnd)	CAP		2.2.1
Coil, Relay	R		4.5
Contact, Normally Closed	N. C.		4.3.1
Contact, Normally Opened	N. O.		4.3.2
Contact, Transfer Single Pole Double Throw	S. P. D. T.		4.3.3
Crossing of Paths (Conductors not Connected)		3.1.5
Fuse, General	FUSE		9.1.1
Ground (Direct Circuit Return to Earth)	GND		3.9.1
Igniter, Glow Bar, Glow Coil, Hot Wire	IGN	
Igniter, Spark, Grounded	IGN	
Igniter, Spark, Ungrounded	IGN	
Junction of Paths (Conductor or Cable)		3.1.6.3
Link, Fusible	FL		2.12.3
Motor, General	MOT		13.1.3

**PREFERRED GRAPHIC SYMBOLS FROM
ANSI IEEE STANDARD 315**




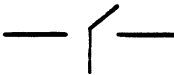



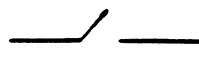



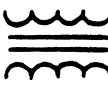
<u>ITEM DESCRIPTION</u>	<u>ABBREVIATION</u>	<u>SYMBOL</u>	<u>IEEE STANDARD 315 SECTION REFERENCE</u>
Resistor, Adjustable	RES		2.1.3
Resistor, Heating	RES		2.1.8
Resistor, Variable	RES		2.1.4
Switch, Double Throw General	S. P. D. T		4.6.2
Switch, Normally Closed Time Delay Opening	N. C. SW		4.16.2
Switch, Normally Open Time Delay Closing	N. O. SW		4.16.1
Switch, Pressure or Vacuum Actuated (Closes on Rising Pressure)	N. O. SW		4.19.1
Switch, Single Throw General	N. O. SW		4.6.1
Switch, Temperature Actuated (Closes on Rising Temperature)	N. O. SW		4.20.1
Switch, Temperature Actuated (Opens on Rising Temperature)	N. C. SW		4.20.2
Thermocouple	TC		2.13.1
Transformer, Magnetic Core Nonsaturating	TRAN.		6.4.2.1

TABLE OF CONVERSION FACTORS

(This Appendix is informative and is not part of the standard.)

Quantity	U.S. Unit		Multiplying Factor		SI Units*	
	Name	Symbol	U.S. to SI	SI to U.S.	Symbol	Name
WEIGHT	ounce-force-inch	ozf-in	7.061×10^{-3}	141.62	N-m	newton-meter
	pound-force-inch	lbf-in	1.129×10^{-1}	8.85	N-m	newton-meter
	pound-force-foot	lbf-ft	1.355	7.38×10^{-1}	N-m	newton-meter
LENGTH	inch	in	2.540×10^{-2}	39.37	m	meter
	inch	in	2.540×10^{-2}	39.37×10^{-3}	mm	millimeter
	foot	ft	3.048×10^{-1}	3.281	m	meter
AREA	square inch	in ²	6.452×10^{-4}	1550	m ²	square meter
	square inch	in ²	6.452×10^{-4}	1550×10^{-6}	mm ²	square millimeter
	square foot	ft ²	9.290×10^{-2}	10.76	m ²	square meter
VOLUME	cubic inch	in ³	1.639×10^{-4}	61.02×10^3	m ³	cubic meter
	cubic foot	ft ³	2.832×10^{-2}	35.31	m ³	cubic meter
	cubic foot	ft ³	2.832×10^{-2}	35.31×10^{-3}	l	liter
	gallon	gal	3.785×10^{-3}	264.1	m ³	cubic meter
	gallon	gal	3.785	264.1×10^{-3}	l	liter
VELOCITY	foot/second	ft/s	3.048×10^{-1}	3.281	m/s	meter/second
	foot/minute	ft/min	5.080×10^{-2}	196.8	m/s	meter/second
	mile/hour	mi/hr	4.470×10^{-1}	2.236	m/s	meter/second
ACCELERATION	foot/second ²	ft/s ²	3.048×10^{-1}	3.281	m/s ²	meter/second ²
FREQUENCY	cycle/second	cs	1	1	Hz	hertz
MASS	ounce	oz	2.835×10^{-2}	35.27	kg	kilogram
	ounce	oz	2.835×10^{-2}	35.27×10^{-3}	g	gram
	pound	lb	4.536×10^{-1}	2.204	kg	kilogram
	gram	gr	6.480×10^{-4}	15.43×10^{-3}	kg	kilogram
MASS PER UNIT AREA	pound/foot ²	lb/ft ²	4.882	2.046×10^{-1}	kg/m ²	kilogram/meter ²
MASS PER UNIT VOLUME	pound/foot ³	lb/ft ³	1.602 x 10	6.243×10^{-3}	kg/m ³	kilogram/meter ³
MASSIFIC VOLUME	foot ³ /pound	ft ³ /lb	6.243×10^{-3}	1.602 x 10	m ³ /kg	meter ³ /kilogram
MASS FLOW RATE	pound/hour	lb/hr	1.260×10^{-3}	7.936×10^3	kg/s	kilogram/second
	pound/foot ² /hour	lb/ft ² /hr	1.356×10^{-3}	7.374×10^3	kg/m ² s	kilogram/meter ² /second
	pound/inch ² /hour	lb/in ² /hr	1.953×10^{-3}	5.120	kg/m ² s	kilogram/meter ² /second
VOLUME FLOW RATE	foot ³ /second	ft ³ /s	2.832×10^{-2}	35.31	m ³ /s	meter ³ /second
	foot ³ /second	ft ³ /s	2.832×10^{-2}	35.31×10^{-3}	l/s	liter/second
	foot ³ /minute	ft ³ /min	4.719×10^{-3}	2.119×10^{-2}	m ³ /s	meter ³ /second
	foot ³ /minute	ft ³ /min	4.719×10^{-3}	2.119×10^{-3}	l/s	liter/second
	gallon/minute	gal/min	6.309×10^{-4}	1.585×10^{-3}	m ³ /s	meter ³ /second
	gallon/minute	gal/min	6.309×10^{-4}	1.585×10^{-4}	l/s	liter/second
	gallon/hour	gal/hr	1.052×10^{-4}	9.505×10^{-3}	m ³ /s	meter ³ /second
	gallon/hour	gal/hr	1.052×10^{-4}	9.505×10^{-4}	l/s	liter/second
	gallon/hour	gal/hr	1.052×10^{-4}	9.505×10^{-4}	l/s	liter/second
PRESSURE	pound force/inch ²	lbf/in ²	6.895×10^3	1.450×10^{-4}	Pa	pascal
	pound force/foot ²	lbf/ft ²	4.788×10^2	2.088×10^{-3}	Pa	pascal
	inch H ₂ O (4 °C)	inch H ₂ O (4 °C)	2.491×10^2	4.014×10^{-3}	Pa	pascal
	atmosphere	inch Hg (10 °C) atm (std)	3.386×10^5 1.013×10^5	2.953×10^{-4} 9.871×10^{-6}	Pa Pa	pascal pascal
ENERGY, WORK, AMOUNT OF HEAT	Btu	Btu	1.055×10^3	9.478×10^{-4}	J	joule
	horsepower hour	hphr	1.055	9.478×10^{-4}	kJ	kilojoule
	horsepower hour	hphr	2.685×10^6	3.724×10^{-7}	J	joule
	horsepower hour	hphr	2.685	3.724×10^{-1}	MJ	megajoule
	kilowatt hour	kWhr	3.6×10^6	2.777×10^{-7}	J	joule
	kilowatt hour	kWhr	3.6	2.777×10^{-1}	MJ	megajoule
POWER, HEAT FLOW RATE	Btu/hr	Btu/hr	2.931×10^{-3}	3.412	W	watt
	Btu/hr	Btu/hr	2.931×10^{-3}	3.412×10^3	kW	kilowatt
	hp	hp	7.457×10^3	1.341×10^{-4}	W	watt
	hp	hp	7.457×10^3	1.341	kW	kilowatt
	ton refrigeration (12,000 Btu/hr)	ton refrigeration (12,000 Btu/hr)	3.516×10^3	2.844×10^{-4}	W	watt
	ton refrigeration (12,000 Btu/hr)	ton refrigeration (12,000 Btu/hr)	3.516	2.844×10^{-1}	kW	kilowatt
	Btu/hour-foot ²	Btu/hr ft ²	3.155	3.1695×10^{-1}	W/m ²	watt/meter ²
HEAT CAPACITY	Btu/degree F	Btu/F	1.899×10^3	5.265×10^{-4}	J/°C	joule/degree Celsius
HEAT CAPACITY	Btu/pound degree F	Btu/lb F	4.187×10^3	2.388×10^{-4}	J/kg °C	joule/kg-degree Celsius
HEAT CAPACITY	Btu/pound degree F	Btu/lb F	4.187	2.388×10^{-3}	kJ/kg °C	kilojoule/kg-degree Celsius
HEAT FLOW RATE	Btu/pound	Btu/lb	2.326×10^3	4.299×10^{-4}	J/kg	joule/kilogram
	Btu/pound	Btu/lb	2.326	4.299×10^{-1}	kJ/kg	kilojoule/kilogram
VOLUME AT CONDITIONS**	ft ³ (60 F, 30 inches Hg, sat)		.9826	1.0177	ft ³ (60 F, 30 inches Hg, dry)	
	" " " "		.02784	35.92	m ³ (15 °C, 760 mm Hg, dry)	
	" " " "		.02832	35.31	m ³ (15 °C, 760 mm Hg, sat)	
	" " " "		.02639	37.89	m ³ (0 °C, 760 mm Hg, dry)	
	" " " "		.02655	37.66	m ³ (0 °C, 760 mm Hg, sat)	

Units (International System of Units) have been adopted by the International Gas Union for use within the gas industry. Where the same quantities have been defined by ISO (International Standards Organization), they are identical to the SI Units.

Standard cubic foot (SCF) measured at 60 F and 30 inches Hg, Saturated, (U.S. Conditions)

Standard cubic meter (m³) measured at 15 °C and 760 mm Hg, dry, (SI Conditions)

Normal cubic meter (m³) measured at 0 °C and 760 mm Hg, dry

TEMPERATURE SCALES AND CONVERSIONS

The unit of temperature in the International System of Units (SI) is the kelvin (K), but it is generally accepted practice to express temperature differences in terms of degrees Celsius ($^{\circ}\text{C}$) because the degree intervals are identical. The term "centigrade" was abandoned in 1948 by the General Conference on Weights and Measures but in fact is still in common use. The accepted abbreviation for centigrade is also $^{\circ}\text{C}$ and for all practical purposes the degree intervals of centigrade, Celsius and kelvin, are identical.

Many temperature measurements are still made in terms of degrees Fahrenheit (F). Although a formal definition of the Fahrenheit scale does not exist, it is based on:

- a. The freezing (ice) point of water = 32 F
- b. The boiling point of water under standard pressure conditions = 212 F
- c. The formula, $5/9 (F - 32) = ^{\circ}\text{C}$

$^{\circ}\text{C}$	F	$^{\circ}\text{C}$	F	$^{\circ}\text{C}$	F
-40	-40.0	25	77.0	70	158.0
-20	-4.0	30	86.0	80	176.0
0	32.0	35	95.0	90	194.0
10	50.0	40	104.0	100	212.0
15	59.0	50	122.0	110	230.0
20	68.0	60	140.0	120	248.0

MULTIPLES AND SUBMULTIPLES OF BASIC UNITS

Factor by which the unit is multiplied	Prefix	Symbol
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^9	giga	G
1 000 000 = 10^6	mega	M
1 000 = 10^3	kilo	k
100 = 10^2	hecto	h
10 = 10^1	deka	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p

**LIST OF Z21 SERIES OF AMERICAN NATIONAL STANDARDS
FOR GAS APPLIANCES AND GAS APPLIANCE ACCESSORIES**

APPLIANCES

Household Cooking Gas Appliances, Z21.1

Gas Clothes Dryers, Z21.5

Volume I (Z21.5.1) Type 1 Clothes Dryers

Volume II (Z21.5.2) Type 2 Clothes Dryers

Gas Water Heaters, Z21.10

**Volume I (Z21.10.1) Storage Water Heaters With Input
Ratings of 75,000 Btu Per Hour or Less**

**Volume III (Z21.10.3) Storage, With Input Ratings Above 75,000
Btu Per Hour, Circulating and Instantaneous Water Heaters**

Gas-Fired Room Heaters, Z21.11

Volume I (Z21.11.1) Vented Room Heaters

Volume II (Z21.11.2) Unvented Room Heaters

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INTRODUCTION

The following is a brief introduction to Part HLW. It is general in nature, and should not be considered as a substitute for actual review of appropriate articles of the document. However, this will give the user a better understanding of the purpose, requirements, and intent of Part HLW.

Part HLW applies to water heaters in commercial or industrial sizes providing corrosion resistance for supplying potable hot water for commercial purposes at pressures not exceeding 160 psig and temperatures not exceeding 210°F.

Part HLW does not apply to residential size water heaters which are excluded by provisions of HLW-101 and hot water heating boilers.

Differences in applicable criteria for water heaters versus hot water heating boilers are as follows.

(a) In a water heater, the temperature of the water is limited to a maximum of 210°F.

(b) A water heater is provided with a corrosion resistant lining or constructed with corrosion resistant materials.

(c) A water heater is intended to supply potable hot water with 100% makeup from a potable water supply system. Therefore, certain controls and indicating instruments, such as a water level indicator, low and high water cut-offs, and pressure and altitude gages, are not necessary on a water heater. Vessels built under the rules of Part HLW may be used for storage of potable water.

The following is a brief outline of the contents of each Article of Part HLW.

Article 1 — General

The scope of Part HLW is given, and definitions of the various water heaters are stated.

Article 2 — Materials

The material requirements for the linings permitted are specified as well as the lining thickness requirements. The material requirements specified for the lin-

ing materials were, in general, taken from existing standards by abstracting those requirements which were considered to be those essential for the applications covered by these rules. Minimum thicknesses for the backing materials for use with each of the water heater linings is specified.

Article 3 — Design

The design criteria for water heaters is given in Article 3. The pressure is specified as a maximum allowable working pressure of 160 psi with a minimum of 100 psi. The maximum water temperature permitted is 210°F.

The maximum allowable working pressure of the water heater shall be established in accordance with the proof test provision of HLW-500. As an alternative, stress values in Table HLW-300 may be used in calculations employing the available formulas when applicable to the geometry of the lined water heater or parts.

Article 4 — Weldments

The provisions for weldment joint design are similar to those given elsewhere in this Section and in Section VIII, Division 1. In addition, some acceptable joint designs are provided which have been commonly used in the construction of water heaters and have provided satisfactory service performance.

Article 5 — Tests

Proof test procedure is delineated for establishing the maximum allowable working pressure of a water heater or parts, and this test is required to be witnessed and accepted by the Authorized Inspector. The Manufacturers' Master Data Proof Test Report for Lined Water Heaters shall be certified by the designated responsible engineering head of the Manufacturer and the forms shall be kept on file by the Manufacturer as a matter of record.

Introduction**1989 SECTION IV****Introduction****Article 6 — Inspection and Stamping**

Inspection and stamping requirements for water heaters are given. An "HLW" Code Symbol Stamp is provided for water heaters made in accordance with Part HLW of Section IV.

Article 7 — Controls

Each water heater is required to have an operating control and a separate high-limit temperature-actuated control which shuts off the fuel supply in case of operating control failure. Water heaters should be equipped with suitable primary safety controls, safety limit switches, burners, or electric elements as appropriate and as required by a nationally recognized standard. Examples of these nationally recognized standards are listed.

Article 8 — Installation

Some acceptable piping installations are shown. Provisions for the installation of safety relief valves and other valves are given.

ARTICLE 1

GENERAL

HLW-100 SCOPE

(a) The rules in Part HLW are applicable to water heaters providing corrosion resistance for supplying potable hot water for commercial purposes at pressures not exceeding 160 psi and temperatures not in excess of 210°F. Part HLW is not intended to apply to hot water heating boilers.

(b) Linings for lined water heaters are limited to porcelain enameled (glass lined), galvanizing, cement, copper, fluorocarbon polymer linings, and amine or polyamine epoxy linings (see HLW-200).

(1) Glass-lined water heaters are defined as those with fired glass internal coatings which are hot water resistant.

(2) Galvanized water heaters are defined as those that are hot zinc dipped after the assembly has been welded.

(3) Cement lined water heaters are those that are lined with a low-soluble, hydraulic, cement-lining material.

(4) Copper-lined water heaters are defined as those that are completely lined with sheet copper.

(5) Fluorocarbon polymer-lined water heaters are defined as those that are lined with a thermosetting fluorocarbon polymer combined with other stabilizing ingredients and applied after all fabrication has been completed.

(6) Amine or polyamine epoxy-lined water heaters are defined as those that are lined with amine or polyamine epoxy of an analysis for use in potable hot water service.

(c) The materials used in the construction of unlined

corrosion resistant water heaters are limited to those listed in Table HLW-301.

(d) Tanks built under the rules of Part HLW may be used for storage of potable water. Article 7 need not apply.

(e) Water heaters and tanks built under the rules of Part HLW may be provided with cathodic protection.

(f) Water heaters used for deionized water fabricated of stainless steel listed in Table HLW-301 may be built to Part HLW provided:

(1) all welding meets the requirements of Section IX;

(2) the maximum thickness shall be $\frac{1}{2}$ in.

(g) Any water heater or storage tank that meets all of the requirements of Part HLW, including those for inspection, may be stamped with the Code HLW Symbol even though exempted from such stamping.

HLW-101 SERVICE RESTRICTION AND EXCEPTION

The rules of Part HLW are restricted to potable water heaters and water storage tanks for operation at pressures not exceeding 160 psi and water temperatures not in excess of 210°F, except that water heaters are exempted when none of the following limitations is exceeded:

(a) heat input of 200,000 Btu/hr;

(b) water temperature of 210°F;

(c) nominal water-containing capacity of 120 gal, except that they shall be equipped with safety devices in accordance with the requirements of HLW-800.

ARTICLE 2

MATERIAL REQUIREMENTS

HLW-200 LINING

(a) *Glass Lined.* Glass lining shall be of an analysis intended for use in hot water service and the minimum average thickness shall be 0.005 in. The walls, ends, and other parts that are of steel and are glass lined shall be of a quality that is suitable for glass lining by the manufacturer's glass lining process. Glass lining may be applied to parts before assembly. The surfaces of the water heater vessel that are exposed to hot water shall have a coating with a minimum number of discontinuities, and the discontinuities shall average not more than $\frac{1}{8}$ sq in./sq ft of internal surface excluding edges and fittings. Thinning at corners may not extend over $\frac{1}{4}$ in. from the edge.

(b) *Galvanized.* The galvanized coating shall be based upon at least 1 oz of zinc/sq ft of surface based upon mathematical calculations corresponding to a coating thickness of 0.0017 in. The weight of the zinc coating shall be determined by weighing the water heater before galvanizing and again after the coating is applied.

The zinc used for coating shall conform to ASTM B 6, Specification for Zinc (Slab Zinc) and shall be at least equal to the grade designated as "Prime Western." The aluminum content of the bath during actual galvanizing operations shall not exceed 0.01%. The galvanizer shall not damage the material by overpickling or by the use of excessively high temperature in pickling or galvanizing.

(c) *Cement Lined.* For cement lined water heaters, the cement shall be applied to provide a minimum thickness of $\frac{3}{16}$ in. The lining shall be properly cured, adhere firmly to, and completely cover the interior of the vessel. The joints at the top of the water heater shall be sealed to prevent corrosion in back of the lining. The water absorption of the lining material shall not be more than 17% of the dry weight of the test specimen. The calcium oxide content shall not exceed 35%. The silicon content shall not be less than 25%.

(d) *Copper-Lined.* The material used for lining may

be any copper of weldable or brazeable quality with a minimum thickness of 0.005 in. Lining attachments to steel backing by welding or brazing shall be in accordance with Section IX.

(e) *Fluorocarbon Polymer-Lined.* Fluorocarbon polymer linings shall be of an analysis intended for use in potable hot water service, and the minimum thickness shall be 0.003 in. The lining shall be cured at a temperature and for a length of time suitable to assure continuity of lining and elimination of solvents. The water absorption rate of the cured lining shall be less than 2% by the method specified in ASTM D 570 shown in Appendix I. Surfaces to be fluorocarbon polymer-lined must be cleaned to remove all scale, oxidation, oil, etc., prior to application of the lining. Interior surfaces may be coated with electroless nickel prior to lining. Flue tubes may be covered with a minimum thickness of 0.006 in. of sheet copper prior to the application of the fluorocarbon polymer lining.

(f) *Amine or Polyamine Epoxy-Lined*

(1) Amine or polyamine epoxy linings shall be of an analysis intended for use in potable hot water service, and the minimum thickness shall be 0.003 in. The lining shall be cured at a temperature and for a length of time suitable to assure continuity of lining and elimination of solvents. The water absorption rate of the cured lining shall be less than 2% by the method specified in ASTM D 570 shown in Appendix I. Surfaces to be epoxy lined must be cleaned to remove all scale, oxidation, oil, etc., prior to application of the lining.

(2) The use of amine or polyamine epoxy linings shall be limited to electric water heaters with immersion type elements, and storage tanks.

HLW-201 PRIMARY PRESSURE PARTS MATERIAL

(a) The materials used for shells, heads, flues, headers, or tubes shall be limited to those listed in Tables

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ARTICLE 7

CONTROLS

HLW-700 CONTROLS

HLW-701 TEMPERATURE CONTROL

HLW-701.1 Each individual automatically fired water heater, in addition to the operating control used for normal water heater operation shall have a separate high limit temperature actuated combustion control that will automatically cut off the fuel supply. The temperature range of the high limit temperature actuated control shall not allow a setting over 210°F.

(a) On gas-fired water heaters, the high limit temperature control when actuated shall shut off the fuel supply with a shutoff means other than the operating control valve. Separate valves may have a common body.

(b) On electrically heated water heaters, the high limit temperature control when actuated shall cut off all power to the operating controls.

(c) On oil-fired water heaters, the high limit temperature control when actuated shall cut off all current flow to the burner mechanism.

HLW-702 LIMIT CONTROLS

Limit controls used with electric circuits should break the hot or line sides of the control circuit.

HLW-703 CONTROLS AND HEAT GENERATING APPARATUS

(a) All water heaters should be equipped with suitable primary (flame safeguard) safety controls, safety

limit switches, and burners, or electric elements as required by a nationally recognized standard.¹

(b) The symbol of the certifying organization² which has investigated such equipment as having complied with a nationally recognized standard shall be affixed to the equipment and shall be considered as evidence that the controls and heat generating apparatus were manufactured in accordance with that standard.

HLW-704 ELECTRICAL WIRING

HLW-704.1 Electrical Code Compliance. All field wiring for controls, heat generating apparatus, and other appurtenances necessary for the operation of the water heater should be installed in accordance with the provisions of the National Electrical Code and/or should comply with the applicable local electrical codes. All water heaters supplied with factory mounted and wired controls, heat generating apparatus, and other appurtenances necessary for the operation of the water heaters should be installed in accordance with the provisions of the nationally recognized standards such as listed in footnote 1 of HLW-703.

¹Examples of these nationally recognized standards that are currently effective:

ANSI C95.3, Standard for Safety Oil-Fired Water Heaters (UL 732)

ANSI Z 21.10.3, American National Standards for Gas Water Heaters, Volume III, Circulating Tank, Instantaneous and Large Automatic Storage Type Water Heaters.

Underwriters' Laboratories Inc. UL 795, Standards for Safety, Commercial-Industrial Gas-Heating Equipment

Underwriters' Laboratories Inc. UL 1453, Standard for Safety, Electric Booster and Commercial Storage Tank Water Heaters

²A certifying organization is one that provides uniform testing, examination, and listing procedures under established, nationally recognized standards and that is acceptable to the authorities having jurisdiction.

ARTICLE 8

INSTALLATION REQUIREMENTS

HLW-800 SAFETY RELIEF VALVES

HLW-800.1 Safety Relief Valve Requirements for Water Heaters

(a) Each water heater shall have at least one officially rated safety relief valve or at least one officially rated pressure temperature relief valve. The valve(s) shall be marked with the ASME Code Symbol V or HV to evidence compliance with the construction and rating requirements of the ASME Boiler and Pressure Vessel Code. No safety relief valve shall be smaller than $\frac{3}{4}$ in. standard pipe size.

(b) The pressure setting shall be less than or equal to the maximum allowable working pressure of the water heater. However, if any of the other components in the hot water supply system (such as valves, pumps, expansion or storage tanks, or piping) have a lesser working pressure rating than the water heater, the pressure setting for the relief valve(s) shall be based upon the component with the lowest maximum allowable working pressure rating. If more than one safety relief valve is used, the additional valve(s) may be set within a range not to exceed 10% over the set pressure of the first valve.

(c) The required relieving capacity in Btu/hr of the safety relief valve shall not be less than the maximum allowable input unless the water heater is marked with the rated burner input capacity of the water heater on the casing in a readily visible location, in which case the rated burner input capacity may be used as a basis for sizing the safety relief valves. The relieving capacity for electric water heaters shall be 3500 Btu/hr per kW of input. In every case, the following requirements shall be met. Safety relief valve capacity for each water heater shall be such that with the fuel burning equipment installed and operated at maximum capacity the pressure cannot rise more than 10% of maximum allowable working pressures.

(d) If operating conditions are changed or additional heater heating surface is installed, the safety relief valve capacity shall be increased, if necessary, to meet the

new conditions and shall be in accordance with the above provisions. In no case shall the increased capacity exceed the maximum allowable input capacity. The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

HLW-801 MOUNTING SAFETY RELIEF VALVES

HLW-801.1 Installation. Safety relief valves shall be installed by either the installer or the manufacturer before a water heater is placed in operation.

HLW-801.2 Permissible Mountings. Safety relief valves shall be connected to the top of water heaters or directly to a tapped or flanged opening in the water heater, to a fitting connected to the water heater by a short nipple, to a Y-base, or to a valveless water heater connecting water outlets on the same heater. Safety relief valves shall be installed with their spindles upright and vertical with no horizontal connecting pipe, except that, when the safety relief valve is mounted directly on the water heater vessel with no more than 4 in. maximum interconnecting piping, the valve may be installed in the horizontal position with the outlet pointed down. The center line of the safety relief valve connection shall be no lower than 4 in. from the top of the shell.

HLW-801.3 Requirements for Common Connection for Two or More Valves

(a) When a water heater is fitted with two or more safety relief valves on one connection, this connection shall have a cross-sectional area not less than the combined areas of inlet connections of all the safety relief valves with which it connects.

(b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas. When the size of the water heater requires a safety relief valve larger than $4\frac{1}{2}$ in. diameter, two or more valves having the

required combined capacity shall be used. When two or more valves are used on a water heater, they may be single, directly attached, or mounted on a Y-base.

HLW-801.4 Threaded Connections. A threaded connection may be used for attaching a valve.

HLW-801.5 Prohibited Mountings. Safety relief valves shall not be connected to an internal pipe in the water heater or a cold water feed line connected to the water heater.

HLW-801.6 Use of Shutoff Valves Prohibited. No shutoff of any description shall be placed between the safety relief valve and the water heater, or on discharge pipes between such valves and the atmosphere.

HLW-801.7 Safety Relief Valve Discharge Piping

(a) When a discharge pipe is used, its internal cross-sectional area shall be not less than the full area of the valve outlet or of the total of the valve outlets discharging thereinto, and shall be as short and straight as possible and so arranged as to avoid undue stress on the valve or valves. When an elbow is placed on a safety relief discharge pipe, it shall be located close to the valve outlet.

(b) The discharge from safety relief valves shall be so arranged that there will be no danger of scalding attendants. When the safety relief valve discharge is piped away from the water heater to the point of discharge, there shall be provisions for properly draining the piping and valve body. The size and arrangement of discharge piping shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the relieving devices below that required to protect the water heater.

HLW-805 WATER SUPPLY

HLW-805.1 Connections. Water supply shall be introduced into a water heater through an independent water supply connection. Feedwater shall not be introduced through openings or connections provided for cleaning, safety relief valves, drain, pressure gage, or temperature gage.

HLW-805.2 Pressure. If the water supply pressure to a water heater exceeds 75% of the set pressure of the safety relief valve, a pressure reducing valve is required.

HLW-805.3 Stop Valves. Stop valves should be placed in the supply and discharge pipe connections of a water heater installation to permit draining the water heater without emptying the system.

**TABLE HLW-809.1
EXPANSION TANK CAPACITIES
FOR A WATER HEATER¹**

System Volume, gal	Tank Capacities, gal	
	Prepressurized Diaphragm Type	Nonprepressurized Type
50	1	3
100	2	6
200	3	12
300	4	18
400	5	24
500	6	30
1000	12	60
2000	24	120

NOTE:

(1) Capacities in this Table are given as a guide to reduce or eliminate relief valve weeping under conditions of partial water system demands or occasional water draw during recovery.

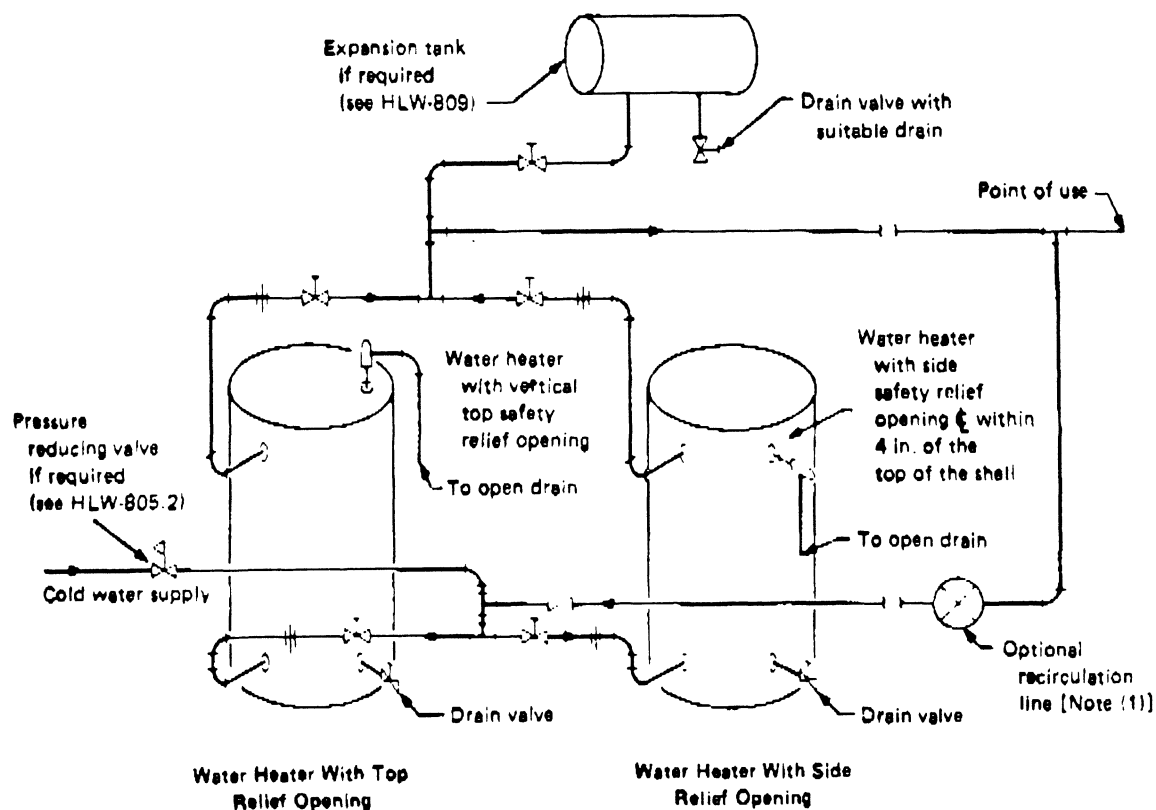
System volume includes water heater capacity plus all piping capacity for a recirculation system or water heater capacity only for a nonrecirculation system.

The capacities are based upon a water temperature rise from 40°F to 180°F, 60 psi fill pressure, maximum operating pressure of 125 psi, 20% water recovery, and an acceptance factor of 0.465 for prepressurized types and 0.09156 for nonprepressurized types. A procedure for estimating system volume and for determining expansion tank sizes for other design conditions may be found in Chapter 13 of the 1987 Systems and Applications Volume of the ASHRAE Handbook.

HLW-809 PROVISIONS FOR THERMAL EXPANSION IN HOT WATER SYSTEMS

HLW-809.1 Expansion Tank. If a system is equipped with a check valve or pressure reducing valve in the cold water inlet line, consideration should be given to the installation of an airtight expansion tank or other suitable air cushion. Otherwise, due to the thermal expansion of the water, the safety relief valve may lift periodically. If an expansion tank is provided, it shall be constructed in accordance with Section VIII, Division 1. See Fig. HLW-809.1 for a typical acceptable installation. Except for prepressurized diaphragm type tanks, which should be installed on the cold water side, provisions shall be made for draining the tank without emptying the system.

HLW-809.2 Piping. Provisions shall be made for the expansion and contraction of hot water mains connected to water heaters by providing substantial anchorage at suitable points and by providing swing joints when water heaters are installed in batteries, so that there will be no undue strain transmitted to the water

**GENERAL NOTE.**

Thermometer requirements are in HLW-820.

NOTE:

(1) Recirculation system may be gravity or pump actuated.

**FIG. HLW-809.1 A TYPICAL ACCEPTABLE PIPING INSTALLATION FOR STORAGE
WATER HEATERS IN BATTERY**

APPENDIX E

DEFINITIONS

E-100 TERMS RELATING TO DESIGN

Action, Popping, or Pop — The action of a safety or safety relief valve when it opens under steam pressure. The disk of the valve is designed so that the force of the steam lifting the disk is increased when the disk is lifted slightly off its seat. The increase in force accelerates the rising action of the disk to the wide open position at or near the opening pressure.

Blowdown — The difference between the opening and closing pressures of a safety or relief valve.

Boiler, Automatically Fired — A boiler equipped with a means of introducing heat or of causing fuel, whether solid, liquid, gaseous, or electric, to be introduced into the boiler or boiler furnace, the means being so regulated by the rate of flow, the generating pressure, or temperature of the boiler fluid or of a vessel or space being heated as to maintain a determined, desired condition within a designated tolerance.

Boiler, Horizontal-Return Tubular — A firetube boiler consisting of a cylindrical shell, with tubes inside the shell attached to both end closures. The products of combustion pass under the bottom half of the shell and return through the tubes.

Bottom Blowoff Valve — A valve or cock located in the bottom blowoff connection of a boiler which, when opened, permits free passage of scale and sediment during the blowoff operation.

Column, Fluid Relief — That piping, connected to the top of a hot water heating boiler, which is provided for the thermal expansion of the water. It will connect to either an open or a closed expansion tank.

Drain Valve — A valve or cock located in a boiler connection which, when opened, will drain the lowest water space practicable.

Electric Boiler, Submerged Electrode Type — A submerged electrode type electric boiler incorporates a design wherein two or more metallic electrodes are directly suspended in the boiler water. When a source of electric power is connected to the electrodes, current will flow between the electrodes and through the water,

thus raising the temperature of the water to produce steam.

Electric Boiler, Resistance Heating Element Type — Electric boilers of the resistance heating element type are either:

(a) of a design where the electric resistance element is directly attached to the external surface of the pressure vessel; or

(b) an immersed type where the electric resistance element is inserted through an opening in the pressure vessel so that the element is in direct contact with the water.

Feedwater — Water introduced into a boiler during operation. Includes makeup and return condensate or return water.

Flue — A hollow cylinder exceeding 5 in. in O.D. and used for the conveyance of gases with a temperature 850°F or less.

Furnace — A hollow cylinder exceeding 5 in. O.D. in which combustion takes place or used for the conveyance of gases having a temperature exceeding 850°F or less.

Gases, Primary Furnace — Gases in a zone where the anticipated temperature of the gas exceeds 850°F.

Hot Water Heating Boiler — A boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at a pressure not exceeding 160 psig or a temperature of 250°F at or near the boiler outlet.

Hot Water Supply Boiler — A boiler completely filled with water that furnishes hot water to be used externally to itself at pressures not exceeding 160 psig or at temperatures not exceeding 250°F at or near the boiler outlet.

Joints, Swing — Threaded, flanged, welded, or brazed pipe and fittings so arranged that the piping system which they comprise, when connected to a boiler, can expand and contract without imposing excessive force on it.

Lined Potable Water Heater — A water heater with a corrosion resistant lining, used to supply potable hot water.

Makeup Water — Water introduced into the boiler to replace that lost or removed from the system.

Pressure, Accumulation Test — That steam pressure at which the capacity of a safety, safety relief, or a relief valve is determined. It is $33\frac{1}{3}\%$ over the steam safety valve set pressure and 10% over the safety relief valve set pressure.

Pressure, Design — The pressure used in the design of a boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the different parts of the boiler.

Pressure, Maximum Allowable Working — The maximum gage pressure permissible in a completed boiler. The MAWP of the completed boiler shall be less than or equal to the lowest design pressure determined for any of its parts. This pressure is based upon either proof tests or calculations for every pressure part of the boiler using nominal thickness exclusive of allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure relieving devices protecting the boiler.

Pressure, Operating — The pressure of a boiler at which it normally operates. It shall not exceed the maximum allowable working pressure and it is usually kept at a suitable level below the setting of the pressure relieving devices to prevent their frequent opening.

Rated, Officially — A safety, safety relief, or relief valve for use on a heating boiler which has been capacity rated in accordance with HG-402.

Stress, Maximum Allowable — The maximum unit stress permitted in a given material used under these rules.

Siphon — A bent pipe or tube, between a steam pressure gage and the steam connection on a boiler, so fabricated that it contains a water seal which prevents steam entering the Bourdon tube of the gage.

Surface, Heating, Square Feet of — That area of the boiler surface exposed to the products of combustion. In computing the heating surface for the purpose of determining the safety or relief valve requirements, only the tubes, fireboxes, shells, tubesheets, and the projected area of the headers need be considered, except that for vertical firetube boilers only that portion of the tube surface up to the middle point of the gage glass is to be computed.

Thickness, Required — The minimum thickness determined by the formulas in this Code.

Tube, Fire — A hollow cylinder 5 in. or less in outside diameter and used for the conveyance of gases, flame, or hot air.

Tube, Water — A hollow cylinder used for the conveyance of liquids.

Unlined Water Heater — A water heater made from materials that are resistant to the corrosion action of potable hot water.

Valve, Pressure-Temperature Relief — An automatic relieving device actuated by the static pressure upstream of the valve (which opens further with increase in the pressure over the opening pressure) or by the temperature of the fluid. It is used primarily for liquid service.

Valve, Safety — An automatic pressure relieving device actuated by the static pressure upstream of the valve and characterized by full-opening pop action. It is used for gas or vapor service.

Valve, Safety, Lift of — The movement of the disk off the seat of a safety, safety relief, or relief valve when the valve is opened. It normally refers to the amount of movement of the disk off the seat when the valve is discharging at rated pressure.

Valve, Safety Relief — An automatic pressure relieving device actuated by the pressure upstream of the valve and characterized by opening pop action with further increase in lift with an increase in pressure over popping pressure.

Water Heater — A closed vessel in which water is heated by the combustion of fuels, electricity, or any other source and withdrawn for use external to the system at pressures not exceeding 160 psig and shall include the apparatus by which heat is generated and all controls and devices necessary to prevent water temperatures from exceeding 210°F.

Wet-Bottom Boiler — Any type of boiler which has a stayed or self-supporting, partially or fully water-cooled, shell or furnace bottom.

E-101 TERMS RELATING TO WELDING

Arc Stud Welding — An arc welding process wherein coalescence is produced by heating with an arc drawn between a metal stud, or similar part, until the surfaces to be joined are properly heated, when they are brought together under pressure. Partial shielding may be obtained by the use of a ceramic ferrule surrounding the stud. Shielding gas or flux may or may not be used.

Arc Welding — A group of welding processes wherein coalescence is produced by heating with an electric arc or arcs, with or without the application of pressure and with or without the use of filler metal.

Atomic Hydrogen Welding — An arc welding process wherein coalescence is produced by heating with an electric arc maintained between two metal electrodes in an atmosphere of hydrogen. Shielding is ob-

APPENDIX E

TERMINOLOGY

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E-100 TERMS RELATING TO DESIGN

Action, Popping, or Pop — The action of a safety or safety relief valve when it opens under steam pressure. The disk of the valve is designed so that the force of the steam lifting the disk is increased when the disk is lifted slightly off its seat. The increase in force accelerates the rising action of the disk to the wide open position at or near the opening pressure.

Blowdown — The difference between the opening and closing pressures of a safety or relief valve.

Boiler, Automatically Fired — A boiler equipped with a means of introducing heat or of causing fuel, whether solid, liquid, gaseous, or electric, to be introduced into the boiler or boiler furnace, the means being so regulated by the rate of flow, the generating pressure, or temperature of the boiler fluid or of a vessel or space being heated as to maintain a determined, desired condition within a designated tolerance.

A89 *Boiler, Electric, Resistance Heating Element Type* — Electric boilers of the resistance heating element type are either:

(a) of a design where the electric resistance element is directly attached to the external surface of the pressure vessel; or

(b) an immersed type where the electric resistance element is inserted through an opening in the pressure vessel so that the element is in direct contact with the water.

Boiler, Horizontal-Return Tubular — A firetube boiler consisting of a cylindrical shell, with tubes inside the shell attached to both end closures. The products of combustion pass under the bottom half of the shell and return through the tubes.

A89 *Boiler, Hot Water Heating* — A boiler designed to heat water for circulation through an external space heating system.

A89 *Boiler, Hot Water Supply* — A boiler used to heat water for purposes other than space heating.

Boiler, Steam Heating — A boiler designed to convert water into steam which is supplied to an external space heating system.

Bottom Blowoff Valve — A valve or cock located in the bottom blowoff connection of a boiler which, when opened, permits free passage of scale and sediment during the blowoff operation.

Column, Fluid Relief — That piping, connected to the top of a hot water heating boiler, which is provided for the thermal expansion of the water. It will connect to either an open or a closed expansion tank.

Drain Valve — A valve or cock located in a boiler connection which, when opened, will drain the lowest water space practicable.

Electric Boiler, Submerged Electrode Type — A submerged electrode type electric boiler incorporates a design wherein two or more metallic electrodes are directly suspended in the boiler water. When a source of electric power is connected to the electrodes, current will flow between the electrodes and through the water, thus raising the temperature of the water to produce steam.

Feedwater — Water introduced into a boiler during operation. Includes makeup and return condensate or return water.

Flue — Passage through which gases pass from the combustion chamber or furnace to the venting system.

Furnace — That part of a boiler in which combustion of fuel takes place or in which primary furnace gases are conveyed.

Gases, Primary Furnace — Gases in a zone where the anticipated temperature of the gas exceeds 850°F.

Joints, Swing — Threaded, flanged, welded, or brazed pipe and fittings so arranged that the piping system which they comprise, when connected to a boiler, can expand and contract without imposing excessive force on it.

Makeup Water — Water introduced into the boiler to replace that lost or removed from the system.

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Pressure, Accumulation Test — That steam pressure at which the capacity of a safety, safety relief, or a relief valve is determined. It is 33⅓% over the steam safety valve set pressure and 10% over the safety relief valve set pressure.

Pressure, Design — The pressure used in the design of a boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the different parts of the boiler.

Pressure, Maximum Allowable Working — The maximum gage pressure permissible in a completed boiler. The MAWP of the completed boiler shall be less than or equal to the lowest design pressure determined for any of its parts. This pressure is based upon either proof tests or calculations for every pressure part of the boiler using nominal thickness exclusive of allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure relieving devices protecting the boiler.

Pressure, Operating — The pressure of a boiler at which it normally operates. It shall not exceed the maximum allowable working pressure and it is usually kept at a suitable level below the setting of the pressure relieving devices to prevent their frequent opening.

Rated, Officially — A safety, safety relief, or relief valve for use on a heating boiler which has been capacity rated in accordance with HG-402.

Stress, Maximum Allowable — The maximum unit stress permitted in a given material used under these rules.

Siphon — A bent pipe or tube, between a steam pressure gage and the steam connection on a boiler, so fabricated that it contains a water seal which prevents steam entering the Bourdon tube of the gage.

Surface, Heating, Square Feet of — That area of the boiler surface exposed to the products of combustion. In computing the heating surface for the purpose of determining the safety or relief valve requirements, only the tubes, fireboxes, shells, tubesheets, and the projected area of the headers need be considered, except that for vertical firetube boilers only that portion of the tube surface up to the middle point of the gage glass is to be computed.

Thickness, Required — The minimum thickness determined by the formulas in this Code.

A89 Tube, Fire — A hollow cylinder used for the conveyance of gases, flame, or hot air.

Tube, Water — A hollow cylinder used for the conveyance of liquids.

A89 Valve, Pressure-Temperature Relief — An automatic relieving device actuated by the static pressure upstream of the valve (which opens further with in-

crease in the pressure over the opening pressure) or by the temperature of the fluid. It is used primarily for liquid service.

Valve, Safety — An automatic pressure relieving device actuated by the static pressure upstream of the valve and characterized by full-opening pop action. It is used for gas or vapor service.

Valve, Safety, Lift of — The movement of the disk off the seat of a safety, safety relief, or relief valve when the valve is opened. It normally refers to the amount of movement of the disk off the seat when the valve is discharging at rated pressure.

Valve, Safety Relief — An automatic pressure relieving device actuated by the pressure upstream of the valve and characterized by opening pop action with further increase in lift with an increase in pressure over popping pressure.

Water Heater — A vessel in which water is heated by the combustion of fuel, or by electricity and withdrawn for external use. **A89**

Water Heater, Lined — A water heater with a corrosion resistant lining designed to heat potable water. **A89**

Water Heater, Unlined — A water heater made from corrosion resistant materials designed to heat potable water. **A89**

Wet-Bottom Boiler — Any type of boiler which has a stayed or self-supporting, partially or fully water-cooled, shell or furnace bottom.

E-101

TERMS RELATING TO WELDING

Arc Stud Welding — An arc welding process wherein coalescence is produced by heating with an arc drawn between a metal stud, or similar part, until the surfaces to be joined are properly heated, when they are brought together under pressure. Partial shielding may be obtained by the use of a ceramic ferrule surrounding the stud. Shielding gas or flux may or may not be used.

Arc Welding — A group of welding processes wherein coalescence is produced by heating with an electric arc or arcs, with or without the application of pressure and with or without the use of filler metal.

Atomic Hydrogen Welding — An arc welding process wherein coalescence is produced by heating with an electric arc maintained between two metal electrodes in an atmosphere of hydrogen. Shielding is ob-

tained from the hydrogen. Pressure may or may not be used and filler metal may or may not be used.

Automatic Welding — Welding with equipment which performs the entire welding operation without constant observation and adjustment of the controls by an operator. The equipment may or may not perform the loading and unloading of the work.

Backing — Material (metal, weld metal, asbestos, carbon, granular flux, etc.) backing up the joint during welding to facilitate obtaining a sound weld at the root.

Base Metal — The metal to be welded or cut.

Brazing — A group of metal-joining processes wherein coalescence is produced by heating to suitable temperatures above 800°F and by using a nonferrous filler metal, having a melting point below that of the base metals. The filler metal is distributed between the closely fitted surfaces of the joint by capillary attraction.

Butt Joint — A joint between two members lying approximately in the same plane.

Corner Joint — A joint between two members located approximately at right angles to each other in the form of an L.

Double-Welded Butt Joint — A butt joint welded from both sides.

Double-Welded Lap Joint — A lap joint in which the overlapped edges of the members to be joined are welded along the edges of both members.

Edge Joint — A joint between the edges of two or more parallel or nearly parallel members.

Filler Metal — Metal to be added in making a weld.

Fillet Weld — A weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, tee joint, or corner joint.

Flux Cored Arc Welding (FCAW) — A gas metal arc welding process which produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work. Shielding is provided by a flux contained within the tubular electrode. Additional shielding may or may not be obtained from an externally supplied gas or gas mixture.

Flux Cored Arc Welding-Electrode (FCAW-EG) — A variation of the flux cored arc welding process in which molding shoes are used to confine the molten weld metal for vertical position welding. Additional shielding may or may not be obtained from an externally supplied gas or gas mixture.

Flux Cored Electrode — A composite filler metal electrode consisting of a metal tube or other hollow configuration containing ingredients to provide such functions as shielding atmosphere, deoxidation, arc stabilization, and slag formation. Alloying materials may

be included in the core. External shielding may or may not be used.

Full Fillet Weld — A fillet weld whose size is equal to the thickness of the thinner member joined.

Gas Metal Arc Welding-Electrode (GMAW-EG) — A variation of the gas metal arc welding process using molding shoes to confine the molten weld metal for vertical position welding.

Gas Tungsten-Arc Welding — An arc welding process wherein coalescence is produced by heating with an electric arc between a single tungsten (nonconsumable) electrode and the work. Shielding is obtained from a gas or gas mixture (which may contain an inert gas). Pressure may or may not be used. Filler metal may or may not be used. (This process has sometimes been called TIG Welding.)

Gas Welding — A group of welding processes wherein coalescence is produced by heating with a gas flame or flames with or without the application of pressure, and with or without the use of filler metal.

Joint Efficiency — The efficiency of a welded joint is expressed as a numerical (decimal) quantity and is used in the design of a joint as a multiplier of the appropriate allowable stress taken from Tables HF-300.1 and HF-300.2.

Joint Penetration — The minimum depth a groove weld extends from its face into a joint, exclusive of reinforcement.

Lap Joint — A joint between two overlapping members.

Machine Welding — Welding with equipment which performs the welding operation under the observation and control of an operator. The equipment may or may not perform the loading and unloading of the work.

Manual Welding — Welding wherein the entire welding operation is performed and controlled by hand.

Oxyacetylene Welding — A gas welding process wherein coalescence is produced by heating with a gas flame or flames obtained from the combustion of acetylene with oxygen, with or without the application of pressure and with or without the use of filler metal.

Oxygen Cutting — A group of cutting processes wherein the severing of metals is effected by means of the chemical reaction of oxygen with the base metal at elevated temperatures. In the case of oxidation resistant metals, the reaction is facilitated by use of a flux or metal powder.

Oxyhydrogen Welding — A gas welding process wherein coalescence is produced by heating with a gas flame or flames obtained from the combustion of hydrogen with oxygen, without the application of pressure and with or without the use of filler metal.

Plasma Arc Welding — A gas tungsten arc welding process wherein coalescence is produced by heating with a constricted arc between an electrode and work-piece (transferred arc) or the electrode and the constricting nozzle (nontransferred arc). Shielding is obtained from hot ionized gas issuing from the orifice which may be supplemented by an auxiliary source of shielding gas. Shielding gas may be an inert gas or a mixture of gases, pressure may or may not be used, and filler metal may or may not be used.

Pressure Gas Welding — A gas welding process wherein coalescence is produced simultaneously over the entire area of abutting surfaces, by heating with a gas flame or flames obtained from combustion of hydrogen with oxygen, without the application of pressure, and with or without the use of filler metal.

Pressure Welding — Any welding process or method wherein pressure is used to complete the weld.

Reinforcement of Weld — Weld metal on the face of a groove weld in excess of the metal necessary for the specified weld size.

Resistance Stud Welding — A resistance welding process wherein coalescence is produced by the heat obtained from resistance to electric current at the interface between the stud and the work piece, until the surfaces to be joined are properly heated, when they are brought together under pressure.

Resistance Welding — A group of welding processes wherein coalescence is produced by the heat obtained from resistance of the work to the flow of electric current in a circuit of which the work is a part, and by the application of pressure.

Seal Weld — Any weld used primarily to obtain tightness.

Semiautomatic Arc Welding — Arc welding with equipment which controls only the filler metal feed. The advance of the welding is manually controlled.

Shielded Metal-Arc Welding — An arc welding process wherein coalescence is produced by heating with an electric arc between a covered metal electrode and the work. Shielding is obtained from decomposition of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.

Single-Welded Butt Joints — A butt joint welded from one side only.

Single-Welded Lap Joint — A lap joint in which the overlapped edges of the members to be joined are welded along the edge of one member.

Size of Weld

(a) **Groove Weld** — The joint penetration (depth of chamfering plus the root penetration when specified).

(b) **Fillet Weld**

(1) **For Equal-Leg Fillet Welds**. The leg length of the largest isosceles right triangle which can be inscribed within the fillet weld cross section.

(2) **For Unequal-Leg Fillet Welds**. The leg lengths of the largest right triangle which can be inscribed within the fillet weld cross section.

Submerged Arc Welding — An arc welding process wherein coalescence is produced by heating with an electric arc or arcs between a bare metal electrode or electrodes and the work. The welding is shielded by a blanket of granular, fusible material on the work. Pressure is not used and filler metal is obtained from the electrode and sometimes from a supplementary welding rod.

Tee Joint — A joint between two members located approximately at right angles to each other in the form of a T.

Thermit Welding — A group of welding processes wherein coalescence is produced by heating with superheated liquid metal and slag resulting from a chemical reaction between a metal oxide and aluminum, with or without the application of pressure. Filler metal, when used, is obtained from the liquid metal.

Throat of a Fillet Weld

(a) **Theoretical**. The distance from the beginning of the root of the joint perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the fillet weld cross section.

(b) **Actual**. The shortest distance from the root of a fillet weld to its face.

Undercut — A groove melted into the base metal adjacent to the toe of a weld and left unfilled by weld metal.

Weld — A localized coalescence of metal wherein coalescence is produced by heating to suitable temperatures, with or without the application of pressure and with or without the use of filler metal. The filler metal has a melting point approximately the same as the base metals.

Weld Metal — That portion of a weld which has been melted during welding.

Welded Joint — A union of two or more members produced by the application of a welding process.

Welder — One who is capable of performing a manual or semiautomatic welding operation.

Welding Operator — One who operates machine or automatic welding equipment.

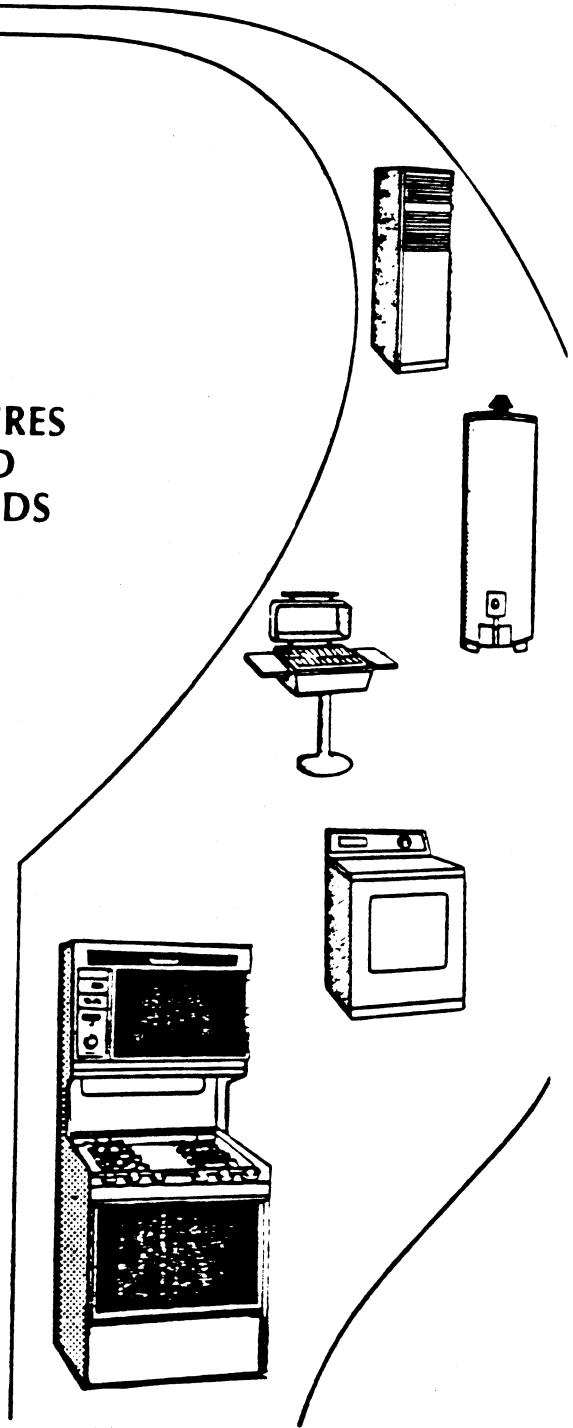
Tab E

Z21 ACCREDITED STANDARDS COMMITTEE

GENERAL PROCEDURES FOR CREATING AND REVISING STANDARDS

American Gas
Association

SECRETARIAT



FOREWORD

This booklet fills a long-felt need of the many volunteers who actively participate in the standards development program of Accredited Standards Committee Z21. It will be useful to anyone interested in knowing how the Z21 Committee devises new standards and updates existing standards concerned with the performance and installation of gas burning appliances and related accessories.

The booklet describes the manner in which these standards are developed in conformance with established principles of due process and consensus, as promulgated by the American National Standards Institute. It also contains, in an appendix, a list of the Z21 gas appliance and accessory standards for which the Committee is responsible.

Originally commissioned by the Chairman's Advisory Committee, the booklet is basically the work product of Robert W. Newell (retired) while a member of the Advisory Committee. The staff of the Committee's Secretariat was responsible for converting the original manuscript into the booklet's published form.

If information regarding the contents of the booklet or additional copies are desired, Forrest G. Hammaker, the Committee's Administrative Secretary, may be contacted by telephone (216/524-4990) or at the address below.

Howard I. Forman
Chairman,
Z21 Accredited Standards Committee

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Those desiring permission to republish material herein should consult the Z21 Committee's Administrative Secretary at the American Gas Association Laboratories, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131.

**ACCREDITED STANDARDS COMMITTEE Z21
ON PERFORMANCE AND INSTALLATION OF
GAS BURNING APPLIANCES AND RELATED ACCESSORIES**

**GENERAL PROCEDURE FOR CREATING NEW STANDARDS
AND MAKING CHANGES TO EXISTING STANDARDS**

ACCREDITED STANDARDS COMMITTEE Z21

GENERAL PROCEDURE FOR CREATING NEW STANDARDS AND MAKING CHANGES TO EXISTING STANDARDS

The gas industry is served by an organization which has the responsibility to create and maintain standards for testing and evaluating gas-fired appliances, controls and accessories. The organization is titled **ACCREDITED STANDARDS COMMITTEE Z21** on Performance and Installation of Gas Burning Appliances and Related Accessories, and is commonly known as the Z21 Committee.

The Z21 Committee has been accredited to function as a standards making body by the American National Standards Institute (ANSI).^{*} The Committee is comprised of approximately forty members, including the Chairman and the Administrative Secretary. Broad and diverse interest levels are represented on the Committee. These levels include U.S. and Canadian gas utilities and suppliers, gas appliance and accessory manufacturers, electrical associations, insurance underwriter companies, independent testing agencies, government agencies, and independent interest groups.

The primary function of the Z21 Committee is to develop and maintain standards for testing and evaluating gas appliances and their accessories, with major emphasis placed on the safety of their operation and construction. Appendix "A" is a list of 48 current Z21 standards which have been reviewed and approved by ANSI as constituting American National Standards.

In developing the Z21 standards, advantage is taken of the expertise and know-how within the gas industry, government agencies and others. Presently, nineteen working subcommittees of the Z21 Committee have been appointed for the purpose of drafting, supervising and maintaining the currency and accuracy of the standards. Their recommendations for action on standards are sent to the parent Z21 Committee for review, acceptance and approval. The subcommittees are essentially comprised of skilled gas utility personnel, skilled appliance and accessory manufacturer representatives (usually design engineers) and independent interested personnel.

The Flow Chart on pages 4 and 5 shows the Z21 due process and consensus procedures for standards development. It depicts the steps leading to the development of new standards and the process of making needed changes in existing standards.

The task of each of the subcommittees takes the form of creating needed standards or changing existing standards for upgrading and updating purposes.

^{*} ANSI is a private non-profit organization which approves standards as American National Standards and serves as a coordinator of voluntary standards activities in the United States.

The contents of the standards are reviewed in formal scheduled meetings by each of the subcommittees. After thorough discussions of the involved items, the results of the subcommittee's efforts are sent out to the pertinent portions of the gas industry and other interested parties for review and comment. After an appropriate amount of time given to the review period, the subcommittee again meets for verification or making desired changes resulting from the review. Upon acceptance by the subcommittee, based on a 4/5 affirmative vote of the members voting, the subcommittee's recommendations accompanied with appropriate statements explaining the rationale underlying such action are forwarded to the Z21 Committee for review and approval.

The Z21 Committee formally meets regularly each year, hears discussion pro and con for the subcommittees' recommendations and votes on acceptance of the proposed standard or changes. If not accepted by the Z21 Committee, the recommended changes are usually returned with instructions to the specific subcommittee for additional evaluation and possible changes for improvement.

If the recommendations are accepted and approved by the Z21 Committee, the standard or changes to the standard are forwarded to the American National Standards Institute (ANSI) for a 60-day period of public review, which is announced in the "Standards Action" section of the ANSI Reporter, a bi-weekly publication. Following public review, the standard or changes in the standard, are submitted to the ANSI Board of Standards Review (BSR) for consideration of approval. The BSR will review the vote of the Z21 Committee on the standard, as well as comments (and responses) resulting from the ANSI public review. Should the BSR conclude there is not a consensus favoring the standard, it will be returned to the Z21 Committee (and supervising subcommittee) to attempt resolution of the objections.

When the BSR approves the standard, an announcement of approval is published in "Standards Action." The Secretariat then publishes and distributes the standard as a full edition or an addenda, as appropriate, for use by the gas appliance industry and other interested parties. The American Gas Association Laboratories establishes an effective date for their application of the standard, or standard changes, to their certification program.

The Z21 Committee is chaired by an individual whose administrative ability is widely recognized and who is not affiliated with any of the organizations that comprise the membership of the Committee or provide members for its subcommittees, or any other support for the Z21 Committee. The administrative services required by the Z21 Committee and its subcommittees are provided by the Administrative Secretariat, the American Gas Association. Record keeping and secretarial tasks are performed by the Secretariat staff located at the American Gas Association Laboratories in

Cleveland, Ohio. More importantly, the Secretariat staff provides knowledge, continuity of past experience, foundation and background for effective standard making activities.

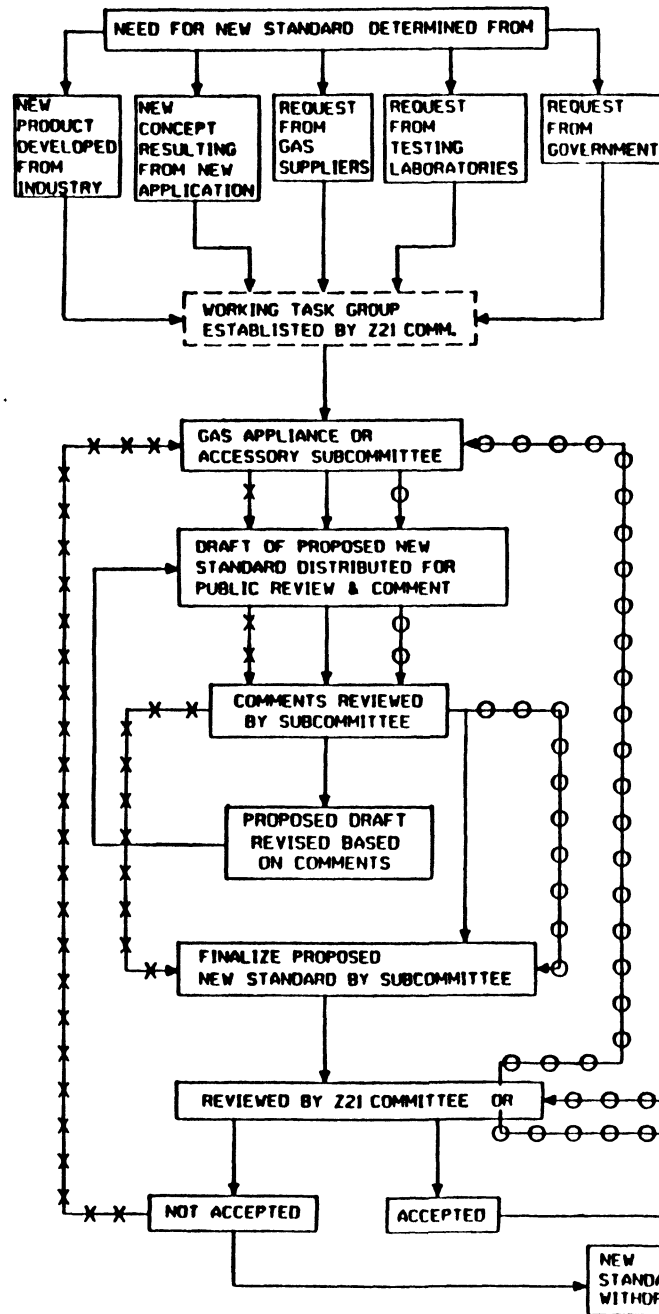
Another adjunct to the Z21 Committee function is performed by the Z21 Committee Chairman's Advisory Committee. The Advisory Committee, in addition to the Z21 Committee Chairman and Vice Chairman, is comprised of selected Z21 Committee members. The Advisory Committee is an administrative assistant to the Chairman in evaluating controversial items concerning matters other than standards proposals. It helps to formulate or revise policies as required, carry out the Z21 Committee's other activities and expected actions, and provides general support for effective reviews and actions performed by the Z21 Committee. Guidance and monitoring Z21 Committee functions is performed by the Advisory Committee members for the Chairman. Such matters as working out details for award presentations to deserving Z21 Committee and subcommittee members, and making unannounced visits to various subcommittee meetings to provide assistance on behalf of the Chairman, are examples of such administrative functions.

The published ANSI Z21 gas appliance and accessories standards are recognized with widespread acceptance and use throughout the United States. Evidence of compliance by certification of the designs is indicated on labels and in directories under the supervision of various independent testing and evaluation agencies.* Such evidence of certification is used by those bodies responsible for administering local codes governing the use of gas appliances and related accessories, as well as other organizations concerned with gas equipment designs complying with the ANSI national standards.

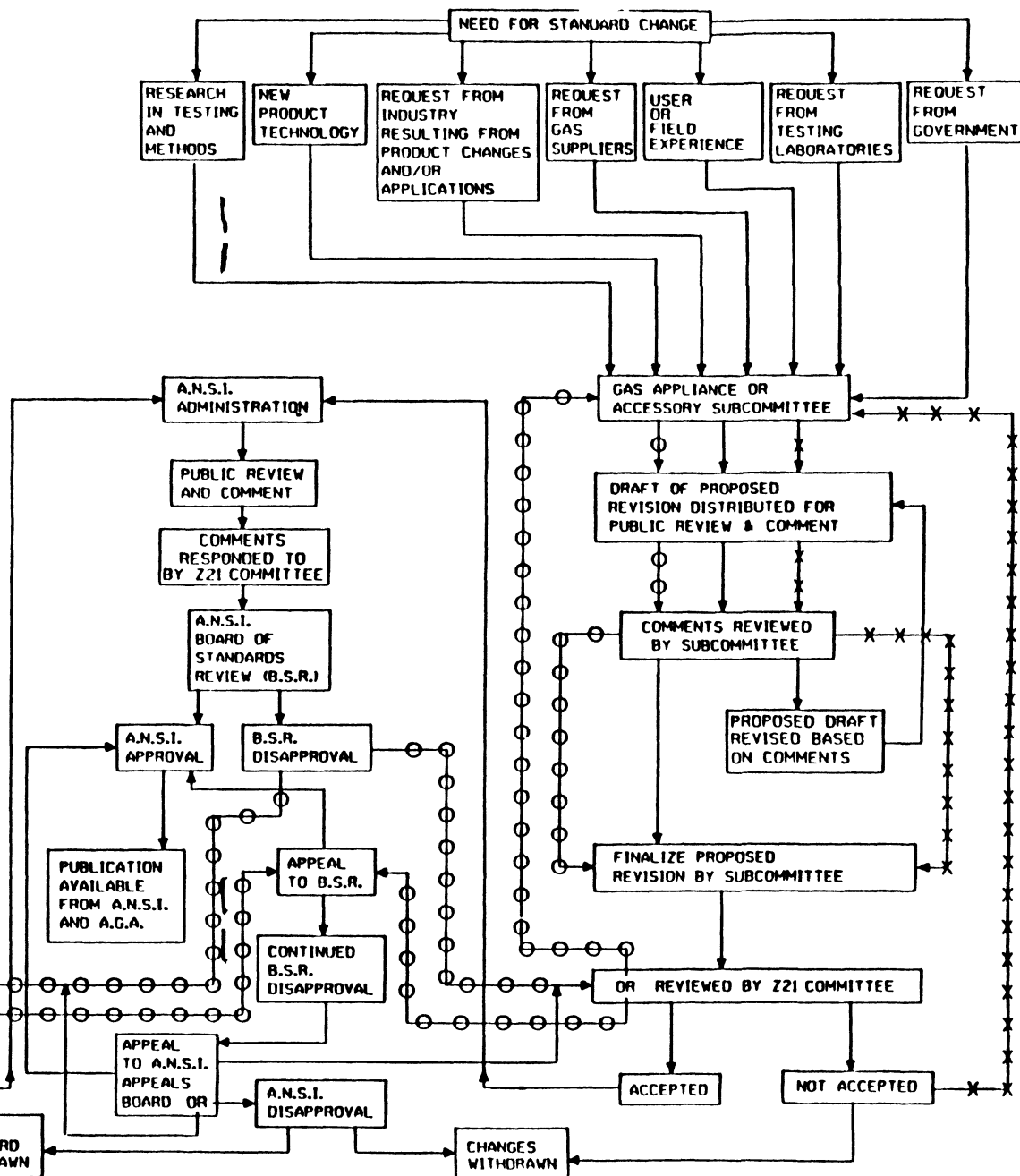
* For example: the American Gas Association Laboratories; Underwriters Laboratories, Inc.; and ETL, Inc.

FLOW CHART

NEW STANDARDS



CHANGES OF EXISTING STANDARDS



APPENDIX

LIST OF Z21 SERIES OF AMERICAN NATIONAL STANDARDS FOR GAS APPLIANCES AND GAS APPLIANCE ACCESSORIES

APPLIANCES

Household Cooking Gas Appliances, **Z21.1**

Gas Clothes Dryers, **Z21.5**

Volume I (**Z21.5.1**) Type 1 Clothes Dryers

Volume II (**Z21.5.2**) Type 2 Clothes Dryers

Gas Water Heaters, **Z21.10**

Volume I (**Z21.10.1**) Storage Water Heaters With Input
Ratings of 75,000 Btu Per Hour or Less

Volume III (**Z21.10.3**) Storage, With Input Ratings Above
75,000 Btu Per Hour, Circulating and Instantaneous Water
Heaters

Gas-Fired Room Heaters, **Z21.11**

Volume I (**Z21.11.1**) Vented Room Heaters

Volume II (**Z21.11.2**) Unvented Room Heaters

Gas-Fired Low-Pressure Steam and Hot Water Boilers, **Z21.13**

Refrigerators Using Gas Fuel, **Z21.19**

Gas-Fired Absorption Summer Air Conditioning Appliances, **Z21.40.1**

Gas-Fired Illuminating Appliances, **Z21.42**

Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces, **Z21.44**

Gas-Fired Central Furnaces (Except Direct Vent Central Furnaces),
Z21.47

Gas-Fired Gravity and Fan Type Floor Furnaces, **Z21.48**

Gas-Fired Gravity and Fan Type Vented Wall Furnaces, **Z21.49**

Vented Decorative Gas Appliances, **Z21.50**

Gas-Fired Pool Heaters, **Z21.56**

Recreational Vehicle Cooking Gas Appliances, **Z21.57**

Outdoor Cooking Gas Appliances, **Z21.58**

Decorative Gas Appliances for Installation in Vented Fireplaces,
Z21.60

Gas-Fired Toilets, **Z21.61**

Portable Catalytic Camp Heaters for Use With Propane Gas, **Z21.62**

Portable Camp Heaters of Other Than the Catalytic Type for Use
With Liquefied Petroleum Gases, **Z21.63**

Direct Vent Central Furnaces, **Z21.64**

Portable Camp Cook Stoves for Use With Propane Gas, **Z21.72**

Portable Camp Lanterns for Use With Propane Gas, **Z21.73**

Portable Refrigerators for Use With HD-5 Propane Gas, **Z21.74**

ACCESSORIES

Gas Hose Connectors for Portable Indoor Gas-Fired Equipment,
Z21.2

Draft Hoods, **Z21.12**

Manually Operated Gas Valves, **Z21.15**

Domestic Gas Conversion Burners, **Z21.17**

Gas Appliance Pressure Regulators, **Z21.18**

Automatic Gas Ignition Systems and Components, **Z21.20**

Automatic Valves for Gas Appliances, **Z21.21**

Relief Valves and Automatic Gas Shutoff Devices for Hot Water
Supply Systems, **Z21.22**

Gas Appliance Thermostats, **Z21.23**

Metal Connectors for Gas Appliances, **Z21.24**

Gas Filters on Appliances, **Z21.35**

Quick-Disconnect Devices for Use With Gas Fuel, **Z21.41**

Flexible Connectors of Other Than All-Metal Construction for Gas Appliances, **Z21.45**

Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances, **Z21.54**

Automatic Vent Damper Devices for Use With Gas-Fired Appliances
Electrically Operated, **Z21.66**
Mechanically Actuated, **Z21.67**
Thermally Actuated, **Z21.68**

Connectors for Movable Gas Appliances, **Z21.69**

Earthquake Actuated Automatic Gas Shutoff Systems, **Z21.70**

Automatic Intermittent Pilot Ignition Systems for Field Installation, **Z21.71**

INSTALLATION

Domestic Gas Conversion Burners, **Z21.8**

NOTES



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Tab F



STATE OF DELAWARE
DEPARTMENT OF PUBLIC SAFETY
DIVISION OF BOILER SAFETY
SUITE 213
BLUE HAN MALL
DOVER, DELAWARE 19901

TELEPHONE: (302) 734-81

OFFICE OF THE
DIRECTOR

MEMORANDUM

TO: ALL BOILER, PRESSURE VESSEL, WATER HEATER SUPPLIERS

FROM: JOSEPH G. CVAR
ACTING DIRECTOR *J.G.C.*

DATE: February 27, 1990

RE: 1989 Amendments to the Regulations for Boilers,
Pressure Vessels and Nuclear Installations
(Eleventh Edition)

By notice dated October 26, 1987, this Office advised you that the Apollo Hydro Heat System could not be approved for installation in the State of Delaware based upon the Division's regulations and its preliminary findings about this system.

A second notice dated September 21, 1988 indicated that "[h]ot water heaters can only be used for potable water in this State. Hooking up heat exchangers for heat from hot water heaters is illegal in this State. Hot water heat can only be supplied by boilers."

This is to advise you of a change in the above position due to the adoption, after public hearings, by the State of Delaware, Department of Public Safety, Division of Boiler Safety, of new regulatory amendments on November 22, 1989, the date of the approval of the regulations by the Attorney General of the State of Delaware. Therefore, the above notices are rescinded to the extent that they apply to the gas water heaters referenced below.

The new regulations permit the use, subject to the requirements in the regulations, of certain gas water heaters in space heating applications. In addition to making other changes, the Division of Boiler Safety added to its regulations a new Section XIX governing gas water heaters suitable for potable water and space heating with a maximum heat input of 200,000 BTU per hour or 58,600 watts, which do not exceed a maximum water temperature limit of 210 degrees Fahrenheit (99 degrees Celsius) and do not exceed nominal water containing capacity of 120 gallons. For your reference a copy of Section XIX is contained in the enclosed regulations.

1989 Amendments
Page 2
February 27, 1989

The units covered by Section XIX may or may not be subject to field inspection. Water heaters of 100,000 BTU and under are not subject to field inspection. (See, Section III of the Eleventh Edition of the regulations). Water heaters with heat inputs in excess of 100,000 BTU up to and including 200,000 BTU located in residences, including apartment buildings having not more than 6 living units, are also exempt from field inspection. (See, Section III of the Eleventh Edition of the regulations). To determine if a vessel is subject to field inspection, and to determine whether any additional changes may affect you or your business, you should consult the new Eleventh Edition of the Division's regulations. A copy of the Eleventh Edition of the regulations is enclosed.

If you have any questions regarding the new amendments to the regulations, please contact our office.

Enclosure

JGC/rac

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STATE OF DELAWARE
DEPARTMENT OF PUBLIC SAFETY
DIVISION OF BOILER SAFETY
SUITE 218
BLUE HEN MALL
DOVER, DELAWARE 19901

TELEPHONE: (302) 738-6889

OFFICE OF THE
DIRECTOR

MEMORANDUM

TO: ALL STATE BOILER INSPECTION CHIEFS

FROM: JOSEPH G. CVAR
ACTING DIRECTOR J.G.C.

DATE: February 27, 1990

RE: 1989 Amendments to the Regulations for Boilers,
Pressure Vessels and Nuclear Installations
(Eleventh Edition)

This notice is to inform you of a recent change in the State of Delaware, Department of Public Safety, Division of Boiler Safety Rules and Regulations for Boilers, Pressure Vessels and Nuclear Installations.

After public hearing, the State of Delaware, Department of Public Safety, Division of Boiler Safety, adopted new regulatory amendments on November 22, 1989, the date of the approval of the regulations by the Attorney General of the State of Delaware.

The new regulations permit the use of certain gas water heaters in space heating applications. In addition to making other changes, the Division of Boiler Safety has added to its regulations a new Section XIX governing gas water heaters suitable for potable water and space heating with a maximum heat input of 200,000 BTU per hour or 58,600 watts, which do not exceed a maximum water temperature limit of 210 degrees Fahrenheit (99 degrees Celsius) and do not exceed nominal water containing capacity of 120 gallons. For your reference, a copy of Section XIX is contained in the enclosed regulations.

These regulations present a change in the Division's position concerning these "combination systems." Other changes were also made to the Division's regulations. If you have any questions regarding the new amendments to the regulations, please contact our office.

Enclosure

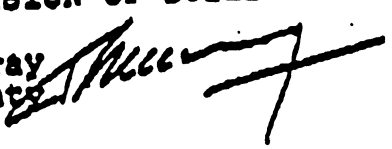
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STATE OF DELAWARE
DEPARTMENT OF PUBLIC SAFETY
P.O. Box 818
DOVER, DELAWARE 19903

TELEPHONE (302) 736 .

MEMORANDUM

TO: ALL EMPLOYEES OF THE DIVISION OF BOILER SAFETY

FROM: Secretary Patrick W. Murray
Department of Public Safety 

DATE: February 27, 1990

SUBJECT: POLICY DIRECTIVE
1989 Amendments to the Regulations for Boilers,
Pressure Vessels and Nuclear Installations
(Eleventh Edition)

After public hearings, the State of Delaware, Department of Public Safety, Division of Boiler Safety, adopted new regulatory amendments on November 22, 1989, the date of the approval of the regulations by the Attorney General of the State of Delaware.

In addition to other changes, a new Section XIX has been added to the Division's regulations. The new Section XIX governs gas water heaters suitable for potable water and space heating with a maximum heat input of 200,00 BTU per hour or 58,600 watts, which do not exceed a maximum water temperature limit of 210 degrees Fahrenheit (99 degrees Celsius) and do not exceed nominal water containing capacity of 120 gallons. A copy of Section XIX is contained in the enclosed regulations.

These regulations present a change in the Division's position concerning these "combination systems." Prior to the adoption of these regulatory amendments, the Department's position was that these "combination systems" could not be installed in Delaware unless the systems were constructed to Section IV, American Society of Mechanical Engineers Boiler Pressure Vessel Code.

Policy Directive
Page 2
February 27, 1990

EFFECTIVE TODAY, ALL EMPLOYEES OF THE DIVISION OF BOILER SAFETY, IN ANY DISCUSSION WITH PERSONS NOT EMPLOYED BY THE DEPARTMENT, MUST IDENTIFY THE NEW REGULATIONS AS THE EXISTING OFFICIAL POLICY OF THE DEPARTMENT. WHEN ANY SUCH EMPLOYEE MAKES ANY STATEMENT OR EXPRESSES ANY OPINION OR POSITION CONTRARY TO THE OFFICIAL POSITION OF THE DEPARTMENT CONTAINED IN THE REGULATIONS, THE EMPLOYEE MUST IDENTIFY TO THOSE PERSONS PARTICIPATING IN THE DISCUSSION OR COMMUNICATION THAT THE VIEWS EXPRESSED ARE THE PERSONAL OPINION OF THE EMPLOYEE AS AN INDIVIDUAL AND DO NOT REPRESENT THE POSITION OF THE DEPARTMENT, ITS EMPLOYEES OR AGENTS.

This Policy Directive is intended to avoid any public confusion or mistaken perception regarding the Department's position concerning "combination systems," without placing any undue restriction on the employee's freedom of speech. Failure to comply with this Policy Directive may result in the imposition of disciplinary action against the employee who violates the policy.

If any employee of the Division has any questions regarding this Policy Directive, please contact my office.

Enclosure

PWM/rac

Tab G

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS

A NON-PROFIT CORPORATION



RECOMMENDATION OF THE PLUMBING RESEARCH COMMITTEE

Samples of the product described herein have been tested by an independent testing laboratory and have been reviewed and recommended for acceptance by the Plumbing Research Committee of the International Association of Plumbing and Mechanical Officials as meeting the requirements of the UNIFORM PLUMBING CODE. This recommendation is subject to the conditions set forth in the characteristics below and is not to be construed as any recommendation, assurance or guarantee by the Association of the product or of product acceptance by local jurisdictions or authorities using the UNIFORM PLUMBING CODE or otherwise affiliated with the Association.

Accepted April 1990

Void after April 1991

PRODUCT: Water & Space Heating Systems

FILE NO. 2552

APPLICANT: State Industries, Inc.
500 Bypass Road
Ashland City, TN 37015

IDENTIFICATION: Label with manufacturer's name or trademark, model designation and UPC certification mark®.

CHARACTERISTICS: A combination domestic water and space heating system using listed solar panels, boilers or water heaters to heat potable water that is piped to hot water fixtures as well as circulated through copper fan coil units to provide space heating. Valves are provided to isolate components so that space heating units may be bypassed during periods when space heating is not desired. Valves are also installed so that various components may be maintained without the loss of use of the potable water system. To be installed in accordance with the manufacturer's instructions and the provisions of the applicable latest editions of the Uniform Plumbing Code, the Uniform Solar Energy Code and the Uniform Mechanical Code.

MODELS: Apollo Comfort Products #AHW, CBC, HB, HBC, HH, RFC, VB & WM

This recommendation is for the period indicated herein and is void after date shown above. Any change in material, manufacturing process, marking or design without having first obtained the approval of the Plumbing Research Committee, or evidence of non-compliance with applicable standards or of inferior workmanship, may be deemed as sufficient cause for revocation of the recommendation. Reproduction of or reference to this form for advertising purposes may be made only by specific written permission of the International Association of Plumbing and Mechanical Officials. This authorizes the use of the UPC certification mark on products covered by this certificate.

Any alteration of this certificate could be grounds for revocation of the listing.


CHAIRMAN, PLUMBING RESEARCH COMMITTEE


EXECUTIVE DIRECTOR

Tab H

ARTICLE 1

SCOPE AND SERVICE RESTRICTIONS

HG-100 SCOPE

The requirements of Part HG apply to steam heating boilers, hot water heating boilers, hot water supply boilers, and to appurtenances thereto, and shall be used in conjunction with the specific requirements in Part HF, Boilers of Wrought Materials, and Part HC, Cast Iron Boilers, whichever is applicable. Part HG is not intended to apply to, potable water heaters except as provided for in Part HLW.

HG-101 SERVICE RESTRICTIONS

HG-101.1 Service Restrictions. The rules of this Section are restricted to the following services:

(a) steam boilers for operation at pressures not exceeding 15 psi;

(b) hot water heating boilers and hot water supply boilers for operating at pressures not exceeding 160 psi and/or temperatures not exceeding 250°F, at or near the boiler outlet.

HG-101.2 Services in Excess of Those Covered by This Section. For services exceeding the limits specified in HG-101.1, the rules of Section I shall apply.

ARTICLE 2

MATERIAL REQUIREMENTS

HG-200 GENERAL MATERIAL REQUIREMENTS

HG-200.1 Materials Subject to Pressure Stress. Material subject to stress due to pressure shall conform to one of the specifications given in Section II and shall be limited to those that are permitted in HF-200 for boilers of wrought materials and HC-200 for cast iron boilers.

HG-200.2 Internal Parts Subject to Deterioration. Materials shall not be used for internal parts which are liable to fail due to deterioration when subjected to saturated steam temperatures at or below the maximum allowable working pressure.

HG-200.3 Materials Not Found in Section II. Material not covered by specifications in Section II shall not be used unless authorization to use the material is granted by the Boiler and Pressure Vessel Committee on the basis of data submitted to the Committee in accordance with Appendix A.

HG-200.4 Materials Use Not Limited by Specification Title. The title or scope paragraph of a material specification in Section II as respects product form or service shall not limit the use of a material, provided the material is suitable for the application and its use is permitted by the rules of this Section.

HG-200.5 Materials Use Not Limited by Method of Production. Materials covered by specifications in Section II are not restricted as to the method of pro-

duction unless so stated in the specification, and as long as the product complies with the requirements of the Specification.

HG-200.6 Materials With Thicknesses Exceeding Specification Limits. Materials having thicknesses outside of the limits given in the title or scope clause of a specification in Section II may be used in construction, provided they comply with the other requirements of the Specification and with all thickness requirements of this Code.

HG-200.7 Materials Not Identified by Mill Test Reports. Materials not identified by mill test reports may be used for nonpressure parts such as baffles, external supports, and insulating rings, the failure of which will not endanger the vessel to which they are attached. The allowable stress value shall not exceed 80% of the maximum allowable stress permitted for similar material in Tables HF-300.1 and HF-300.2. Satisfactory performance of a specimen in such service shall not make the material acceptable for use in pressure parts of a vessel.

HG-201 SPECIFIC MATERIAL REQUIREMENTS

Specific material requirements for assemblies constructed of wrought materials are given in Part HF, Article 2 and for assemblies constructed of cast iron in Part HC, Article 2.

Tab I



February 16, 1990

RECEIVED
FEB 22 1990 A.M.

E L O

Ernest Wenczel
State Industries Inc
Ashland City, TN 37015

Subject: Section IV (1981 Edition, 1988 Addenda); HLW-100

Item: BC89-339

Reference: Your letter dated September 11, 1989

Dear Sir:

Our understanding of the questions in your inquiry, and our replies, are as follows:

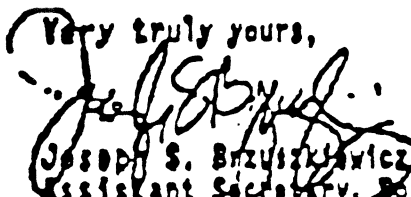
Question (1): If a water heater is installed with an optional recirculating line that returns heated water to a water heater as illustrated in Figs. HLW-809.1 and Fig. HLW-809.2, would it then be required to be H-Stamped?

Reply (1): No.

Question (2): Do provisions of Part HG as defined in HG-100 Scope and HG-101.1 Service Restrictions (b) apply to Part HLW?

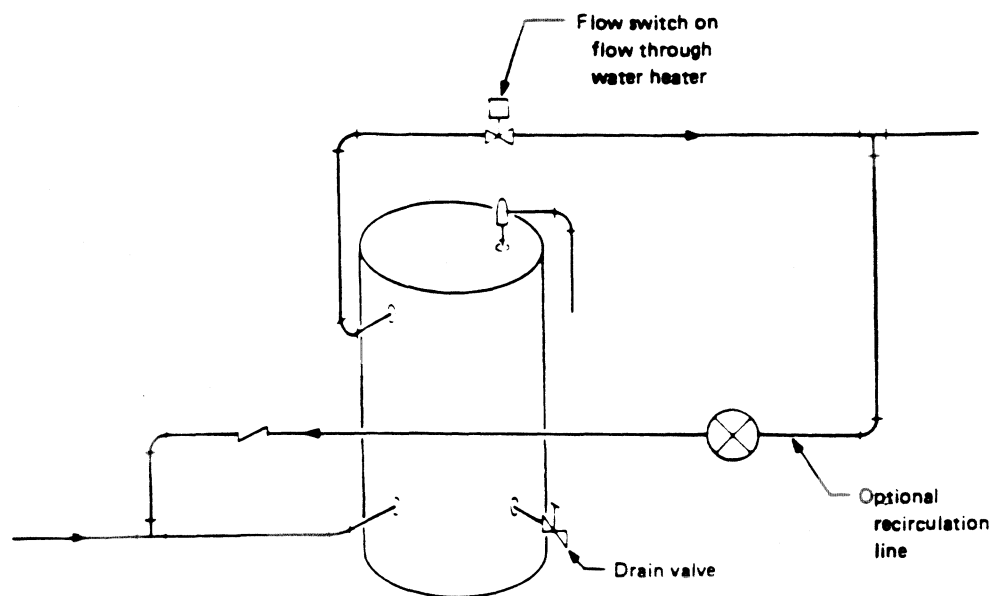
Reply (2): No.

Very truly yours,


Joseph S. Brzustowski
Assistant Secretary, Boiler and
Pressure Vessel Committee
(212) 706-7802

JSB/

Tab J



GENERAL NOTE:
Thermometer requirements are in HLW-820.

FIG. HLW-809.2 A TYPICAL ACCEPTABLE PIPING INSTALLATION FOR FLOW THROUGH WATER HEATER WITH PROVISIONS FOR PIPING EXPANSION

Tab K



May 31, 1990

Ernest Wenczl
State Industries, Inc.
Ashland City, TN 37015

RECEIVED

JUN 04 1990 A.M.

P. E. Q.

Subject: ASME Section IV, Part HLW

Item: BC90-307

Reference: Your letter dated February 9, 1990

Dear Sir:

Our understanding of the question in your inquiry, and our reply, are as follows:

Question: Is any provision of Part HLW intended to limit, within the parameters of HLW-100(a) the use of the heated potable water?

Reply: No

Very truly yours,

A handwritten signature in cursive script that reads "Karen M. Ciciora".

Karen M. Ciciora
Secretary, Section IV
(212) 705-7026

KMC/j1

Tab L

ADOPTIONS

1. If premiums are paid in one sum for the entire duration of the indebtedness, the following rates per \$100.00 of initial indebtedness repayable in indicated number of equal monthly installments:

Number of Equal Monthly Installments	Single Premium Rates per \$100.00 of Initial Indebtedness	
	Column I	Column II
1	\$1.28	\$1.43
2	1.71	1.90
3	2.05	2.28
4	2.26	2.52
5	2.49	2.76
6	2.66	2.95
7	2.80	3.12
8	2.95	3.29
9	3.11	3.45
10	3.24	3.60
12	3.35	3.72

2-5. (No change.)

(h)-(j) (No change)

LABOR

(a)

DIVISION OF WORKPLACE STANDARDS

Boilers, Pressure Vessels and Refrigeration

Readoption with Amendments: N.J.A.C. 12:90

Proposed: October 16, 1989 at 21 N.J.R. 3247(a).

Adopted: December 15, 1989 by Charles Serrano, Commissioner, Department of Labor.

Filed: December 15, 1989 as R.1990 d.24, with substantive and technical changes not requiring additional public notice and comment (see N.J.A.C. 1:30-4.3).

Authority: N.J.S.A. 34:1-20, 34:1-47, 34:1A-3(e), and 34:7-18.

Effective Date: December 15, 1989, Readoption;

January 16, 1990, Amendments.

Expiration Date: December 15, 1994.

Summary of Public Comments and Agency Responses:

The Department received 13 comments concerning the proposed re adoption of N.J.A.C. 12:90, Boilers, Pressure Vessels and Refrigeration which appeared in the October 16, 1989 New Jersey Register at 21 N.J.R. 3247(a). Several commenters, including the Department of Community Affairs (DCA), requested a public hearing on the proposed readoption.

With regard to the requests of the commenters other than DCA concerning the public hearing, the Department believes that the deletion of the proposed language concerning dual purpose vessels alleviates the concern of these commenters and obviates the need for a public hearing.

With regard to DCA's request for a public hearing, DCA did not submit its comments during the comment period, and thus the request for a public hearing was not timely. Furthermore, the Department is unable to hold a public hearing prior to the expiration date for the rule, and, therefore, denies DCA's request. However, the Department has contacted DCA to discuss its concerns, and believes that the changes upon adoption are satisfactory to both agencies and adequately address the problems raised by DCA.

COMMENT: N.J.A.C. 12:90-7.5(a)2 and 7.6(a)2 address the eligibility for a low pressure vessel boiler operator examination and a high pressure boiler operator in charge examination. According to the rules as proposed, the program shall be "established by the Chief Engineer and approved by the Office of Boiler and Pressure Vessel Compliance." If the proposed amendment is to be adopted, the commenter requested that each of the training programs for these two types of operators be established by way of a proposed rulemaking setting forth program content, as this would allow licensed operators to offer input and would relieve the Division of Workplace Standards from having to establish and review individual programs for each licensed operator.

LABOR

RESPONSE: The Department is merely codifying existing Departmental procedures concerning the intensive training program, and thus intends to adopt the amendment as proposed.

COMMENT: Amend N.J.A.C. 12:90-4.1(c) to include language which will exempt water heaters in residences.

RESPONSE: The Department has decided to delete the proposed language concerning water heaters upon adoption. Water heaters which meet the following standards are not currently regulated: Heat input not exceeding 200,000 Btu/hour, water temperature not exceeding 210 degrees Fahrenheit and a normal water containing capacity not exceeding 120 gallons that are equipped with safety devices in accordance with the requirements of HLW 800 of Section 4 of the ASME Code.

COMMENT: Amend N.J.A.C. 12:90-4.2(b), 5.2(b) and 5.1(a) to update the ASME Boiler and Pressure Vessel Code from 1986 to 1989.

RESPONSE: The Department agrees with the comment, and has amended the adoption to update the ASME code reference.

COMMENT: Amend N.J.A.C. 12:90-4.2(c), 4.8(a)3 and 5.1(a)3 to update the National Board Inspection Code from 1987 to 1989.

RESPONSE: The Department is not prepared to effect this change at the present time, as the entire version of the new code has not yet been approved for adoption by the Division of Workplace Standards.

COMMENT: Delete the language "except that the following sections shall not apply" from N.J.A.C. 12:90-4.2(c). The commenter states (1) that the third paragraph of the purpose and scope pertains to pressure vessels, and thus does not need to be referenced in this subchapter; and (2) that the other excepted section permits authorized owner/user inspectors to inspect repairs made by their employer, and that New Jersey is the only jurisdiction that takes exception to this practice, which has been shown, by industry experience, to be safe.

RESPONSE: The Department has previously considered these concepts, and has decided that the existing language is more protective for the public than the commenter's suggested language.

COMMENT: Amend N.J.A.C. 12:90-5.2(c) to include:

The National Board Inspection Code 1989 and API 510-1989 are adopted as safety standards under this subchapter and shall apply according to the provisions thereof.

Delete "except that the following section shall not apply." According to the commenter, API 510 is intended for the chemical and petroleum industries for maintenance of pressure vessels. The NBIC is intended for all industries for maintenance of boilers, and for industries other than chemical and petroleum for the maintenance of pressure vessels. The paragraph which is excepted recognizes API 510, which pertains to pressure vessels of chemical and petroleum industries. Another commenter suggested the same change. The second excepted paragraph is safe and reasonable according to industry standards.

RESPONSE: The Department has previously considered these concepts, and has decided that the existing language is more protective for the public than the commenter's suggested language.

COMMENT: Add "API 510-1989, Pressure Vessel Inspection Code" to N.J.A.C. 12:90-8.1(a).

RESPONSE: Since the Department does not intend to use this standard in the rule, it need not be referenced.

COMMENT: One commenter requested that in N.J.A.C. 12:90-4.1(b) and 4.2(a) the rationale for the proposed changes state that the changes will result in the denial of economic advantages and comfort to the people of New Jersey, and that the changes are in conflict with BOCA, SBCCI, IAPMO, and ANSI Z21.10.1a-1988.

RESPONSE: The Department has decided to delete this section.

COMMENT: Add a definition of "dual purpose," and "water heater," to clarify N.J.A.C. 12:90-4.1(b), 4.2(b) and 5.1(b), respectively.

RESPONSE: The Department has eliminated all references to dual purpose and water heaters, so no definition of these terms is necessary.

COMMENT: Amend N.J.A.C. 12:90-8.1(a) to read "Latest ASME Boiler and Pressure Vessel Code."

RESPONSE: The Department prefers to amend the code citations when new codes have been issued and approved to avoid any uncertainty as to which code is currently in use.

COMMENT: Several commenters suggested that the Department delete the amendments to N.J.A.C. 12:90-4.1, 4.2 and 5.1 concerning the dual purpose vessels, as they would effectively prohibit the use of water heaters to provide both potable hot water and space heat in combination by making their construction, installation, registration and repair subject to excessive boiler regulation without furthering any legitimate safety concern. If some regulation is still required, adopt the ANSI standards for gas water heaters.

RESPONSE: The Department agrees with the several commenters' suggestions, and has deleted the suggested language from the adoption.

COMMENT: Two commenters stated that the economic impact statement did not accurately reflect the adverse economic impact on the public.

RESPONSE: As the Department is not planning to adopt the text of the Economic Impact Statement, no changes need to be made.

COMMENT: Amend N.J.A.C. 12:90-4.2(c) to include the following:

3. The first sentence of Section R-308.2, which for the purpose hereof shall instead be deemed to read: "A pressure test as required pursuant to R-308.3 shall be applied."

This commenter states that the above language would permit alternate pressure tests to be used on altered boilers and pressure vessels, and that the alternate tests used be those in Section R-308.3 of the 1987 NBIC.

RESPONSE: The Department disagrees with the commenter's suggestion. Hydrostatic pressure testing shall be done in accordance with the requirements for new construction for altered vessels.

COMMENT: The Department should not use standards other than those which are in force in effect in the State, specifically BOCA Mechanical Code 1987 and the ASME-89 standards.

RESPONSE: The Department agrees with the commenter, and has amended the language upon adoption to reflect the suggested changes.

Full text of the readoption appears in the New Jersey Administrative Code at N.J.A.C. 12:90.

Full text of the proposed amendments follows (additions to proposal indicated in boldface with asterisks "**thus**"; deletions from proposal indicated in brackets with asterisks "[thus]").

12:90-2.1 Definitions

The following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

...
"Examiner" means an individual identified as a member of the examining board pursuant to N.J.S.A. 34:1-38.1.

...
"Fireman" means a boiler operator.

...
"Long boom crane" means a hoisting machine with a boom length of over 99 feet.

...
"Mechanical Inspection Bureau" means the bureau established pursuant to N.J.S.A. 34:1-38.1 et seq. (1917) and is synonymous with the Office of Boiler and Pressure Vessel Compliance.

12:90-3.2 Right of entry

(a) For the purpose of examination or inspection of any boiler, pressure vessel, refrigeration system, power plant or other equipment, the Commissioner may enter such premises at all reasonable hours in accordance with N.J.S.A. 34:1-15.

(b) Any person, corporation or firm violating any provision of this section shall, for each offense, be liable for a penalty of \$50.00 pursuant to N.J.S.A. 34:1-16.

12:90-3.3 Equipment requiring a licensed operator

(a) No person shall operate the equipment listed below without the appropriate license as specified in N.J.A.C. 12:90-3.4 through 3.8.

1.-3. (No change.)

4. Any refrigerating system using a refrigerant which is either flammable or toxic and rated over 24 tons of refrigerating capacity;

5. Any hoisting machine with a boom length exceeding 99 feet;

or

6. (No change.)

12:90-3.4 Licenses for high pressure boilers

(a)-(b) (No change.)

Table 3.4
Licenses for High Pressure Boilers

Boiler horsepower over	Boiler horsepower not over	Chief Engineer's License (1)	Shift Engineer's License
3,000		1-A gold seal 1st class engineer	1-C blue seal 3rd class engineer
1,000	3,000	1-B red seal 2nd class engineer	1-C blue seal 3rd class engineer
500	1,000	1-C blue seal 3rd class engineer	black seal boiler operator in charge
100	500	black seal boiler operator in charge	black seal boiler operator in charge
6	100(2)	—	boiler operator special

Notes to Table

(1)-(2) (No change.)

(c) A fireman's special license for electric, coil or waste heat boilers may be issued for unlimited horsepower use, and may not be used for the operation of other types of boilers.

12:90-3.5 Licenses for low pressure boilers

(a)-(b) (No change.)

(c) A person with a low pressure license may operate low pressure boilers of unlimited horsepower.

12:90-3.7 Licenses for power generating plants

(a)-(b) (No change.)

Tab M

EXHIBIT M

Installed Cost Comparison

Boiler System versus Combination System

Parameters:

Comparison is based on installation in identical buildings having a design heat loss of 30,000 btu/hour in Salt Lake City, Utah.

The Combination System and the boiler system each use natural gas as an energy source.

The boiler selected is a popular low cost steel boiler. The typical installation includes a gas water heater because of the high operating cost typical of a gas-fired summer/winter hook up using a tankless boiler coil and energy saving preferences in Utah.

The air handler unit contains the heat exchanger coil, evaporator coil, circulating pump, etc., and is used in both installations.

Labor and material costs are estimates only and will vary from one installation to the next.

Estimates of additional labor and material costs when a boiler is used are included. Costs common to both systems are omitted such as air handler, ductwork and gas piping costs.

Estimated Costs	Boiler	Combination
Boiler (75,000 btu/hr input)	1,038.57	
Water heater (40 gal. gas)	225.00	
Water heater wiring	100.00	
Expansion tank	39.31	
Dual controls	41.91	
Boiler treatment	10.00	
Boiler wiring, labor and material	100.00	
Boiler plumbing labor and service reserve	560.00	
Air handler (30,000 btu/hr)	350.00	\$350.00
Water heater (Apollo)		336.00
Flue pipe	145.00	55.00
Combination System service reserve		<u>50.00</u>
Total estimated cost installed	<u>\$2,609.79</u>	<u>\$791.00</u>

As shown above, a typical Utah boiler installation is \$1,818.79 more expensive than a Combination System installation. When this \$1,818.79 is added to a 15-year mortgage loan at 12% interest, this \$1,818.79 cost accrues interest of \$2,109.92.

In addition to obvious lower equipment and installation costs, another highly significant savings results when space utilization is considered. A boiler system adds approximately 12 square feet to the equipment space requirements. At a construction cost of \$80.00 per square foot, this means that a boiler requires an additional indirect expenditure of \$960.00 when compared to a Combination System. When financing costs are added based on a \$960.00 addition to a 15-year mortgage loan at 12% interest, this \$960.00 cost with interest becomes a \$2,074.00 cost.

Another advantage of the Combination System over a boiler system is lower operating cost. Based on estimated gas and electric rates, the Combination System is estimated to save approximately \$38.00 annually when compared to a boiler system using an electric water heater for domestic hot water. Please see calculations attached.

When one compares the total cost of a Combination System with a boiler system over a 15-year period, the savings are apparent:

	Boiler	Combination
Estimated installation cost	\$ 2,609.79	791.00
Installation financing cost	2,109.92	
Space cost with interest	2,074.00	
Fuel cost over 15 years	<u>7,635.00</u>	<u>7,065.00</u>
Total	\$14,428.71	\$7,856.00
Net Savings		<u>\$6,572.71</u>

COMPARATIVE ANNUAL OPERATING COSTS

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Apollo Comfort Products

APOLLO NATL GAS HYDRO HEAT SYSTEM VS. ALTERNATIVE SYSTEM CONSISTING OF:

WATER HEATING - NATL GAS

SPACE HEATING - NATL GAS

NOTE: THIS REPORT IS FOR COMPARISON PURPOSES ONLY. ESTIMATE ANNUAL OPERATING COSTS ARE NOT NECESSARILY PROJECTED COSTS. ACTUAL OPERATING COSTS MAY BE HIGHER OR LOWER THAN THOSE INDICATED FOR ANY SYSTEM. THIS REPORT IS MERELY A GUIDE IN SELECTING AN APPROPRIATE SYSTEM. SOME FACTORS THAT MAY CAUSE VARIATION INCLUDE:

*** DWELLING ORIENTATION	*** OUTDOOR WEATHER CONDITIONS
*** INDOOR THERMOSTAT SETTING	*** QUALITY OF INSTALLATION
*** WATER HEATER THERMOSTAT SETTING	*** DAILY AMOUNT OF HOT WATER USED
*** NUMBER OF OCCUPANTS	

INPUT DATA

DATE	02/01/91
CITY	SALT LAKE
PROJECT	SAMPLE HOME
HEATING DEGREE DAYS (65 F BASE)	5990
DESIGN TEMPERATURE DIFFERENCE	70
COST OF NATURAL GAS IN \$/THERM	0.43
GAS SERVICE CHARGE PER MONTH	5.00
REGULAR COST OF ELECTRICITY IN \$/KWH	0.072
WATER HEATER STORAGE TEMPERATURE IN DEG. F	140
DESIGN HEAT LOSS OF STRUCTURE IN BTU/H	30000
TONS OF COOLING IF AIR CONDITIONED	3
NATL GAS APOLLO WATER HEATER INPUT IN BTU/H	40000
NATL GAS APOLLO WATER HEATER RECOVERY EFF. IN %	85
NATL GAS APOLLO WATER HEATER ENERGY FACTOR (DEC.)	0.81
NATL GAS ALTERN WATER HEATER INPUT IN BTU/H	40000
NATL GAS ALTERN WATER HEATER RECOVERY EFF. IN %	75
NATL GAS ALTERN WATER HEATER ENERGY FACTOR (DEC.)	0.57
NATL GAS KOHER AFUE (FROM GAMA DIRECTORY) IN %	76

ESTIMATED TYPICAL ANNUAL OPERATING COSTS IN DOLLARS

	APOLLO H H - NATL GAS		
	FUEL	ELECT	TOTAL
ANNUAL	425	48	471
	ALTERNATIVE		
	WATER HEATING - NATL GAS		
	SPACE HEATING - NATL GAS		
	FUEL	ELECT	TOTAL
ANNUAL	472	37	509

COMPARED TO ALTERNATIVE, APOLLO H H SAVES \$ 38 (7%) PER YEAR
A NATL GAS FURN WITH AFUE = 88 WOULD MATCH OPERATING COST OF APOLLO