

DIRECT GAS-FIRED CIRCULATING HEATERS FOR AGRICULTURAL ANIMAL CONFINEMENT BUILDINGS



INTERNATIONAL
APPROVAL SERVICES - U.S., INC.
8501 East Pleasant Valley Rd.,
Cleveland, Ohio 44131

First Edition - 1996

Printed in U.S.A.

by

**International Approval Services - U.S., Inc.,
8501 East Pleasant Valley Road
Cleveland, Ohio 44131**

**Approved
March 8, 1996
AMERICAN NATIONAL
STANDARDS INSTITUTE, INC.**

Copyright © 1996, International Approval Services - U.S., Inc.

Permission is granted to republish material herein in laws or ordinances, and in regulations, administrative orders, or similar documents issued by public authorities. Those desiring permission for other republication should consult International Approval Services - U.S., Inc., 8501 East Pleasant Valley Road, Cleveland, Ohio 44131.



Documents
Document Sharing Hub

PREFACE

This publication represents a basic standard for safe operation, substantial and durable construction, and acceptable performance of direct gas-fired circulating heaters for agricultural animal confinement buildings. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on direct gas-fired circulating heaters for agricultural animal confinement buildings 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 direct gas-fired circulating heaters for agricultural animal confinement buildings, 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 International Approval Services - U.S., Inc., 8501 East Pleasant Valley Road, Cleveland, Ohio 44131. A proposal form is provided in the back of this document.

Safe and satisfactory operation of direct gas-fired circulating heaters for agricultural animal confinement buildings depends to a great extent upon its proper installation, and it should be installed in accordance with the *National Fuel Gas Code, ANSI Z223.1*, manufacturers' installation instructions, and local municipal building codes.

Users of this American National Standard are advised that the devices/products/activities within its scope may be subject to regulation at the Federal state or local level. Users are strongly urged to investigate this possibility through appropriate channels. In the event of a conflict with this standard, the Federal, state or local regulation should be followed.

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., 11 West 42nd Street, New York, N.Y. 10036, (212) 642-4900.

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 THE DEVELOPMENT OF STANDARD FOR DIRECT GAS-FIRED CIRCULATING HEATERS FOR AGRICULTURAL ANIMAL CONFINEMENT BUILDINGS

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

In 1988, International Approval Services-U.S. Inc. (formerly the American Gas Association laboratories), developed its A.G.A. Requirement 5-88 on agricultural heaters. This standard was used for design certification testing of gas-fired agricultural heaters by IAS U.S. Interest was indicated in 1990 to develop a nationally recognized standard, at which time IAS U.S. agreed to relinquish its standard to the Z83 Project. The Z83 Committee assigned the activity to its construction heater subcommittee.

As time progressed, there was a desire to expedite development of a national standard and it was believed that this could be accomplished more readily by returning the draft standard to IAS U.S. for development under its ANSI Canvass Method sponsorship. The Z83 Committee and its construction heater subcommittee agreed that IAS U.S. undertake development of the standard.

IAS U.S. proceeded to establish a new project activity. The American National Standards Institute (ANSI) was contacted in October 1994 to inform them that IAS U.S. was undertaking this project under its Canvass Method sponsorship. A Canvass List was formed of interested parties to exercise review and approval of the standard. The A.G.A. (IAS U.S.) Requirements Committee, an internal standards writing committee of IAS U.S., and a Technical Advisory Group (TAG) comprised of non-IAS interested parties, were appointed to serve as the technical advisors on this activity. The project was assigned the designation IAS U.S. LC 2.

IAS U.S. LC 2 provides coverage for newly-produced direct-fired circulating heaters primarily intended for use in agricultural animal confinement buildings.

At its December 1, 1994 meeting, the IAS U.S. Requirements Committee reviewed and modified proposed IAS U.S. LC 2, in light of recommendations developed previously by an ad hoc working group of the Z83 construction heater subcommittee.

By letter ballot dated December 22, 1994, individuals selected to serve on the Technical

Advisory Group (TAG) were forwarded a copy of proposed IAS U.S. LC 2 standard dated December 1994. They were asked to review the document for technical accuracy. The results of the ballot indicated the document required further review and development.

At its February 2, 1995 meeting, the IAS U.S. Requirements Committee modified the December 1994 draft of proposed IAS U.S. LC 2, in light of substantive comments received from the Technical Advisory Group (TAG). Subsequently, a second draft of proposed IAS U.S. LC 2 dated February 1995 was forwarded to the TAG for their review. Comment was received that the standard should be limited to heaters having a nominal gas supply pressure not exceeding 1/2 psig. This comment was based on a recommendation made by the GAMA Controls Division Standards Review Task Group at its February 1994 meeting.

After TAG approval and modification in light of the above comment, a third draft of IAS U.S. LC 2, dated March 1995, was prepared and distributed to the canvass list by letter ballot.

A June 15, 1995 meeting of the IAS Requirements Committee was held in response to requests submitted by two participants. Both individuals originally voted "Object" on the Canvass ballot dated February 28, 1995. In order to resolve the objections, both individuals agreed to change their vote to "Abstain" on the February 1995 ballot, provided a meeting of the IAS Requirements Committee was scheduled to address their comments prior to a public review submittal to the American National Standards Institute (ANSI).

A subsequent fourth draft of proposed IAS U.S. LC 2 dated June 1995 was distributed to the TAG by ballot. The TAG was requested to vote on whether the June 1995 draft of proposed IAS U.S. LC 2 was ready for distribution to the canvass list.

In view of the favorable vote by the TAG members, the June 1995 Draft of proposed IAS U.S. LC 2 was distributed to and approved by the canvass list by letter ballot and was approved by the American National Standards Institute (ANSI) on March 8, 1996.

CONTENTS

Page

PART I. CONSTRUCTION

1.1	Scope	1
1.2	General Construction	2
1.3	Materials	3
1.4	Assembly	3
1.5	Accessibility	4
1.6	Main burners	4
1.7	Combustion Air Control	5
1.8	Orifices and Orifice Fittings	5
1.9	Ignition Means (Systems)	5
1.10	Combination Gas Controls	7
1.11	Manual Gas Valves	7
1.12	Heater Gas Piping	8
1.13	Gas Hose Assemblies	9
1.14	Automatic Valves and Safety Shutoff Valves	10
1.15	Gas Pressure Regulators	11
1.16	Thermostats	12
1.17	Adjustment of Minimum Input Rating	12
1.18	Limit Controls	12
1.19	Electrical Equipment and Wiring	13
1.20	Motors	19
1.21	Instructions	19
1.22	Marking	24

PART II. PERFORMANCE

2.1	General	30
2.2	Test Gases	30
2.3	Test Pressures and Burner Adjustments	31
2.4	Combustion	31
2.5	Burner and Pilot Operating Characteristics	31
2.6	Manual and Piloted Ignition Systems	32
2.7	Direct Ignition Systems	37
2.8	Limit Controls	38
2.9	Manifold and Control Assembly Capacity	39
2.10	Wall, Floor, Ceiling and Electrical Equipment and Wiring Temperatures	40
2.11	Rain Test for Heaters for Outdoor Installation	42
2.12	Wind Test	42
2.13	Washdown Test	43
2.14	Season Cracking	44
2.15	Marking Material Adhesion and Legibility	44

TABLES IN PARTS I AND II

Table I.	Minimum Corrosion Protection of Ferrous Materials Used in the Construction of Heaters for Outdoor Installation or Subject to Spray Washdown (see 1.3.5)	47
Table II.	Maximum Ignition System Timings	48

Contents (Continued)

	Page
Table III. Minimum Acceptable Wall Thickness for Nonferrous Tubing	48
Table IV. Maximum Tubing and Fitting Temperatures	49
Table V. Minimum Length to Shoulder	49
Table VI. Junction Box Free Space Per Conductor	49
Table VII. Minimum Average Thickness of Sheet-Metal Junction Boxes*	50
Table VIII. Electrical Clearances, Inches (mm)	51
Table IX. Insulation Thickness of Factory Wiring Exposed in Burner or Fan Compartment ...	52
Table X. Maximum Allowable Rise Above Room Temperature for Various Component Parts	53
Table XI. Maximum Allowable Motor Winding Temperatures, °F (°C)	54
Table XII. Characteristics of Test Gases	54
Table XIII. Operating Test Conditions	54
 FIGURES IN PARTS I AND II	
Figure 1. Arrangement of Spray Heads and Associated Piping for Simulated Rainstorm Test	56
Figure 2. Spray Head Assembly and Details of Construction	56
 EXHIBIT A. LIST OF REFERENCE STANDARDS	57
 PART III. MANUFACTURING AND PRODUCTION TESTS	60
PART IV. DEFINITIONS	62
 APPENDIX A. PERTINENT REFERENCES TO ANSI Y14.15	70
APPENDIX B. WIRE COLOR DESIGNATIONS	71
APPENDIX C. RECOMMENDED WIRE COLOR USAGE	72
APPENDIX D. PREFERRED GRAPHIC SYMBOLS OF COMMONLY USED ITEMS, EXTRACTED FROM STANDARD ANSI/IEEE 315, GRAPHIC SYMBOLS FOR ELECTRICAL AND ELECTRONICS DIAGRAMS, AND ABBREVIATIONS FOR THESE ITEMS	73
APPENDIX E. TABLE OF CONVERSION FACTORS	75

**AMERICAN NATIONAL STANDARD FOR
DIRECT GAS-FIRED CIRCULATING HEATERS FOR
AGRICULTURAL ANIMAL CONFINEMENT BUILDINGS**

PART I

CONSTRUCTION

1.1 SCOPE

- 1.1.1** This standard applies to newly-produced direct gas-fired circulating heaters (see Part IV, Definitions) of 400,000 Btu (117 228 W) or less, hereinafter referred to as heaters, constructed entirely of new, unused parts and materials and primarily intended for permanent installation in agricultural animal confinement buildings. All the products of combustion generated by the heater are released into the area being heated.

These requirements apply to heaters having a gas supply pressure rating not exceeding $\frac{1}{2}$ psi (3.45 kPa) at the gas inlet of the appliance.

- 1.1.2** This standard does not apply to heaters intended for use in green houses.
- 1.1.3** This standard applies to self-contained heaters with integral means for air circulation.
- 1.1.4** This standard does not cover heaters employing a flameless catalytic combustion process, heaters for use with liquid phase fuel gases or infrared type heaters.
- 1.1.5** This standard applies to heaters having an air outlet temperature of 350°F (176.5°C) above room temperature or less (see 2.8.2).
- 1.1.6** Special construction provisions applicable to a heater for outdoor installation are outlined under 1.2.5, 1.3.5, 1.3.6, 1.5, 1.7.3, 1.9.3-2b and 1.22.4.
- 1.1.7** Heaters covered by this standard are intended for use with natural or liquefied petroleum gases.
- The construction of heaters for use with the above-mentioned gases is covered under Part I.
- The performance of heaters for use with the above-mentioned gases is covered under Part II.
- 1.1.8** Special construction provisions for heaters intended for installations subject to spray washdown are outlined under 1.2.7 and 1.21.1.
- 1.1.9** Exhibit A contains a list of standards specifically referenced in this standard, and sources from which these reference standards may be obtained.

- 1.1.10** 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.
- 1.10.11** All references to psi throughout this standard are to be considered gage pressure unless otherwise specified.

1.2 GENERAL CONSTRUCTION

- 1.2.1** The construction of the heater shall be such that it will not show signs of becoming warped, bent, broken or otherwise damaged during the initial test installation or during any of the tests specified herein so as to prevent its compliance with any of these provisions and, whether specifically covered by the various provisions of 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.

- 1.2.2** Asbestos shall not be used in the construction of a heater.
- 1.2.3** Every part of the heater shall be secure against displacement and shall be constructed so as 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 and cannot be improperly located or misaligned when removed or replaced during cleaning or other servicing.

- 1.2.4** All components shall be suitable for the temperatures to which they are exposed. In those instances where component temperature suitability is not determined under the other provisions of this standard or by established compliance with a nationally recognized standard pertaining to the specific component, the testing agency at its discretion may rely upon the recommendations of the component manufacturer as submitted by the heater manufacturer.
- 1.2.5** A heater for outdoor installation shall have all controls and electrical wiring enclosed and protected from environmental climate conditions.
- 1.2.6** A heater shall be constructed so it cannot be tipped over when subjected to the following Method of Test. This provision shall not apply to heaters which are provided with means (including necessary screws, bolts, or both) and instructions for attaching them to the wall, floor or ceiling.

Method of Test

Appliances weighing up to 100 pounds (45.4 kg) shall be tipped in any direction at an angle of 15 degrees (0.26 rad) from the vertical and shall not tip over when released.

Appliances weighing over 100 pounds (45.4 kg), shall not tip over when a horizontal force equal to $\frac{1}{10}$ of the appliance weight is applied in any direction at the center of the top of the appliance.

- 1.2.7** A heater intended for installations subject to spray washdown shall have all controls and electrical wiring enclosed and protected to prevent moisture and operational damage resulting from the washdown process. (Also see Section 2.13.)

1.3 MATERIALS

- 1.3.1** Evidence acceptable to the testing agency shall be supplied that all materials used in the construction of the heater have been evaluated and found to be suitable for the environment for which the heater is intended. Test data based on ASTM or other appropriate test procedures, certifications or historical data may be submitted for this purpose. The data shall include, but not be limited to, evidence that the materials have been evaluated, as appropriate, for resistance to corrosion, as caused by moisture and animal waste by products such as ammonia and hydrogen sulfide.
- 1.3.2** Components constructed from copper or copper alloy shall not be used except when such components are protected from the effects of ammonia and also comply with 2.14.
- 1.3.3** Materials used in the construction of a heater shall be suitable for the temperatures to which they will be exposed in use.
- 1.3.4** Gaskets of access panels or doors shall have sufficient durability to withstand expected usage and maintenance. Gaskets, when used, shall be suitable for the temperatures to which exposed.
- 1.3.5** On heaters for outdoor installation or subject to spray washdown, ferrous material used in the construction of the outside casing 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 or materials which have been shown to give equivalent protection.

Nonferrous cabinets, enclosure and outside portions of casings may be employed without special corrosion protection. The acceptability of the material shall be judged on the basis of its strength and rigidity.

- 1.3.6** Outside casings shall be constructed of AISI C1010 sheet steel not less than 0.0195 inch (0.495 mm) thick or material having equivalent strength and rigidity.

1.4 ASSEMBLY

- 1.4.1** The construction and assembly of a heater shall be of a neat and workmanlike character with parts well fitted and bolts or other fasteners drawn up to give rigidity. Any exposed edges of the heater which might be brought in contact with the hand during normal usage or adjustment shall be smooth.

- 1.4.2 Bolts, nuts, screws (except sheet-metal screws), and other threaded parts, used in the general assembly of the heater shall have threads conforming to the Standard for *Unified Inch Screw Threads (UN and UNR Thread Form)*, *ANSI/ASME B1.1*, or the Standard for *Metric Screw Threads - M Profile*, *ANSI/ASME B1.13M*, or other nationally recognized standard.
- 1.4.3 In submitting a heater for test, the manufacturer may furnish a list of manufacturing tolerances applicable thereto and may have the heater tested for compliance with this standard in both extremes of tolerances specified.

1.5 ACCESSIBILITY

- 1.5.1 All controls shall be accessible for normal servicing and functional adjustment in position and shall be replaceable during normal servicing. Manifold assemblies which permit removal of control(s) intact shall be considered to meet this provision for servicing. Removal of an access panel or door to secure access to a control compartment shall be considered acceptable.
- 1.5.2 Provision shall be made to permit observation of the igniter or pilot flames of each main burner under operating conditions. A panel(s) or door(s) may be removed to allow such observation. If a panel or door must be removed for observation, the heater shall comply with 2.4 with the panel or door removed.

1.6 MAIN BURNERS

- 1.6.1 Bodies of burners (including burner head, burner tube and burner head) shall be of substantial and durable construction. They shall be constructed of either:
- a. Materials having melting points above 1450°F (788°C), or
 - b. Materials having melting points of from 1000 to 1450°F (538 to 788°C).
- The design and materials used in “b” above shall comply with 2.10.3.
- 1.6.2 Burner ports shall be machined or otherwise accurately made.
- 1.6.3 Joints in the pressure zone or burner head of a burner assembly shall be gastight.
- 1.6.4 Bolt holes shall not intersect gasways unless adequate provision is made to provide permanent gastightness.
- 1.6.5 Burners or burner and support assemblies shall be removable, constructed so that they are essentially self-locating and shall be secured so that they will not twist, slide, or drop out of position in normal use. Burners which are bolted or locked into position shall be provided with securing means that are accessible and constructed of a corrosion-resistant material.

1.7 COMBUSTION AIR CONTROL

- 1.7.1 Primary air openings shall be fixed and nonadjustable.
- 1.7.2 In the event the blower motor providing combustion air becomes inoperative, the heater design shall be such as to prevent gas flow to the main burner(s).

A properly applied centrifugal, pressure-operated 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 flattened shaft, a locking type set screw on a flattened shaft, or the equivalent.

- 1.7.3 On a heater for outdoor installation, all outside air inlet openings shall be such as to prevent the entrance of a $1\frac{1}{8}$ inch (28.6 mm) diameter rod.

1.8 ORIFICES AND ORIFICE FITTINGS

- 1.8.1 A fixed orifice(s) shall be provided for the main burner(s) and shall be readily accessible.
- 1.8.2 Main burner orifices and orifice holders shall be made of materials having melting points of at least 1450°F (788°C).

1.9 IGNITION MEANS (SYSTEMS)

- 1.9.1 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* or *Combination Gas Controls for Gas Appliances, ANSI Z21.78* ·CGA 6.20, or other nationally recognized standards covering such components.
- 1.9.2 If a piezoelectric spark device is used for pilot burner ignition it shall comply with the Standard for *Manually-Operated Piezo-Electric Spark Gas Ignition Systems and Components, ANSI Z21.77* ·CGA 6.23.
- 1.9.3 Each combustion chamber of a heater shall be equipped with an ignition system designed to function in one of the following manners:
- Provide for manual (direct) lighting of main burner gas for heaters having inputs of 50,000 Btu per hour (14 654 W) or less. If the presence of the main burner flame is not proved, provide for automatic shutoff of main burner gas.
 - 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 the main burner and pilot gas.
 - 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.

- 1.9.4 In addition to the automatic gas ignition system functions specified in 1.9.3-b, 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.
- 1.9.5 Pilot burners shall be of substantial and durable construction. They shall be of materials having melting points above 1450°F (788°C). Nickel alloys of greater than 1.0 percent nickel are not acceptable because of catalytic cracking effect.
- 1.9.6 An ignition device shall be located so as to be easily seen. A panel(s) or door(s) may be removed to allow such observation.
- 1.9.7 Pilot burners shall be placed so their flames may be directly observed with the main operation, shall be observable with the main burner(s) on.
- 1.9.8 A manually lighted burner shall be located so as to be capable of being lighted without burning the hand. If a main or pilot ignition device or lighter rod is necessary for safe and convenient pilot ignition, it shall be provided. If a lighter rod is used, it shall not exceed 12 inches (305 mm) in length, and means shall be provided for permanently attaching it to the heater.
- 1.9.9 When a manually lighted pilot is provided, the design of the control system shall be such that main burner gas flow cannot occur while the pilot is being lighted in accordance with the manufacturer's lighting instructions (see 1.22.3). The interruption of main burner gas flow shall not depend on the operation of a manual valve nor on 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 a control shall be necessary to permit main burner gas flow.
- 1.9.10 When an automatic relight pilot system is used, it shall be of a 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.
- 1.9.11 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 and dirt during normal operation.
- 1.9.12 Automatic ignition devices shall be positively positioned with respect to the main burner port(s). Such devices shall be secure against accidental displacement, incorrect assembly and reversible mounting.

- 1.9.13 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 the main burner and controls as a unit are considered as complying with this provision.
- 1.9.14 Pilot burner primary air openings and gas orifices shall be easily accessible for servicing.
- 1.9.15 Clearance shall be provided for removal and replacement of pilot burners without kinking pilot gas tubing.
- 1.9.16 Electric make-and-break contacts shall not be placed within a combustion chamber unless shielded against deterioration from heat and flue gases.
- 1.9.17 When automatic gas ignition system wiring extends into a combustion chamber, it shall be protected against abrasion. When it is necessary to disconnect leads to remove a component, the leads shall be of sufficient length to reach a convenient disconnect point.
- 1.9.18 The application of a pilot igniter shall be such that its operation will not produce a proved pilot effect at the flame sensor if the pilot is not established.
- 1.9.19 If the position of the pilot igniter is adjustable with respect to the pilot burner, locking means shall be provided for maintaining such adjustment.

1.10 COMBINATION GAS CONTROLS

- 1.10.1 Combination gas controls, if provided, shall comply with the applicable provisions of the Standard for *Combination Gas Controls for Gas Appliances*, ANSI Z21.78 · CGA 6.20.

1.11 MANUAL GAS VALVES

- 1.11.1 A separate manual gas valve for shutting off the gas to the main burner and to the pilot burner, unless provided as part of a combination gas control as specified in 1.10 above, shall be supplied with the heater.
- 1.11.2 An individual manual gas valve subjected to pressures of $\frac{1}{2}$ psi (1.35 kPa) or less shall comply with the applicable provisions of the Standard for *Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves*, ANSI Z21.15 or *Combination Gas Controls for Gas Appliances*, ANSI Z21.78 · CGA 6.20, as applicable.
- 1.11.3 An individual manual gas valve subjected to pressures greater than $\frac{1}{2}$ psi (3.5 kPa) shall comply with the applicable provisions of the Standard for *Valves for Flammable Fluids*, UL 842, or for use with high pressure natural gas systems, with A.G.A. Requirement 2-93 for *Manually Operated Valves for High Pressure Natural Gas*, and shall have a rated working pressure of not less than the maximum pressure to which it is exposed.

1.11.4 Lubricants used on the valve shall be resistant to the action of liquefied petroleum gases.

1.12 HEATER GAS PIPING

The following construction provisions apply to the gas supply lines used within a heater.

1.12.1 Iron or steel pipe employed as gas conduit on a heater shall comply dimensionally with the Standard for *Welded and Seamless Wrought Steel Pipe, ANSI/ASME B36.10M*.

1.12.2 Tapped holes for gas valves, pilots or other branch supply, lines shall carry not less than 3¹/₂ taper pipe threads in accordance with the Standard for *Pipe Threads, General Purpose (Inch) ANSI/ASME B1.20.1*.

1.12.3 When the pilot gas 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 supply line.

1.12.4 Formed piping shall have the bends smoothly made without any appreciable reduction in the cross-sectional area; shall reveal no imperfections occasioned by the bending or forming process; and shall be annealed if necessary to remove internal stresses.

1.12.5 Nonferrous semi-rigid tubing employed as heater gas piping shall have a wall thickness in accordance with Table III.

1.12.6 Aluminum piping or tubing shall not be used.

1.12.7 Copper tubing, or tubing with internal copper surfaces, when used for conveying natural gas shall be internally tinned or equivalently treated to resist sulphur corrosion and shall comply with section 1.3.2.

1.12.8 Nonferrous semi-rigid tubing shall comply with one of the following:

- a. The *Specification for Seamless Brass Tube, ASTM B135*.
- b. Type K or L coverage in the *Specification for Seamless Copper Water Tube, ASTM B88*.
- c. *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service, ASTM B280*.

1.12.9 Tubing and fittings used as gas conduit shall be capable of withstanding a temperature of 1000°F (583°C) without melting.

Tubing and fittings used as gas conduit shall not attain temperatures in excess of those specified in Table IV when the heater is operated as specified in 2.10.

1.12.10 Gas supply piping, tubing and fittings shall be rigidly supported.

- 1.12.11 Thread sealing compounds used on threaded joints of gas piping shall be certified by a nationally recognized testing agency as complying with the *AGA Requirement 4-90, for Pipe Joint Sealing Compounds and Materials*.
- 1.12.12 Unions in gas lines shall be of the ground-joint or flanged-joint type including a gasket resistant to the action of liquefied petroleum gases and suitable for the temperature to which it is exposed.
- 1.12.13 A test gage connection shall be furnished downstream from the last main line gas control for measuring gas pressure at the burner manifold. The connection shall be a minimum $\frac{1}{8}$ inch NPT plug or cap with cleanly cut taper pipe 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;

When the pressure test gage connection is provided as part of the control this pressure test gage connection shall be:

- a. A tapping sealed by a minimum $\frac{1}{8}$ inch NPT plug or cap as specified above; or
- b. A hose fitting 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.

1.13 GAS HOSE ASSEMBLIES

- 1.13.1 A gas hose assembly (consisting of a hose and end fittings), if provided, shall either:
1. Comply with the Standard for *Pigtails and Flexible Hose Connectors for LP Gas, ANSI/UL 569*, [except that the length shall not exceed 10 feet (3048 mm)], or other applicable nationally recognized standard; or
 2. Comply with the following Methods of Test.
 - a. Withstand an internal pressure of 700 psi (4.82 MPa) without leakage.

Method of Test

Three new test samples, each 2 feet (610 mm) long, shall be provided for an assembly to be tested under this provision. Each sample is to be connected to a source of air, nitrogen, or carbon dioxide gas which will provide a 700 psi (4.82 MPa) test pressure. The outlet of the free end fitting is to be closed and the entire sample immersed in water. A suitable pressure gage shall be installed in the pressure supply piping between a positive shutoff valve and the hose assembly connector sample. Each sample shall withstand a 700 psi (4.82 MPa) test pressure for 5 minutes with no evidence of leakage. (During pressurization, safety precautions shall be taken for hose assembly rupture.)

- b. Withstand a pulling force without damage to the hose assembly.

Method of Test

Three new test samples, each 1 foot (25.4 mm) long, shall be provided for a hose assembly to be tested under this provision. The connecting fitting on each end of each sample is to be made up tightly with a corresponding companion part. Each sample shall be connected to a mechanical pulling means so both end fittings, fitting joints and hose are subjected to the pulling force. The pulling force shall be 400 pounds (1.78 kN) for hose assemblies having nominal inside diameters of $\frac{5}{8}$ inch or less and 750 pounds (3.34 kN) for larger hose assemblies. The mechanical pulling means shall extend the sample at a rate of $\frac{1}{2}$ inch per minute until the applicable pulling force is reached and shall then maintain this force for 1 minute. Each hose assembly shall not rupture or show other evidence of failure.

- c. **Withstand a 1750 psi (12.07 MPa) hydrostatic pressure without rupture or permanent distortion.**

Method of Test

The 3 test samples used for the test in “a” shall be used for a hose assembly to be tested under this provision. Each sample is to be connected to a source of hydrostatic pressure which will provide a 1750 psi (12.07 MPa) test pressure, and the outlet of the free end fitting is to be closed. A suitable pressure gage shall be installed in the pressure supply piping between a positive shutoff valve and the connector sample. Each sample shall withstand a 1750 psi (12.07 MPa) test pressure for 1 minute without rupturing or showing evidence of permanent distortion.

- 1.13.2 **The hose component of the gas hose assembly (see 1.13.1) shall comply with the Safety Standard for LP-Gas Hose, ANSI/UL 21.**
- 1.13.3 **End fittings shall be faced or otherwise finished externally to provide an adequate hexagonal or octagonal wrench grip.**
- 1.13.4 **End fitting threads intended for pipe connections shall be taper pipe threads conforming to the Standard for Pipe Threads, General Purpose (Inch) ANSI/ASME B1.20.1.**

The length to shoulder shall be not less than shown in Table V.

- 1.13.5 **Union seats shall not depend upon gaskets for gastightness. Listed quick-disconnect devices are exempt from this provision.**
- 1.13.6 **A quick-disconnect device, if provided, shall be listed or approved by a nationally recognized testing agency as complying with a suitable national standards and shall have a rated working pressure of not less than the maximum working pressure to which the device is subjected.**

1.14 AUTOMATIC VALVES AND SAFETY SHUTOFF VALVES

- 1.14.1 **A safety shutoff valve, unless provided as part of a combination gas control as specified in 1.10, shall be provided to shut off the main burner gas and the pilot gas, if applicable. (See 1.9.3-b).**

- 1.14.2 Automatic valves and safety shutoff valves shall comply with the applicable provisions of the Standard for *Automatic Valves for Gas Appliances*, ANSI Z21.21 · CGA 6.5, or *Combination Gas Controls for Gas Appliances*, ANSI Z21.78 · CGA 6.20, or other nationally recognized standards covering such devices.
- 1.14.3 Diaphragm type valves shall incorporate an internal bleed.
- 1.14.4 Automatic valves and safety shutoff valves shall assume the closed position upon failure of their power supply (electrical or mechanical) and shall not incorporate a manually set device which could prevent such closure.
- 1.14.5 A means for manually opening a main gas safety shutoff valve shall be permitted only on heaters with manually lighted main burners in accordance with 1.9.3-a. Such means shall not cause the valve to remain open when the manual opening force is removed. (Also see 1.9.9.)
- 1.14.6 Except as provided in 1.14.5, a means for manually opening a main gas automatic valve shall not be provided.

1.15 GAS PRESSURE REGULATORS

- 1.15.1 A gas pressure regulator, unless provided as part of a combination gas control as specified in 1.10, shall be supplied with each heater.
- 1.15.2 A gas pressure regulator shall comply with the following, as applicable:
- a. A gas pressure regulator subjected to inlet pressures not exceeding 5 psi (34.5 kPa) shall comply with the applicable provisions of the Standard for *Gas Appliance Pressure Regulators*, ANSI Z21.18 · CGA 6.3, or *Combination Gas Controls for Gas Appliances*, ANSI Z21.78 · CGA 6.20, as applicable.
 - b. An LP-gas pressure regulator subjected to inlet pressures greater than 5 psi (34.5 kPa) shall comply with the applicable provisions of the Standard for *Pressure Regulating Valves for LP-Gas*, ANSI/UL 144 and shall be equipped with an overpressure shutoff device as described in ANSI/UL 144.
- 1.15.3 When a single gas pressure regulator complying with the Standard for *Gas Appliance Pressure Regulators*, ANSI Z21.18 · CGA 6.3, or *Combination Gas Controls for Gas Appliances*, ANSI Z21.78 · CGA 6.20, is used to control the pressure of both pilot and main burner gas, it shall be of the type suitable for main burner and pilot load application as designated by the following symbol adjacent to the regulator model number:
- a.  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 cm³/s); or
 - b.  or  for an appliance having a pilot gas flow rate of 0.50 cubic foot per hour (3.93 cm³/s) or greater.

- 1.15.4 A gas appliance pressure regulator provided on a heater shall be of the adjustable, nonadjustable or multi-stage type (see Part IV, Definitions). The outlet pressure shall approximate that specified by the manufacturer (see 1.22.2-d and -e).

1.16 THERMOSTATS

- 1.16.1 When provided as an integral part of the heater (not for installation remote from the heater) thermostats, unless provided as part of a combination gas control as specified in 1.10 or other than electric type when provided, shall comply with the applicable provisions of the Standard for *Gas Appliance Thermostats, ANSI Z21.23*, or *Combination Gas Controls for Gas Appliances, ANSI Z21.78 · CGA 6.20*, or with the Standard for *Temperature-Indicating and -Regulating Equipment, ANSI/UL 873*, with the inclusion of the following tests:

1. The endurance test shall be conducted for 100,000 cycles, and
2. The calibration shall be verified following the endurance test to be within the tolerances specified in paragraph 2.2 of *ANSI Z21.23*.

- 1.16.2 When a thermostat is provided as an integral part of the heater, the thermostat dial shall bear a Class IIIB marking indicating the direction of movement of the adjustment for temperature control.

1.17 ADJUSTMENT OF MINIMUM INPUT RATING

- 1.17.1 When controls are designed for two or more rates, the adjustment means, when provided, shall be accessible and leakproof.
- 1.17.2 On 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 air and gas supplied to the burner.

1.18 LIMIT CONTROLS

- 1.18.1 Limit controls shall be listed as complying with the Standard for *Limit Controls, UL 353*.
- 1.18.2 Heaters shall be provided with an integral high temperature limit control which will cause safety shutdown of the heater in the event of fan failure. Safety shutdown as the result of fan failure shall be in compliance with 2.10.2 and prevent any overtemperature damage to the heater. The control shall require manual resetting before the heater can be re-started.

1.19 ELECTRICAL EQUIPMENT AND WIRING

- 1.19.1 All electrical equipment, wiring and accessories built in or supplied by the manufacturer for use with a heater shall be submitted for examination with the heater. Such equipment, wiring and accessories shall comply with 1.3.1.
- 1.19.2 Electrical equipment, line-voltage and low-voltage safety-circuit wiring supplied for use with and as a part of a 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 heater. 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 of approved types.
- 1.19.3 The heater shall be supplied with an electrical cord, leadwires in a connection box or enclosed terminal connections to connect the heater to an electrical supply.
- 1.19.4 If provided, the cord provided to connect the heater to a source of electrical supply shall consist of a three-conductor grounding type flexible cord and suitable attachment-plug cap complying with the applicable provisions covering outdoor-use cord sets specified in the Safety Standard for *Cord Sets and Power-Supply Cords, ANSI/UL 817*. The supply cord shall terminate in a suitable enclosure attached to the heater and shall be provided with a strain relief to protect the wiring terminals. Such strain relief will be able to withstand a pull of 35 lbs. without transmitting any strain on the connections. The attachment-plug cap shall be of the grounding type constructed in accordance with the Standard for *Wiring Devices - Dimensional Requirements, ANSI/NEMA WD6*, and shall have a current-carrying capacity greater than the current draw of the heater.

Method of Test

A 35 lb. (16 kg) weight shall be suspended on the cord and supported by the heater so that the strain relief device will be stressed from any angle that the construction of the heater permits. The strain relief is not acceptable if there is movement of the cord, at the point of disconnection of the conductors, to indicate that stress would have resulted on the connections.

- 1.19.5 A service junction box having provisions to accommodate fittings for metal-clad cable or conduit shall be provided for the permanent connection of the line-voltage supply circuit. This box shall be located on a part of the assembly that does not require movement for normal servicing and adjustment.

Unless the junction box is located so the temperature rise of the conductors within the box and surfaces of the box likely to be in contact with conductors shall not exceed 63°F (35°C) rise when the heater is tested in accordance with 2.12, a marking worded as follows shall be prominently displayed on the box by means of a Class V marking "For field wired connections use No. ____ AWG or larger wires suitable for at least ____°C (____°F)." The specified wire size shall be that used in the test or No. 14 AWG, whichever is larger, and the specified temperature rating shall not be more than 90°C. During the conduct of 2.10, all unused electrical connection

openings shall be closed. Ventilation of boxes used for connection of field wiring is not permissible.

- 1.19.6** The size of a junction box in which field-installed conductors are to be connected shall not be less than that indicated in Table VI (Junction Box Free Space Per Conductor). 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 VII (Minimum Average Thickness of Sheet-Metal Junction Boxes), 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 in the field.

- 1.19.7** Enclosures of listed devices which contain terminals for electrical connections need not comply with the free space specifications of 1.19.6. 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.

- 1.19.8** An enclosure for uninsulated live parts at line voltage shall have no openings which are not closed when the heater 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 $\frac{33}{64}$ 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 $\frac{49}{64}$ inch (19.4 mm) diameter rod.

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

- 1.19.9** 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 moving parts.

- 1.19.10** Except for low-voltage thermostat wiring, or a cord as described in 1.19.4, wiring which is external to the heater jacket when all panels are in place and which is part of the heater shall be protected by metal conduit, metal-clad cable, or raceways.

- 1.19.11** Splices in wiring shall be located only in accessible junction boxes. Splices shall be made mechanically secure, soldered and insulated with tape, or suitable fixture-type splicing connectors may be employed.

- 1.19.12** At points where conduit or metal-clad cable terminate, conductors shall be protected from abrasion unless the design of the boxes or fittings is 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 conductor and 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.

- 1.19.13 Wireways shall be smooth and entirely free from sharp edges, burrs, fins, etc., which may cause abrasion of the insulation on the wiring. In order to prevent abrasion of the insulation, openings in metal walls through which insulated wires not in wireways pass shall be provided with smoothly rounded bushings or acceptable metal grommets, or shall have smooth well-rounded surfaces as formed by rolling or extruding the metal around the opening. Bushings shall be phenolic, porcelain, hard fiber, or other suitable material having a smoothly rounded surface.
- 1.19.14 Wiring shall be done with insulated conductors having current-carrying capacity, voltage and temperature ratings consistent with their use. Lead wires for supply connections, shall not be smaller than No. 18 AWG (0.82 mm²).
- 1.19.15 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).
- 1.19.16 Connections from low-voltage electrical devices on the same heater shall be made in such a manner as to be identifiable in the field.
- 1.19.17 The electrical circuit of low-voltage control equipment shall be free from and protected from grounds or short-circuiting where the accidental grounding of any circuit wiring could render any safety device inoperative.
- 1.19.18 A low-voltage circuit shall be supplied by an energy-limiting transformer or a combination of transformer and overcurrent protection device suitable for an Class 2 circuit (see Article 725, Section 725-31, of the *National Electrical Code, ANSI/NFPA 70*) or by a combination of transformer and fixed impedance having output characteristics suitable for a Class 2 circuit.
- When an overcurrent protection device is used, it shall be an integral part of the transformer or be located at the point where the circuit to be protected receives its supply, shall not be of the automatic reclosing type and shall be trip-free from any reclosing mechanism. The device shall be inaccessible to tampering, except for a replaceable fuse which is not interchangeable with a device of a higher current rating.
- A low-voltage supply shall not be obtained from a power source above 30 volts by the use of voltage-dropping resistors.
- 1.19.19 Detachable plug connectors shall not be used in circuits when disconnection of the circuit may allow unsafe operation of the heater, unless means are provided to prevent accidental disconnection.
- 1.19.20 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.
- 1.19.21 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 heater, shall comply with the spacing specification in Table VIII.

Electrical clearances in motors and in components listed by a nationally recognized testing agency shall be deemed to comply with this provision.

- 1.19.22** 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 a green coloring shall not be used for other than grounding purposes when this conductor terminates within an enclosure used for field connections.

- 1.19.23** When within a burner, fan 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 or 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 IX, or Group A of the table when the wiring material is covered as specified in the footnote to Table IX, judged on temperature limitation and usage suitability as defined in the *National Electrical Code, ANSI/NFPA 70*, provided:

- a. The compartment is normally closed, except, circulating openings are permitted.
- b. Wiring below openings located in other than vertical surfaces is protected;
- c. Openings in vertical surfaces will not permit the entrance of a $\frac{33}{64}$ inch (13.1 mm) diameter rod where such straight rod may cause damage to the wiring; and
- d. Permitted openings, other than in "a" above, are at least 24 inches (50.8 mm) above the bottom of the compartment, if the compartment contains a motor.

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

- 1.19.24** A 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 noncurrent-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 test points.)

- 1.19.25 Switches shall have current and voltage ratings not less than those of the circuit loads they control.
- 1.19.26 Single pole switches, including those of safety controls or protective devices, shall not be wired in a grounded line. A safety control circuit shall be two-wire, have a nominal voltage not exceeding 125 volts and be protected against overcurrent at not more than the value appropriate for the rating of the electrical components in the circuit. (Also see 1.19.18) for overcurrent protection of low-voltage control circuits.)
- 1.19.27 A switch, or similar device, provided as a part of the heater, shall be mounted securely and prevented from turning.
- 1.19.28 High-tension terminals for transformers and wire leads shall provide protection against electrical shocks.
- 1.19.29 High-tension terminals on transformers shall be located on the heater so as to be free from contact with metal parts during normal use of the heater.
- 1.19.30 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 brass loops, eyes or other equivalent means to facilitate positive connection. The leads may be integrally joined to the transformer windings provided proper strain relief is furnished.
- 1.19.31 High-tension leads or cable shall be as short as possible, free from any sharp bends and protected from rough usage, abrasion and soakage with water or condensate.
- 1.19.32 Electrodes and bus bars of the, uninsulated type shall be suspended away front metal parts and be 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.
- 1.19.33 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.
- 1.19.34 Electrode tips shall be designed so extreme burning of the points will not result over a period of time.
- 1.19.35 Flexibility in electrodes at their outer ends may be permitted if designed to resist warping and accidental dislocation.
- 1.19.36 If electric ignition is used, the igniter shall be designed and locate so as to minimize 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.
- 1.19.37 An insulator shall be made of suitable ceramic insulating material or the equivalent, impervious to oil and moisture and cleanable by wiping.

1.19.38 Electrical equipment and wiring shall be suitable for the temperatures to which they are exposed and the service to which they are subjected. Temperatures shall be determined as specified in 2.12 (also see 1.19.2) and shall not be in excess of those for which the wires and components are approved. Maximum allowable temperature rise of some typical wires and components are shown in Table X.

1.19.39 A heater shall be subjected to a leakage current test, and the leakage current measured on a heater tested in accordance with the following Method of Test shall not exceed the limits specified below.

Method of Test

The heater shall be operated until equilibrium temperatures are attained, as specified in 2.10.1, when connected in the manner intended to a supply circuit of rated voltage and frequency.

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 as specified in the Standard for *Leakage Current for Appliances*, ANSI C101.1. The leakage current shall not exceed 0.5 milliamperes, except for heaters equipped with a capacitor-type motor leakage current shall not exceed 1.15 milliamperes.

1.19.40 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 heater shall be operated at Test Condition 2 in Table XIII. At the conclusion of the operating period specified, the applicable dielectric test(s) outlined 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. A heater 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 $\frac{1}{2}$ 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 heater 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 shall be obtained, rather than depending upon a visual inspection of the material.

1.20 MOTORS

- 1.20.1 Electrical motors shall be totally enclosed and designed for continuous duty and shall be provided with overcurrent protection in accordance with the *National Electrical Code, ANSI/NFPA 70*. Fractional horsepower motors may be protected with temperature- or current-sensitive devices or temperature- and current-sensitive devices which will prevent motor winding temperatures from exceeding those specified in Table XI. If the impedance of the motor windings is sufficient to prevent winding temperatures in open motors or enclosure temperatures on totally enclosed motors in excess of 302°F (150°C) with the rotor locked, no additional motor protection is necessary, but the motor shall bear a Class III marking indicating that it is impedance protected. The above tests may, at the option of the manufacturer submitting the heater, be conducted using the resistance method for determining temperature rise.

- 1.20.2 Motors shall operate at temperatures not in excess of the limits specified in Column 1 of Table X. At the option of the manufacturer, the temperature of motor windings may be measured by the resistance method. The heater shall be operated at normal test pressure as specified in 2.10.1.

1.21 INSTRUCTIONS

- 1.21.1 Each heater shall be accompanied by clear, concise printed instructions and diagrams, stated in terms clearly understandable to the operator, adequate for proper field assembly, maintenance, safe use and operation.

The front cover or the first page of the instructions shall contain the manufacturer's, distributor's, jobber's or dealer's name, as it appears on the name plate; and address and appliance model or series number.

The safety-related items included in the instructions shall be prominently displayed and shall precede the instructions concerning the functional use of the heater.

The instructions shall be marked with directions to the operator to retain them for future reference.

The instructions shall be reviewed by the testing agency for comprehensibility, accuracy and compatibility with results of test.

Either the front cover or the first page of the instructions shall bear the following boxed warnings. The letters used for the boxed warnings shall be boldfaced type having a minimum uppercase letter height of 0.120 inch (305 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.

GENERAL HAZARD WARNING!

FAILURE TO COMPLY WITH THE PRECAUTIONS AND INSTRUCTIONS PROVIDED WITH THIS HEATER, CAN RESULT IN DEATH, SERIOUS BODILY INJURY AND PROPERTY LOSS OR DAMAGE FROM HAZARDS OF FIRE, EXPLOSION, BURN, ASPHYXIATION, CARBON MONOXIDE POISONING, AND/OR ELECTRICAL SHOCK.

IF YOU NEED ASSISTANCE OR HEATER INFORMATION SUCH AS AN INSTRUCTIONS MANUAL, LABELS, ETC. CONTACT THE MANUFACTURER.

WARNING!

KEEP SOLID COMBUSTIBLES, SUCH AS BUILDING MATERIALS, PAPER OR CARDBOARD, FEATHERS, STRAW AND DUST A SAFE DISTANCE AWAY FROM THE HEATER AS RECOMMENDED BY THE INSTRUCTIONS. NEVER USE THE HEATER IN SPACES WHICH CONTAIN OR MAY CONTAIN VOLATILE OR AIRBORNE COMBUSTIBLES, OR PRODUCTS SUCH AS GASOLINE, SOLVENTS, PAINT THINNER, DUST PARTICLES OR UNKNOWN CHEMICALS. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN A FIRE OR EXPLOSION, PROPERTY DAMAGE, PERSONAL INJURY OR LOSS OF LIFE.

^{*} This letter height and line spacing correspond to 12 point type.