

American National Standard For **Gas Appliance Thermostats**

Eleventh Edition - 2010

The standard is a revised edition of the former standard for
Gas Appliance Thermostats,

Z21.23-2000

Z21.23a-2003

Z21.23b-2005



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American National Standards Institute, Inc.

Standard Developer

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Preface

This publication represents a basic standard for safe operation, substantial and durable construction, and acceptable performance of gas appliance thermostats. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on gas appliance thermostats 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 gas appliance thermostats, the safety construction and performance of which may exceed the various provisions specified herein. In its preparation, recognition has been given to possibilities of improvement through ingenuity of design. As technical advances take place, revisions may become necessary. When they are believed desirable, recommendations or suggestions should be forwarded to the Chairman of Standards Committee Z21/83, 8501 East Pleasant Valley Road, Cleveland, Ohio 44131. A proposal form is provided in the back of this document.

Safe and satisfactory operation of gas appliance thermostats depends to a great extent upon its proper installation, use and maintenance. It should be installed, as applicable, in accordance with the National Fuel Gas Code, ANSI Z223.1/NFPA 54; the (U.S.) Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280, or when such standard is not applicable, Manufactured Home Installations, ANSI/NCSBCS A225.1 or the Standard for Manufactured Home Installations, Sites, and Communities, ANSI/NFPA 501A, manufacturers' installation instructions, and local municipal building codes.

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History Of The Development Of Standard For Gas Appliance Thermostats

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

There appears to be no evidence of the existence of construction and performance standards for gas appliance thermostats prior to the preparation of this standard, except for certain performance provisions in previous American Gas Association standards for domestic gas appliances, such as gas ranges and gas water heaters. These standards were primarily concerned with appliance performance, and thermostats were considered only to the extent of their effect on appliance operation.

In September 1930, a representative of the National Gas Appliance Manufacturer's Association appeared before American Standards Association Sectional Committee Z21 requesting recognition of various accessories used on, or in conjunction with, gas appliances. A special committee was appointed to study this problem which resulted in the formation of the Subcommittee on Listing Requirements for Gas, Pressure and Temperature Control Accessories in May 1931 for the development of standards for various control accessories.

At the first meeting of this group in March 1932, the general scope of its assignment was considered and, since there were a number of distinct types of accessories to be considered, representative subgroups were appointed to draft standards for specific classes of accessories.

One of these subgroups was the Subcommittee on Listing Requirements for Thermostats and Thermostatic Pilots. A draft standard for thermostats was developed by this group and distributed to the industry for review and comment during August 1933. The draft standard was reconsidered in April 1934 in conjunction with the comments received and was adopted with minor revisions. The resultant draft standard was adopted by the Z21 Committee at its June 1934 meeting. The first edition of this standard was subsequently approved as American Standard by the American Standards Association in February 1935.

An expansion of the standard to cover thermostats used on various gas appliances, including substituting the words "gas appliance thermostats" for the term "water heater, gas range and space heater thermostats" was distributed for review and comment in April 1939. The revisions were adopted by the Z21 Committee, and the second edition of this standard was subsequently approved as American Standard in February 1940.

The development of new types of gas appliance thermostats, such as range top burner thermostats and low temperature oven thermostats, and general progress in the development of gas appliance thermostats prompted the subcommittee to prepare extensive revisions to the standard. Following the procedures outlined above, these revisions were adopted by the Z21 Committee at its March 1961 meeting. This third edition was subsequently approved as American Standard by the American Standards Association, Inc., in October 1961.

The increasing use of electric switch type thermostats prompted further revisions to the standard to cover this type of thermostats, in addition to integral gas valve type thermostats, and revisions covering thermostats of both types for use in gas refrigerators. These revisions were subsequently adopted by the Z21 Committee at its March, 1963 meeting. The fourth edition was approved as American Standard by the American Standards Association, Inc., in December 1963.

In August, 1966, the American Standards Association, Inc., was reconstituted as the United States of America Standards Institute which, in October, 1969, was in turn renamed the American National Standards Institute, Inc. As a result, the fifth through seventh editions of the gas appliance thermostat standard were approved as American National Standards by the American National Standards Institute, Inc., between 1971 and 1980.

Following the procedure outlined above, further revisions to this standard were developed in line with industry developments. This, the tenth edition of the gas appliance thermostat standard was approved as an American National Standard by the American National Standards Institute, Inc., on August 27, 2010.

Previous editions of the gas appliance thermostat standard, and addenda thereto, approved by ANSI or its predecessor organizations are as follows:

Z21.23-1935		Z21.23-1975	Z21.23a-1977	Z21.23b-1978
Z21.23-1940	(R1947, 1950, 1953)	Z21.23-1980	Z21.23a-1985	Z21.23b-1988
Z21.23-1961		Z21.23-1989	Z21.23a-1991	Z21.23b-1993
Z21.23-1963	(R1968)	Z21.23-1993	Z21.23a-1994	Z21.23b-1997
Z21.23-1971	Z21.23a-1971 Z21.23b-1974	Z21.23-2000	Z21.23a-2003	Z21.23b-2005

NOTE: This edition incorporates changes to the 2000 edition of Z21.23, and addenda thereto. Changes other than editorial, are denoted by a vertical line in the margin.

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American National Standard For Gas Appliance Thermostats

Part I: Construction

1.1 Scope

1.1.1

This standard applies to newly produced gas appliance thermostats of the integral gas valve type having a maximum operating gas pressure of $\frac{1}{2}$ psi (3.5 kPa) or electric type (see Part IV, Definitions), constructed entirely of new, unused parts and materials.

This standard does not apply to an electric type comfort heating thermostat (wallmounted) for installation remote from an appliance.

When the operating performance characteristics of the thermostat can be affected by the separate components, such as power supply, transformer and valve(s), the thermostat shall be tested as part of a complete system.

Compliance of a device with this standard does not imply that such device is acceptable for use on gas appliances without supplemental tests with the device applied to the particular appliance design.

1.1.2

An accessory incorporated as an integral part of a thermostat shall comply with all provisions of the applicable standard for such a device.

1.1.3

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.

1.1.4

All references to psi throughout this standard are to be considered gauge pressures unless otherwise specified.

1.2 General

1.2.1

Representative complete thermostats, together with necessary adapters or connectors, shall be provided for examination under this standard as specified by the testing agency. If the thermostat assembly includes accessories which are covered by other standards, but which have not been certified under those standards, additional quantities of each accessory shall be provided as specified by the testing agency.

1.2.2

A description of the operating principle and necessary installation and service instructions of the thermostat shall be provided.

1.2.3

The manufacturer shall specify the maximum recommended ambient temperature(s) for the thermostat and its components. The specified maximum ambient temperature shall not be less than 125°F (51.5°C), and the specified minimum ambient temperature shall not be greater than 32°F (0°C).

1.2.4

For electric type thermostats, the manufacturer shall specify the electrical ratings desired for each model submitted.

1.2.5

For electric type thermostats, the manufacturer may furnish a test fixture which simulates the control characteristics of an appliance and any necessary additional components that, with the thermostat, constitute a complete control system. This equipment shall be used to test for calibration accuracy as specified in 2.4, Accuracy of Temperature Set Point, and for additional performance tests as specified in Part II of this standard.

1.2.6

Any operating mechanism, such as the thermostatic valve mechanism, susceptible to mechanical damage which could result in faulty or unsafe operation, shall be protected by a substantial enclosure so as to prevent interference with the safe operation of the device.

1.2.7

When an integral gas valve type thermostat is constructed so that the use of an adapter is necessary to permit pipe or semirigid gas tubing connection to be made, the adapter(s) furnished by the manufacturer shall be used in these tests.

1.2.8

The construction of thermostats shall be such that they will not show signs of becoming bent, warped, broken or defective so as to prevent their continued compliance with this standard.

1.2.9

The construction of parts and materials used that are not covered by this standard 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.

1.2.10

Thermostat valve bodies shall be constructed of materials having melting points of at least 800°F (427°C).

1.2.11

A thermostat in which a nonmetallic flexible diaphragm constitutes the only gas seal shall have the atmospheric side of the diaphragm enclosed to limit the leakage to atmosphere in the event of diaphragm rupture to not more than 1.0 ft³/hr (7.87 cm³/s) of 1.53 specific gravity gas at 11.0 in wc (2.74 kPa) pressure, or shall be provided with means for venting the gas in the event of diaphragm rupture.

1.2.12

A thermostat in which a metallic flexible diaphragm constitutes the only gas seal shall have the atmospheric side of the diaphragm protected to prevent accidental damage to the diaphragm.

1.2.13

An electric type thermostat which is provided with an "off" position shall incorporate a positive means to prevent closing of its contacts at a temperature of -35°F (-37°C) when in the "off" position.

1.2.14

A device involving electronic control circuits shall be investigated under conditions of actual service to determine if it complies with all applicable standards and is otherwise suitable for its intended application.

1.2.15

If zinc-based die castings are used, they shall be made of ASTM Alloy AG40A or AC41A, or have equivalent properties. Zinc die castings shall not be used for parts when failure could cause unsafe operation of the device.

1.2.16

Thermistor(s) used as temperature sensors shall comply with the applicable provisions of the *Standard for Thermistor-Type Devices, UL 1434*.

1.2.17

Thermistors used as temperature sensors shall not carry a load current.

1.3 Data Furnished By Manufacturer

The manufacturer shall furnish the following as appropriate, for use by the testing agency in examining gas appliance thermostats under this standard;

- a. Drawings, blueprints, or photographs that describe each model, as specified by the testing agency;
- b. Mounting classification (see 2.1.1);
- c. Ambient temperature range in which the thermostat is intended to operate;
- d. Pressure drop capacity at 1.0 in wc (249 Pa);
- e. The rated current(s) at rated voltage;
- f. Thermostat operating temperature range and thermostat calibration reference points;
- g. Supporting documentation relative to the suitability of materials (see 1.9, Materials);
- h. Type of thermostat and a description of the operating principle; and
- i. Maximum cycling rate(s) for continued operation test.

1.4 Connections

1.4.1

When for connection to pipe, the inlet, outlet, pilot or other connections shall be provided with cleanly cut taper threads in accordance with the *Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1*.

1.4.2

Pipe thread length and length-to-shoulder dimensions shall not be less than as shown in Table I, Minimum Thread Length and Length to Shoulder.

1.4.3

Inlet and outlet gas connections of an integral gas valve thermostat shall be designed so that when a pipe that is threaded two threads beyond standard size (for the size in question) is run into the threaded portion of a valve body, it will not adversely affect the operation of the valve.

1.4.4

When for connection to semirigid tubing, the connection together with the fittings used thereon shall be in accordance with or be inter-changeable with the fittings described in *Part I, SAE Handbook*.

1.4.5

Copper semirigid tubing or tubing having internal copper surfaces, when used for conveying gas, shall be internally tinned or equivalently treated to resist sulfur corrosion.

1.4.6

When the thermostat is to be screwed into a tank or fitting, it shall be provided with taper pipe threads as specified in 1.4.1.

1.5 Mounting

1.5.1

Provision shall be made for securely mounting the thermostat in position. Bolts, screws, or other parts used for mounting a device in position shall be independent of those used for securing component parts of the device.

1.5.2

Special tools shall not be required for mounting or demounting the thermostat.

1.6 Bolts, Nuts, Screws And Other Threaded Parts

Bolts, nuts, screws and other threaded parts used in attaching covers, housings, casings and external mounting brackets shall have threads conforming to the *Standard for Unified Inch Screw Threads (UN and UNR Thread Form)*, ANSI/ASME B1.1.

1.7 Adjustments

1.7.1

When adjustment means are provided, as for calibration or bypass, such means shall be convenient and adequate for the purpose.

1.7.2

Means for maintaining all adjustments shall be provided. Lock nuts or adjusting nuts held by springs or compression will be considered satisfactory except when their adjustment can be accidentally disturbed.

1.7.3

Bypass rate adjustments shall be independent of pilot rate adjustments.

1.7.4

Bypass adjustments shall be capped or otherwise concealed in such a manner as to prevent tampering or accidental change in adjustment. Thermostats, which by their design are intended for concealed installation, shall be considered as complying with this provision.

1.7.5

Factory adjustment means for timings shall be permanently sealed by means suitable for both continuous and intermittent exposure at the manufacturer's specified minimum and maximum operating temperatures. Suitability of the sealing means shall be judged before and after completion of all tests specified in this standard.

1.7.6

Means shall be provided to prevent change in temperature adjustment due to jarring, vibration or shock.

1.8 Strength

The following provisions apply only to integral gas valve type thermostats.

1.8.1

The strength of all parts and joints of the thermostat body shall be such that no evidence of leakage or permanent deformation will develop as a result of the tests specified herein.

1.8.2

Thermostat bodies shall be sufficiently strong to withstand, without deformation, breakage or leakage, the turning effort specified below exerted to connect the thermostat body to a manifold, tank or fitting. If a separate inlet flange is provided, the listed torque shall be applied to it.

Method of Test

A tool which fits snugly about the thermostat body or flange or to a section of the shank shaped for a wrench, if such a section is provided, shall be utilized to apply the turning force. The appropriate turning force shall be applied to the hex of the thermostat body or flange adjacent to where it is attached to the piping, or if no hex or flange is provided in this position, to the thermostat body. Two drops of SAE No. 10 viscosity machine oil shall be applied to the thread. The measured torque shall be applied to the thermostat body or flange to screw it to a fitting of suitable size. After the force has been applied for 15 minutes it shall be released and the thermostat subjected to the applicable leakage tests outlined in 2.2, Leakage. The thermostat or flange shall then be removed and examined for deformation and breakage.

Nominal Pipe Size In.	Turning Effort	
	In-Lb	(N•m)
$\frac{1}{8}$	170	(19.2)
$\frac{1}{4}$	220	(24.7)
$\frac{3}{8}$	280	(31.6)
$\frac{1}{2}$	375	(42.4)
$\frac{3}{4}$	560	(63.3)
1	750	(84.7)
$1\frac{1}{4}$	875	(98.9)

1.9 Materials

For a thermostat containing part(s) intended for contact with potable water, the manufacturer shall supply evidence satisfactory to the testing agency that material used as a protective coating for thermal sensing element tubes is suitable for the service, particularly with respect to toxicity, solubility, brittleness and temperature limits. Evidence of current certification under the *Standard for Plastic Piping System Components and Related Materials, ANSI/NSF 14* with appropriate end use shall be deemed acceptable.

1.10 Temperature Markings

Temperature markings referred to below may be either indicated in degrees Fahrenheit or be of the nomenclature type.

1.10.1

When numbered graduation in degrees F are provided on the dial, it is recommended that such numbered markings be limited according to the type of appliance on which the thermostat is for use, as shown in Table II, Recommended Dial Temperature Markings.

1.10.2

When means are provided for the user to vary the temperature setting, such means shall clearly indicate the direction of movement to increase or decrease the temperature and the minimum and maximum operating positions. One of the dial graduations shall be located at the calibration reference point.

1.10.3

Thermostats for use on ovens and broilers shall be provided with dials marked with successively numbered temperatures not more than 50°F (28°C) apart. Above 200°F (93.5°C), graduations shall be provided at least every 25°F (14°C). These thermostats shall be constructed so as to allow the dial to be set at any marked temperature position.

1.10.4

On adjustable type thermostats, the calibration reference points shall be as shown in Table III, Calibration Reference Point(s).

For temperature ranges other than those recommended in Table II, Recommended Dial Temperature Markings, the calibration reference point(s) shall be specified by the manufacturer.

1.11 Resistance To Corrosion

The manufacturer shall supply evidence acceptable to the testing agency that all materials have been evaluated and found to be suitable for their intended usage. Test data based on ASTM or other appropriate test procedures, certifications or historical data may be submitted for this purpose. The evidence shall show that the materials have been evaluated, as appropriate for resistance to moisture, corrosion and the effects of fuel gases, including the sulfur compounds therein, and that nonmetallic diaphragm and seal materials are suitably resistant to the effects of ozone.

1.12 Assembly

1.12.1

The construction of thermostats to be used where certain parts will be immersed in liquids shall be such that, in the event of failure of such parts, it will not be possible for liquids to pass into the gas channels. Thermostats constructed so that the only surface exposed to liquids is that of a single piece without joints or screws, or is constructed with joints or seams which are properly welded, brazed or soldered, shall be considered as complying with this provision.

1.12.2

If an integral gas valve thermostat can be partially or completely disassembled without the use of special tools, construction shall be such that either:

- a. The parts of the thermostat cannot be readily reassembled improperly in a manner which could result in an unsafe condition; or
- b. The standard fasteners are covered with a sealing means to discourage disassembly. The sealing means shall be suitable for exposure to the minimum and maximum ambient temperatures specified for the control.

This provision does not apply to parts of the thermostat intended for field replacement or servicing (see 1.14-f).

1.12.3

When a wire gauze or perforated sheet screen is inserted in the valve body, it shall be fixed so that it may not be dislodged or deformed so as to interfere with the operation of the valve mechanism in any way.

1.12.4

The construction shall be such that parts which would normally be removed for servicing cannot be readily misassembled to cause faulty or unsafe operation.

1.13 Electrical

Electrical components and wiring supplied as part of the system shall be of approved types or shall be investigated as an integral part of the system for construction and performance equivalent to approved types.

Electrical components 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 when used within the limits of its listing or certification.

Millivolt circuits need not comply with spacing, insulation, enclosure and grounding provisions when shorting of such a circuit will not result in unsafe operation of the device.

1.13.1 Insulating Material

- a. A joint shall be provided with insulation equivalent to that of the wires involved if permanence of spacing between the joint and uninsulated live metal parts of opposite polarity or grounded dead metal parts is not assured.
- b. Material used shall be judged with respect to its suitability for the particular application. In determining the suitability of an electrical insulating material, consideration shall be given to its mechanical strength, dielectric strength, heat and moisture resistant properties, the degree to which it is enclosed or protected, and any other features having a bearing on its application in the device.

1.13.2 Conductors and Connections

- a. An electrically operated device shall be provided with suitable terminals, connectors or with leads entering the enclosure through a suitable opening.
- b. Supply conductors shall have adequate current-carrying capacity. No supply conductor smaller than 18 AWG (0.82 mm²), or its equivalent shall be used, and the insulation shall not be less than 1/32 in (0.8 mm) in thickness.
- c. The internal wiring of a device shall be suitably insulated and shall have adequate current carrying capacity for the intended service.
- d. Strain relief shall be provided for all conductors leaving an electrical enclosure. The strain relief device shall be capable of withstanding a direct pull of 20 lb (89 N) applied to each conductor for one minute without damage to the conductor and without displacing the strain relief device.
- e. Wirebinding screws for supply conductors shall not be smaller than a No. 8 except that a No. 6 screw may be used for the connection of an 18, 16 or 14 AWG (0.82 mm², 1.3 mm² or 2.1 mm²) conductor. Terminal plates for these wires binding screws shall be of metal not less than 0.030 in (0.76 mm) in thickness tapped with not less than 2 full threads.
- f. A terminal or lead for the connection of a neutral supply conductor shall be identified by means of a substantially white metallic plating or by having white or natural gray insulation, and shall be readily distinguishable from other terminals or leads, or properly identified to indicate the terminal for connection to a neutral supply conductor.

- g. The leads or terminals of an individual thermostat, that are provided for making electrical connections and which are intended to be disconnected in order to replace or service the thermostat, shall be identified by a number(s), letter(s), symbol(s) or combination thereof, in a color which contrasts with the background. This provision does not apply when:
 - 1. The individual thermostat incorporates means which will physically prevent miswiring; or
 - 2. The individual thermostat incorporates only two terminals or leads, the interchange of which does not change the operation of the thermostat.
- h. Conductors joined by splicing shall be mechanically secure without solder and, unless made with an approved splicing device, shall then be soldered with a fusible metal or alloy, brazed or welded. Provisions shall be made to prevent mechanical strain on splicing devices. The means to prevent mechanical strain shall be capable of withstanding a direct pull of 20 lb (89 N) applied to the conductor for one minute without damage to the splice.

1.13.3 Current-Carrying Parts

- a. Uninsulated livemetal parts, including terminals, shall be secured to their supporting surfaces by methods other than friction between surfaces so that they will be prevented from turning or shifting in position if such motion may result in reduction of spacings to less than those specified elsewhere in this standard. A lock washer properly applied is acceptable. Contact assemblies shall be secured such that the alignment of contacts will be maintained.
- b. Where corrosion could interfere with the electrical characteristics of the device, parts shall be constructed of corrosion resistant material or have a corrosion resistant finish.

1.13.4 Grounding

- a. A lead intended for the connection of an equipment-grounding conductor shall have a free length of 6 in (152 mm) or more. The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead visible to the installer in the field in a field-wiring compartment shall be so identified.
- b. A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal shaped, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked "G," "GR," "GND," "Ground," "Grounding" or by a suitable marking on a wiring diagram provided on the control. The wire-binding screw or pressure wire connector shall be so located that it is unlikely to be removed during normal servicing.

1.13.5 Bonding

A line voltage device shall be constructed so that all dead-metal parts which are exposed or which are likely to be touched by a person during normal usage of the device and which are liable to become energized, shall have electrical continuity to the device body.

All such dead-metal parts shall show continuity to the device body as indicated by a resistance not in excess of 0.1 ohm measured between the device body and any dead-metal parts (insulating finishes may be scraped from the test points).

1.13.6 Switches

Single-pole switches in safety circuits shall not be wired in a neutral or grounded line. Switches shall have current and voltage ratings not less than that of the circuits they control.

1.13.7 Transformers

Low voltage circuits (30 volts or less) shall be supplied by a Class 2 transformer (see Article 725, Section 725-31, *National Electrical Code, ANSI/NFPA 70*), unless wiring suitable for linevoltage service is used and all spacings through-air and over insulating surfaces for live-metal parts to ground are not less than $\frac{1}{16}$ in (1.6 mm).

A supply transformer, if provided as an integral part of a device operating at less than line voltage, shall be of the isolating type (separate primary and secondary windings).

1.13.8 Spacings

- a. The electrical clearance resulting from the assembly of line-voltage parts into the complete component, except for thermo-electric circuits, shall comply with the spacings specified in Table IV, Minimum Spacings Line Voltage Circuits for Safety Circuits.

Film-insulated wire is considered to be equivalent to an uninsulated live-metal part in determining compliance of device with the spacing specification in this standard.

- b. For parts connected to Class 2 low-voltage circuits and millivoltage circuits intended for access after the control in manufactured (e.g., field- or factory-wired terminals), the spacings shall not be less than those indicated in Table V, Minimum Spacings - Millivoltage Circuits Intended for Access After the Control Manufacturer and for Class 2 Low Voltage Safety Circuits (0-30 Volts), if a short circuit or ground between those parts could result in unsafe operation.

For millivoltage circuits not intended for access after the device is manufactured, if shorting of the circuit can result in unsafe operation, the construction of the device shall be such that the spacings are permanently maintained.

- c. For parts connected to an isolated limited secondary circuit (other than Class 2), the spacings shall not be less than those indicated in Table VI, Minimum Spacings - Isolated Limited Secondary Circuits for Safety Controls, if a short circuit or ground between those parts could result in unsafe operation.

For an isolated-limited-secondary circuit, other than safety circuit, the spacings between uninsulated live parts of opposite polarity and between uninsulated live parts and dead metal that may be grounded in service are not specified. The minimum spacings are based on acceptable performance of specified dielectric voltage withstand and other normal and abnormal operation tests.

1.13.9 Barriers

- a. With the following exceptions, an insulating barrier or liner which is used to provide spacings shall be of material suitable for the particular application and not less than a minimum 0.028 in (0.71 mm) thick. A barrier or liner which is used in conjunction with not less than $\frac{1}{2}$ the specified spacing through-air, may be less than 0.028 in (0.71 mm) but not less than 0.013 in (0.33 mm) thick, provided the barrier or liner is (1) of good quality of suitable insulating material resistant to moisture; (2) capable of adequate mechanical strength if exposed or otherwise likely to be subjected to mechanical injury; (3) reliably held in place; and (4) located so it will not be adversely affected by operation of the equipment in service-particularly arcing.

Insulating material having a thickness less than that specified in the preceding paragraph may be used if found acceptable for the purpose or if listed or certified for the purpose by a nationally recognized testing agency.

Mica may be less than 0.028 in (0.71 mm) thick but not less than 0.013 in (0.33 mm) thick when the mica is used in lieu of the throughair spacing specified in Table IV, Minimum Spacings-Line Voltage Circuits for Safety Circuits, provided the mica is tightly held in a fixed position by the parts between which the spacing is involved.

- b. A barrier used to provide separation between the wiring of different circuits shall have adequate mechanical strength and shall be reliably held in place.

A barrier between uninsulated live-metal parts connected to different circuits, and a barrier between uninsulated live-metal parts of one circuit and the wiring of another circuit shall also comply with 1.13.9a.

Openings in a barrier for the passage of conductors shall not be larger than $\frac{1}{4}$ in (6.4 mm) in diameter and shall not exceed in number, the number of wires which pass through the barrier.

1.13.10 Enclosures

- a. Electrical parts of a device, other than low-voltage terminals, shall be located or enclosed so that suitable protection against accidental contact with uninsulated live parts will be provided, except that an enclosure is not required for a device designed for assembly as part of another device which is enclosed.
- b. A space within the enclosure of a device shall be sufficient to provide adequate room for distribution of wires and cables required for the proper field wiring of the device (see Article 370, Section 370-6, *National Electrical Code, ANSI/NFPA 70*). The cover of the enclosure shall be provided with a means for firmly securing it in place.

When threads for the connection of conduit are provided, there shall not be less than $3\frac{1}{2}$ nor more than 5 threads. When not tapped all the way through the opening, there shall be a smooth well rounded inlet opening for the conductors with an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

- c. An enclosure and a dial, name plate, or the like which is in effect a part of the enclosure, shall be of metal or of other suitable noncombustible materials.

1.14 Instructions

Complete instructions covering installation and proper operation shall be furnished by the manufacturer.

The following shall be included in these instructions; where applicable:

- a. The electrical rating of the thermostat in volts, amperes, and hertz.
- b. Maximum and minimum recommended ambient temperatures (see 1.2.3).
- c. The type(s) of gas with which the device is intended to be used.
- d. Electrical diagrams indicating the external connections necessary for the control's intended application(s).

- e. The class of transformer required, if applicable.
- f. Information identifying parts intended for field servicing and procedures for servicing or replacing such parts.
- g. "Caution: Label all wires prior to disconnection when servicing thermostats. Wiring errors can cause improper and dangerous operation."
- h. A step by step functional checkout of a replacement thermostat.
- i. Diagrams to illustrate the specified mounting positions.

1.15 Marking

1.15.1

Each thermostat shall be permanently marked with the following information. Markings which are stamped, cast, etched or lithographed shall be considered permanent.

- a. Manufacturer's or dealer's name, trademark or symbol.
- b. Model designation.
- c. Symbol of the organization making the tests for compliance with this standard.
- d. Adjustable thermostats provided with a dial shall have either marked set points or unique designations which correlate to temperature.
- e. Fixed-setting thermostats shall be marked with the set point in degrees Fahrenheit (°F).

Integral gas valve type thermostats shall also be marked with the following information:

- f. Direction of gas flow.
- g. Maximum operating pressure of $1\frac{1}{2}$ psi (3.5 kPa).

Electric type thermostats shall also be marked with the following information.

- h. When space permits, the electrical rating(s). The thermostat shall be rated in volts, and also in amperes, voltamperes, or watts, and the rating shall indicate whether the device is for direct or alternating current. The rating of a device shall include the current in amperes if the wattage rating is not a close indication of the volt-ampere input. A switching device, other than one for controlling a noninductive load, shall be rated in volts and in amperes. When space does not permit, the model number shall identify the necessary electrical rating(s) data.

1.15.2

A marking to identify this standard shall be provided for each device, as follows:

"ANS Z21.23 Gas Appliance Thermostats."

This marking may be located on the package or on a notice placed inside the package in which the device is shipped.

1.15.3

Each thermostat shall bear a separate marking indicating the date of manufacture. This marking shall be specified in "a," "b" or "c" below.

a. The date in the form of:

1. The month, day and year; or
2. The day, month and year.

The abbreviation of the month shall be at least the first three letters of the month.

The day may be the Monday of the week and the year must be at least the last two digits of the year.

b. A four digit code consisting of:

1. The first and second digits indicating the calendar year in which the component was manufactured (e.g., 10 for 2010); and
2. The third and fourth digits indicating the week in which the component 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 four digit code may be used for more than one week; however, it shall not be used for more than four consecutive weeks, nor more than two weeks into the next calendar year.

If space limitation prevents the use of a four digit code, an alternative date code acceptable to the testing agency shall be provided.

Additional numbers, letters or symbols may follow the four digit code. If additional numbers are used, they shall be separated from the four digit code.

c. A five-digit code consisting of:

1. The first and second digits indicating the calendar year in which the thermostat was manufactured (e.g., 10 for 2010); and
2. The third, fourth and fifth digits indicating the day of the year in which the thermostat was manufactured (e.g., 183 for the one hundred and eighty-third day in the year 2010, which is July 2, 2010).

Additional numbers, letters or symbols may follow the five digit code. If additional numbers are used, they shall be separated from the five-digit code.

1.15.4

Thermostats for liquid immersion shall have the marking specified in 1.15.1 a, b and h, where applicable, located so as to be accessible to view, as normally installed, without disconnection of fluid connections.

1.15.5

Electrical diagrams, when provided, shall have all unidentified graphical symbols conforming to the *Standard for Graphic Symbols for Electrical and Electronics Diagrams, ANSI/IEEE 315*. See Appendix A for preferred symbols of commonly used items, as extracted from the above standard.

Part II: Performance

2.1 General

2.1.1 Mounting Position(s).

The manufacturer shall specify one or more of the following mounting classifications (see 1.3-b):

Upright - Single position on a horizontal axis with respect to the inlet connection, as specified by the manufacturer.

Horizontal - Any position on a horizontal axis with respect to the inlet connection.

Vertical - Any position on a vertical axis with respect to the inlet connection.

Limited horizontal - Any position from upright to 90 degrees (1.57 rad) from upright on a horizontal axis with respect to the inlet connection.

Multipoise - Any position on a horizontal, vertical or intermediate axis with respect to the inlet connection.

The tests specified herein shall be conducted with the thermostat mounted in the manufacturer's specified upright position, unless otherwise specified.

2.1.2

Unless otherwise specified, the tests herein shall be conducted at ambient temperatures of 32°F and 125°F (0°C and 51.5°C) unless either higher, lower, or both higher and lower temperatures are specified by the manufacturer. Where room temperature is specified, the tests shall be conducted at a temperature of $77 \pm 10^\circ\text{F}$ ($25 \pm 5.5^\circ\text{C}$).

For tests conducted at other than room temperature the test temperature shall be within $\pm 3^\circ\text{F}$ ($\pm 1.5^\circ\text{C}$) of the specified value.

2.1.3

Unless otherwise specified, each performance test shall be conducted on one sample of the thermostat.

2.1.4

Electrical contacts shall be tested at the manufacturer's specified electrical ratings, unless otherwise specified.

2.1.5

Fuel gas(es), air or nitrogen may be used for the tests unless otherwise specified. When conducting tests which specify the use of a fuel gas(es), a gas with the characteristics approximately as specified in the test shall be used.

2.1.6

Gas flow test results shall be expressed in terms of a 1000 Btu/ft³ (37.3 MJ/m³), 0.64 specific gravity gas at standard conditions [saturated with water at 60°F (15.5°C) and 30 in Hg column (101.3 kPa)].

2.2 Leakage

The tests under 2.2.2 and 2.2.3 shall be conducted under the following conditions:

- a. With the component parts, except the knob or dial, maintained at the maximum temperature specified by the manufacturer (see 1.2.3).
- b. With the component parts, except the sensing element, maintained at the minimum temperature specified by the manufacturer (see 1.2.3).

2.2.1

A thermostat for liquid immersion shall show no leakage of water into gas channels or through the mechanism housing when subjected throughout one heating and cooling cycle to a hydrostatic pressure of 300 psi (2.1 MPa) on all surfaces normally exposed to tank water.

Method of Test

The thermostat shall be installed in the side of a test tank in a manner that will permit the application of hydrostatic pressure to all surfaces normally in contact with tank water. The tank shall be connected through a manual shutoff valve to the outlet side of a suitable boiler test pump and shall be equipped so that water contained in the tank may be heated from room temperature to 180°F (82°C) in approximately $\frac{1}{2}$ hour. A Bourdon pressure gage, graduated in increments of not more than 5 psi (34.5 kPa), and an adjustable pressure relief valve set to relieve at 300 psi (2.1 MPa) shall be connected in the system near the thermostat.

The manual shutoff valve shall be closed and heating begun. The water temperature shall be increased [the pressure being held constant at 300 psi (2.1 MPa) by means of the relief valve] until a temperature of 180°F (82°C) is attained. The water temperature shall be maintained at this point for a period of 5 minutes. The burner gas shall then be shut off and the water temperature allowed to recede to near room temperature by natural cooling. Throughout the cooling cycle the above specified hydrostatic pressure shall be maintained by means of the boiler test pump. During this test no leakage of water shall be evidenced.

2.2.2

An integral gas valve type thermostat shall not leak externally at a rate in excess of 200 cubic centimeters per hour when tested with clean air at 21.0 in wc (5.23 kPa) pressure with the valve in the open position and the outlet capped.

Method of Test

An airtight connection shall be made between the inlet of the thermostat and a suitable pneumatic system incorporating a flowmeter capable of indicating accurately a flow rate of 200 cubic centimeters per hour. The outlet of the thermostat shall be sealed. Any bypass or other openings not essential to the operation of the valve during this test shall be sealed, unless they discharge into the main gas stream before the outlet of the thermostat.

The thermostat valve shall be opened normally and air admitted slowly at 21.0 in wc (5.23 kPa) pressure. Leakage shall then be determined.

2.2.3

Leakage through an integral gas valve type thermostat with its valve in the closed position as a result of normal operation shall not exceed the applicable value shown in Table VII, Maximum Allowable Leakage, when tested with clean air at 2.0 and 21.0 in wc (498 Pa and 5.23 kPa) pressure applied at the inlet.

Method of Test

Any bypass around the thermostatically actuated valve disc shall be closed or sealed, and the thermostat shall be in calibration (see 2.4, Accuracy of Temperature Set Point). The inlet of the thermostat shall be connected to a suitable pneumatic system. The outlet of the thermostat shall be connected to a flowmeter(s) capable of indicating accurately the flow rates specified in Table VII, Maximum Allowable Leakage. The outlet of the flowmeter(s) shall discharge to the atmosphere.

The valve of the thermostat shall be opened and closed five times, ending in the closed position, before a reading of the flowmeter(s) is taken. For a modulating type thermostat the valve shall be considered to be closed when the sensing element is as much as 25°F (14°C) above the dial setting for heating types, and as much as 10°F (5.5°C) below the dial setting for refrigerating types. Leakage readings shall be taken at internal pressures of 2.0 and 21.0 in wc (498 Pa and 5.23 kPa). Leakage shall be determined.

Any leakage noted shall not be in excess of that specified in Table VII, Maximum Allowable Leakage.

2.3 Strength And Deformation

2.3.1 Bending Moment

An integral gas valve thermostat shall be capable of operation without cracking, breaking, or leaking while being subjected to a bending moment using the weight specified in Table IX, Loads for Bending Moments Test, in accordance with the following Method of Test.

Method of Test

This test shall be conducted at room temperature. A new sample shall be subjected to this test.

- a. The inlet and outlet connections shall be assembled leaktight to the appropriate fittings as described below. The length of the inlet fitting shall be such that, after assembly the dimension from the control inlet to the end of the inlet fitting will be 13 in $\pm 1/2$ in (330 mm $\pm$ 12.7 mm). The tightening torque for threaded pipe or tubing connections shall be one-half that shown in Table IX, Loads for Bending Moment Test.
 1. Pipe threaded connections shall be assembled to Schedule 40 iron pipe, or pipe fitting, using non-Teflon type pipe joint compound.
 2. Tubing connections shall be assembled to steel tubing conforming to the *Standard for Welded and Cold Drawn Low-Carbon Steel Tubing Annealed for Bending and Flaring, ANSI/SAE J525*, which has a minimum wall thickness of 0.028 in (0.71 mm), using the attachment means specified by the manufacturer.
 3. Connections designed for other than threaded pipe or tubing shall be assembled to test fixture(s) representative of the intended connection means.
- b. The outlet fitting shall be rigidly supported 1 in (25.4 mm) from the control outlet, unless the following exceptions apply. When the control has an integral mounting means independent of the inlet and outlet connections, it shall be mounted using the integral mounting means as specified by the manufacturer. When the control is intended to be mounted by either the integral mounting means or the outlet, the mounting means which produces the most severe test condition shall be used. The control inlet shall be in the horizontal position.