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Group**

ANSI Z83.18-2012

Recirculating direct gas-fired industrial air heaters



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The standards set forth herein apply to the fifth edition of the Standard for Recirculating direct gas-fired industrial air heaters, Z83.18-2004, Addenda Z83.18a-2005 and Z83.18b-2008, and supersede corresponding standards therein. Following their preparation by the supervising Technical Advisory Group, they were accepted by the American National Standards Institute (ANSI) and subsequently approved.

NOTE: Changes, other than editorial, are denoted by a vertical line in the margin.



Approved
December 18, 2012
American National Standards Institute, Inc.

Standard Developer

CSA AMERICA INC.,
Operating as "CSA Group"
8501 East Pleasant Valley Road
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***American National Standards Institute, Inc.
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New York, NY
10036***

Preface

This publication represents a basic standard for safe operation, substantial and durable construction, and acceptable performance of recirculating direct gas-fired industrial air heaters. It is the result of years of experience in the manufacture, testing, installation, maintenance, inspection and research on recirculating direct gas-fired industrial air heaters designed for the utilization of gas. There are risks of injury to persons inherent in some appliances that, if completely eliminated, would defeat the utility of the appliance. The provisions in this Standard are intended to reduce such risks while retaining the normal function of the appliance.

Nothing in this standard is to be considered in any way as indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow compliance of recirculating direct gas-fired industrial air heaters, 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 Accredited 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 recirculating direct gas-fired industrial air heaters 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, 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.

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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 The Standard For Recirculating Direct Gas-Fired Industrial Air Heaters

At its March 1983 meeting, the Z83 Subcommittee on Standards for GasFired Heavy Duty Forced Air Heaters considered the need to increase the discharge air temperature limit in the direct gas-fired make-up air heater standard (Z83.4), in light of the increased use of make-up air heaters as total space heating appliances. The heavy duty heater subcommittee appointed a working group of subcommittee members and interested individuals to gather information on the use of direct gasfired make-up heaters for total space heating.

The working group's report to the subcommittee confirmed there were several local codes permitting the installation of gasfired makeup air heaters as total space heating appliances in non-residential buildings. Consequently, the working group was requested to develop standards coverage for makeup air heaters installed as total space heating appliances for inclusion in Z83.4.

Although it was initially intended that the necessary coverage would be included in Z83.4, following review of the working group's suggested coverage of its July 1984 meeting, the subcommittee concluded that because of design and function differences (i.e., recirculation of inside air) a separate standard would better suit the needs of certification agencies and Code officials.

A draft standard for industrial air heaters, developed by the working group at a series of meetings, was adopted by the heavy duty heater subcommittee at its June 1985 meeting and distributed for industry review in December 1985. Following reconsideration of this draft standard in light of comments received at its February 1986 meeting, the heavy duty heater subcommittee recommended the draft standard to the Z83 Committee.

At its October 1986 meeting, the Z83 Committee approved the proposed standard for submittal the American National Standards Institute, Inc.

The first edition of the Standard for Direct Gas-Fired Industrial Air Heaters, was approved by the American National Standards Institute, Inc., in September 1987. The second edition was approved by the American National Standards Institute, Inc., on November 30, 1990. The third edition was approved by the American National Standards Institute, Inc., on June 22, 2000. The fourth edition of the industrial heater standard was approved as American National Standard by the American National Standard Institute, Inc. on December 20, 2004. The fifth edition of the standard was approved by the American National Standards Institute on December 18, 2012.

Following procedures outlined above, further revisions to this standard were developed in line with industry developments.

Previous editions of the industrial air heater standard, and addenda thereto, approved by the American National Standards Institute, are as follows:

Z83.18-1987	Z83.18a-1989	Z83.18b-1989
Z83.18-1990	Z83.18a-1991	Z83.18b-1992
Z83.18-2000	Z83.18a-2001	Z83.18b-2003
Z83.18-2004	Z83.18a-2005	Z83.18b-2008

The following identifies the designation and year of the fifth edition of the standard:

ANSI Z83.18-2012

NOTE: This 2012 edition incorporates changes to the 2004 edition of Z83.18 and addenda thereto. Changes other than editorial are denoted by a vertical line in the margin.

ANSI Z83.18-2012
***Recirculating direct gas-fired
industrial air heaters***



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NOTE

This standard contains SI (Metric) equivalents to the yard/pound quantities, the purpose being to allow the standard to be used in SI (Metric) units. (Standard for use of the International System of Units (SI): The Modern Metric System, IEEE/ASTM SI 10 or Metric Practice Guide, CAN/CSA Z234.1 are used as a guide in making metric conversion from yard/pound quantities.) If a value for a measurement and an equivalent value in other units, the first stated is to be regarded as the requirement. The given equivalent value may be approximate. If a value for a measurement and an equivalent value in other units, are both specified as a quoted marking requirement, the first stated unit, or both shall be provided.

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ANSI Z83.18-2012

Recirculating direct gas-fired industrial air heaters

1 Scope

1.1

This standard applies to newly produced, recirculating direct gas-fired industrial air heaters, hereinafter referred to as heaters, whose purpose is to offset building heat loss. Ventilation air to the heater shall be ducted directly from outdoors and the products of combustion generated by the heater are released into the air stream being heated.

Heaters covered by this standard are intended for use in industrial and commercial applications.

This standard applies to heaters designed for a heated discharge air temperature of 160°F (71°C) or less.

This standard is intended to cover only complete packaged heaters with integral air moving components, i.e., those which are designed by, cataloged by and built on a repetitive basis by the manufacturer.

1.2

Inside air may be introduced before or after the combustion zone.

1.3

Outside ventilation air is required to the heater. See 4.21.1-f, 4.21.1-n, and 4.22.2-u.

1.4

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.

1.5

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

1.6

Section 6, Electrical Equipment and Wiring.

1.7

Section 2, List of Reference Standards, contains a list of standards specifically referenced in this Standard, and sources from which they may be obtained.

2 Reference Standards

AIR MOVEMENT AND CONTROL ASSOCIATION INC.

AMCA 203-1990

Field Performance Measurements of Fan Systems

December 2012

AMERICAN GAS ASSOCIATION

ANSI Z223.1-2012/NFPA 54-2012

*National Fuel Gas Code***AMERICAN NATIONAL STANDARDS INSTITUTE, INC.**

ANSI Y14.15-1966 (R1988), and Supplements ANSI Y14.15a-1971, ANSI Y14.15b-1973

*Electrical and Electronics Diagrams (No Longer Available)***AMERICAN SOCIETY OF HEATING, REFRIGERATION & AIR-CONDITIONING ENGINEERS, INC.**

ANSI/ASHRAE/AMCA 51-2007

*Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI AMCA Standard 210-07)*ASHRAE Handbook and Product Directory-2001, *Fundamentals Volume***AMERICAN SOCIETY OF MECHANICAL ENGINEERS**

ANSI/ASME B1.1-2003

Unified Inch Screw Threads (UN and UNR Thread Form)

ANSI/ASME B1.20.1-1983 (R2006)

Pipe Threads, General Purpose (Inch)

ANSI/ASME B36.10M-2004

Welded and Seamless Wrought Steel Pipe

ANSI/ASME B94.11M-1993

Twist Drills

ANSI/ASME PTC 19.3-1974 (R1998)

*Temperature Measurement***AMERICAN SOCIETY FOR TESTING AND MATERIALS**

ASTM A90/A90M-11

Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

ASTM A653/A653M-11

General Requirements for Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

ASTM B75/B75M-11

Standard Specification for Seamless Copper Tube

ASTM B487-1985 (R2007)

Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section

ASTM B499-2009

Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method; Nonmagnetic Coatings on Magnetic Basis Metals

ASTM B504-1990 (R2011)

Standard Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method

CSA AMERICA, INC.

ANSI Z21.15-2009 • CGA 9.1-M2009, ANSI Z21.15a-2012 • CGA 9.1a-2012

Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves

ANSI Z21.18-2007 • CSA-6.3-2007, Z21.18a-2010 • CSA-6.3a-2010

Gas Appliance Pressure Regulators

ANSI Z21.21-2012 • CSA 6.5-2012

Automatic Valves for Gas Appliances

ANSI Z21.78-2010 • CSA 6.20-2010

Combination Gas Controls for Gas Appliances

ANSI Z21.20-2005, Z21.20a-2008

Automatic Gas Ignition Systems and Components

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Publication No. 999-AP-11

Selected Method for the Measurement of Air Pollutants

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

ANSI/IEEE 315-1975 (R1994), and Supplement, ANSI/IEEE 315a-1986

Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Class Designation Letters)

ANSI/IEEE-SI-10-2002

Standard For Use of the International System of Units (SI): The Modern Metric System

NATIONAL FIRE PROTECTION ASSOCIATION

ANSI Z223.1-2012/NFPA 54-2012

National Fuel Gas Code

ANSI/NFPA 70-2011

National Electrical Code

ANSI/NFPA 90A-2002

Installation of Air Conditioning and Ventilating Systems

ANSI/NFPA 88A-2011

Parking Structures

ANSI/NFPA 88B-1997

Repair Garages

NFPA 255-2006

Standard Method of Test of Surface Burning Characteristics of Building Materials

ANSI/NFPA 409-2011

Standard on Aircraft Hangars

UNDERWRITERS LABORATORIES INC.

ANSI/UL 62-2010

Flexible Cord and Cables

ANSI/UL 372-2007

Automatic Electrical Controls for Household and Similar Use - Part 2: Particular Requirements for Burner Ignition Systems and Components

ANSI/UL 723-2008

Surface Burning Characteristics of Building Materials

3 Definitions

ACCESSIBLE. Having access to, but first may require removal of a panel, door or similar covering.

AIR SHUTTER. An adjustable device for varying the size of the primary air inlet(s).

APPLIANCES - AUTOMATICALLY CONTROLLED. Appliances equipped with automatic devices which:

- (a) Accomplish complete “turn-on” or “shutoff” of the gas to the main burner(s); or
- (b) Graduate the gas supply to the burner(s) but do not effect complete shutoff of the gas.

AUTOMATIC GAS IGNITION SYSTEM. A system designed to ignite and reignite an appliance burner(s). Such systems shall:

- (a) Automatically ignite gas at the main burner, or gas at the pilot burner so the pilot can ignite the main burner;
- (b) Prove the presence of either the ignition source, the main burner flame, or both; and
- (c) Automatically act to shut off the gas supply to the main burner or to the pilot and main burner, when the supervised flame or ignition source is not proved.

AUTOMATIC GAS IGNITION SYSTEM TIMINGS.

(a) **Flame-Establishing Period.**

- (1) **Pilot Flame-Establishing Period.** The period of time between initiation of pilot gas flow and proof of the supervised pilot flame.
- (2) **Main Burner Flame-Establishing Period.** The period of time between initiation of main burner gas flow and proof of the supervised main burner flame.
- (b) **Flame Failure Re-ignition Time.** The period of time between loss of the supervised ignition source of the supervised main burner flame and a reignition attempt. During this time period the main burner gas supply is not shut off.
- (c) **Flame Failure Response Time.** The period of time between the loss of the supervised ignition source or the supervised main burner flame and the action to shut off the gas supply.
- (d) **Ignition Activation Period.** The period of time between energizing the main gas valve and deactivation of the ignition means prior to the lockout time.
- (e) **Lockout Time.** The period of time between energizing the system and lockout if the proof of the supervised main ignition source or the supervised main burner flame is not established.

- (f) **Purge Time.** The period of time intended to allow for the dissipation of any unburned gas or residual products of combustion.
- (1) **Pre-purge Time.** The purge time which occurs at the beginning of an appliance operating cycle prior to initiating ignition.
- (2) **Post Purge Time.** The purge time which occurs at the end of an appliance burner operating cycle.
- (g) **Recycle Time.** The period of time between shutoff of the gas supply following loss of the supervised ignition source or the supervised main burner flame and reactivation of the ignition source.
- (h) **Trial for Ignition Period.** The period of time between energizing and de-energizing the gas valve, if proof of the supervised flame is not established.

BAFFLE. An object placed in an appliance to change the direction of or retard the flow of air, gas-air mixtures or flue gases.

BODY. The principal structure of the appliance, including supporting frame.

BTU/Btu. Abbreviation for British Thermal Unit. The quantity of heat required to raise the temperature of 1 pound of water 1°F.

BURNER. A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.

BURNER, AUTOMATICALLY LIGHTED. One where gas to the main burner is normally turned on and ignited automatically.

BURNER MANIFOLD. Piping and orifice(s) downstream from the modulating valve.

BURNER PROFILE OPENING. The required free area surrounding the burner in which the appliance fan pushes or pulls air through the appliance at a selected velocity.

BURNER PROFILE PLATE(S). An adjustable means of changing or setting the burner profile opening. Profile plates can be fixed adjustable, remote adjustable or of the modulating type as dictated by the appliance design requirements.

CIRCUIT.

- (a) **High-Tension.** A circuit involving a potential of more than 600 volts supplied by a step-up transformer or by a suitable combination of devices which will increase line voltage to over 600 volts.
- (b) **High-Voltage.** A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.
- (c) **Low-Voltage.** A circuit involving a potential of not more than 30 volts.
- (d) **Thermoelectric.** A circuit which receives its electrical energy by a conversion of heat to electricity by means of a thermocouple or thermopile.

COMBUSTIBLE MATERIAL. As pertaining to materials adjacent to or in contact with heat producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that are capable of being ignited and burned. Such material shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered.

COMBUSTION. The rapid oxidation of fuel gases accompanied by the production of heat, or light and heat.

COMBUSTION CHAMBER. The portion of an appliance within which combustion occurs.

COMBUSTION PRODUCTS. Constituents resulting from the combustion of a fuel gas with the oxygen of the air, including the inerts, but excluding excess air.

CONDENSATE (CONDENSATION). The liquid which separates from a gas (including flue gases) due to a reduction in temperature.

CONTROLS. Devices designed to regulate the gas, air, water or electrical supplies to a gas appliance. These may be manual, semi-automatic or automatic.

- (a) **Combustion Control.** A control which automatically regulates the firing rate at predetermined air-fuel ratios in accordance with load demand.
 - (1) **High-low Firing.** The action of a combustion control which positions the air and fuel supply for low-fire and for high-fire in accordance with load demand.
 - (2) **Modulating.** The action of a combustion control which gradually varies the air and fuel supplies within limits in accordance with load demand.
- (b) **Limit Control.** An automatic control responsive to changes in liquid level; in fuel, steam or air pressures; in air, gas or liquid flow; or in temperature; for limiting the operation of the controlled equipment.
- (c) **Operating Control.** A control, other than a safety control or interlock, to start or regulate burner firing according to load demand and to stop or regulate firing on satisfaction of demand or upon reaching normal temperature or pressure in the appliances being fired. Operating controls may also actuate auxiliary equipment.
- (d) **Primary Safety Control.** A control responsive directly to flame properties; sensing the presence of flame and causing fuel to be shut off in the event of ignition or flame failure requiring manual reset.

CUBIC FOOT OF GAS. The amount of gas which would occupy 1 ft³ when at a temperature of 60°F, if saturated with water vapor, and under a pressure equivalent to that of 30 in Hg.

DAMPER(S), BYPASS. A mechanical means to regulate the airflow or velocity across the burner profile opening. (See definition BURNER PROFILE PLATES.)

EFFLUENT. The products of combustion plus the excess air being discharged from the appliance.

ELECTRICAL DIAGRAMS.

- (a) **Connection.** A diagram which shows the connections of an installation or its component devices or parts. It may cover internals or external connections, or both, and contains such detail as is needed to make or trace connections that are involved. The Connection Diagram usually shows general physical arrangement of the component devices or parts.
- (b) **Schematic.** A diagram which shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The Schematic Diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape or location of the component device or parts.

- (1) **Ladder Form of Schematic.** A diagram drawn in the form of a vertical ladder. The outer vertical lines represent the electrical supply conductors. The horizontal steps represent each individual circuit with all component devices.

EXCESS AIR. Air which passes through the combustion chamber in excess of that which is theoretically required for complete combustion.

HEATER OUTLET. The opening where air exits the heater cabinet.

HEATING VALUE (HIGHER). The number of British Thermal Units produced by the combustion at a constant pressure of 1 cubic foot of gas, when the products of combustion are cooled to the initial temperature of the gas and air, when the water vapor formed during combustion is condensed, and when all the necessary corrections have been applied.

IGNITER. A device which utilizes electrical energy to ignite gas at a pilot burner or main burner.

IGNITION DEVICE. A device for igniting gas at a burner. It may be a pilot or an igniter.

IGNITION DEVICE, DIRECT. An igniter utilized to ignite gas at a main burner.

IGNITION SOURCE.

- (a) **Continuous.** An ignition source which, once placed in operation, is intended to remain ignited or energized continuously until manually interrupted.
- (b) **Intermittent/Continuous.** An ignition source which is ignited or energized upon appliance user initiation of the operational cycle and which remains continuously ignited or energized during the appliance use cycle. The ignition source is extinguished or deenergized when the appliance use cycle is completed.
- (c) **Intermittent.** An ignition source which is automatically ignited or energized when an appliance is called on to operate and which remains continuously ignited or energized during each period of main burner operation. The ignition source is automatically extinguished or deenergized when each main burner operating cycle is completed.
- (d) **Intermittent/Interrupted.** An ignition source which is ignited or energized upon appliance user initiation of the operational cycle and which is extinguished or deenergized after the appliance use cycle has been initiated.
- (e) **Interrupted.** An ignition source which is automatically ignited or energized when an appliance is called on to operate and which remains ignited or energized during the main burner Flame-Establishing Period. The ignition source is automatically extinguished or deenergized when each main burner Flame-Establishing Period is completed.

IGNITION SYSTEM, DIRECT. A system in which the ignition means functions to ignite the main burner gas directly and in which a flame sensing means or safety shutoff device senses main burner flames or the absence of main burner flames.

IID. (See Intermittent Ignition System.)

INDUSTRIAL AIR HEATERS, DIRECT GAS-FIRED RECIRCULATING. A heater in which all the products of combustion generated by the gas-burning device are released into the air stream being heated; whose purpose is to offset building heat loss by heating incoming outside air (ventilation air), and, if applicable, inside air (recirculating air).

INPUT RATING. The gas-burning capacity of an appliance in Btu/hr as specified by the manufacturer.

INTERLOCK. A control or device to prove the physical state of a required condition and to furnish that proof to the primary safety shut-off device circuit.

INTERMITTENT IGNITION SYSTEM. A system in which the ignition source is automatically shut off when the appliance is in an off or standby condition.

LIQUEFIED PETROLEUM GASES. The terms "Liquefied Petroleum Gases," "LPG" and "LP-Gas" as used in this standard shall mean and include any material which is composed predominantly of any of the following hydrocarbons, or mixtures of them: propane, propylene, butanes (normal butane or isobutane), and butylenes.

LISTED. Equipment or materials included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

LP GAS-AIR MIXTURE. Liquefied petroleum gases distributed at relatively low pressures and normal atmospheric temperatures which have been diluted with air to produce desired heating value and utilization characteristics.

LOCKOUT. The automatic action to end an ignition sequence. Re-initiating another ignition sequence requires a manual operation.

MAIN BURNER. A device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone, and on which combustion takes place to accomplish the function for which the appliance is designed.

MANIFOLD. The conduit of an appliance which supplies gas to the individual burner.

MIXER. The combination of mixer head, mixer throat and mixer tube.

- (a) **Mixer Head.** The portion of an injection (Bunsen) type burner, usually enlarged, into which primary air flows to mix with the gas stream.
- (b) **Mixer Throat.** The portion of the mixer which has the smallest cross-sectional area and which lies between the mixer head and the mixer tube.
- (c) **Mixer Tube.** The portion of the mixer which lies between the throat and the burner head.

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

NORMAL BUTANE (n-BUTANE), TECHNICAL GRADE. A liquified petroleum gas composed of a minimum of 95 percent n-butane (C_4H_{10}) which may contain other impurities such as isobutane, butylenes and propane not in excess of 5 percent.

NORMAL INLET TEST PRESSURES. Those pressures specified for testing purposes at which adjustment of burner ratings and primary air adjustments are made.

ORIFICE. The opening in an orifice cap, orifice spud or other device whereby the flow of gas is limited and through which the gas is discharged.

ORIFICE CAP (HOOD). A movable fitting, having an orifice which permits adjustment of the flow of gas by changing its position with respect to a fixed needle or other device.

ORIFICE SPUD. A removable plug or cap containing an orifice which permits adjustment of the flow of gas either by substitution of a spud with a different size orifice or by motion of a needle with respect to it.

PILOT. A small gas flame used to ignite the gas at the main burner(s).

- (a) **Continuous Pilot.** A pilot that burns without turndown throughout the entire time the burner is in service, whether the main burner is firing or not.
- (b) **Expanding Pilot.** A continuous pilot that is automatically expanded so as to reliably ignite the main burner. This pilot may be turned down at the end of the main burner flame-establishing period.
- (c) **Intermittent Pilot.** A pilot which is automatically lighted each time there is a call for heat. It burns during the entire period that the main burner is firing.
- (d) **Interrupted Pilot.** A pilot which is automatically lighted each time there is a call for heat. The pilot fuel is cut off automatically at the end of the main burner flame-establishing period.
- (e) **Proved Pilot.** A pilot flame supervised by a primary safety control.

PIPING. As used in this standard, either pipe or tubing, or both.

- (a) **Pipe.** Rigid conduit of iron, steel, copper, brass or aluminum.
- (b) **Tubing.** Semi-rigid conduit of copper, steel or aluminum.

PORT. Any opening in a burner head through which gas or a gas-air mixture is discharged for ignition.

PRIMARY AIR. Air introduced into a burner at the mixer head which mixes with the gas before reaching the port(s).

PRIMARY AIR INLET. The opening(s) through which primary air is admitted into a burner.

PROOF OF CLOSURE SWITCH. An electrical switch actuated by the valve member which verifies that the valve member has closed and which is used as an interlock.

PROPANE HD-5. A special grade of liquefied petroleum gas composed of a minimum of 90 percent liquid volume of propane (C_3H_8) and a maximum of 5 percent liquid volume of propylene (C_3H_6).

REGULATOR, GAS APPLIANCE PRESSURE. A device for controlling a selected outlet gas pressure.

- (a) **Adjustable.**
 - (1) **Spring Type, Limited Adjustment.** A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable over a range of not more than ± 15 percent of the outlet pressure at the midpoint of the adjustment range.
 - (2) **Spring Type, Standard Adjustment.** A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable. The adjustment means shall be concealed.
- (b) **Multi-Rate.** A standard adjustment regulator, the multi-rate adjustment means of which is not concealed and which provides non-field adjustable high and non-field adjustable low-pressure settings for high-low rates on appliances.

- (c) **Multi-Stage.** A regulator for use with a single gas whose adjustment means can be positioned manually or automatically to two or more predetermined outlet pressure settings. Each of these settings may be either adjustable or non-adjustable. The regulator may modulate outlet pressures automatically between its maximum and minimum predetermined outlet pressure settings.
- (d) **Non-adjustable.**
- (1) **Spring Type, Non-adjustable.** A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is not adjustable.
 - (2) **Weight Type.** A regulator in which the regulating force acting upon the diaphragm is derived from a weight or combination of weights.

SAFETY CIRCUIT. A circuit or portion thereof involving one or more safety controls.

SAFETY SHUTDOWN. The action of shutting off all fuel and ignition energy to the appliance by means of a safety control or controls such that restart cannot be accomplished without manual reset.

SAFETY SHUTOFF DEVICE. A device that will shut off the gas supply to the controlled burner(s) in the event the source of ignition fails. This device may interrupt the flow of gas to the main burner(s) only, or to the pilot(s) and main burner(s) under its supervision.

SECONDARY AIR. The air externally supplied to the flame at the point of combustion.

SPECIFIC GRAVITY. As applied to gas, specific gravity is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

STANDARD AIR. Air at 70°F and 29.92 in Hg having a specific weight of 0.075 lb/ft³.

STOP. A fixed point on a control, such as a temperature limit control, which prevents the adjustment of the control beyond the stop point.

THERMAL ACTUATED ELEMENT. That part of a control device which is directly acted upon by temperature changes and originates or supplies motion or energy directly or indirectly to operate a control valve.

TOOLS, SPECIAL. Those tools that are not available on the open retail market.

VALVE.

- (a) **Automatic.** An automatic or semi-automatic device consisting essentially of a valve and operator that controls the gas supply to the burner(s) during normal operation of an appliance. The operator may be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other means.
- (b) **Burner.** A manually operated valve which permits control of the flow of gas.
- (c) **Combustion (Input) Control.** An automatic gas-control valve for regulating gas input.
- (d) **Diaphragm Type Automatic.** A device consisting essentially of an automatic valve actuated by means of the application of gas pressure upon a flexible diaphragm.
- (e) **Electric Type Automatic.** A device actuated by electrical energy for controlling the gas supply.
- (f) **Individual Main Burner.** A valve which controls the gas supply to an individual main burner.

- (g) **Lubricated Plug.** A valve of the plug-and-barrel type which has bearing surfaces designed to be relubricated without disassembly of the valve.
- (h) **Manual Main Shutoff.** A manually operated valve in the gas line for the purpose of completely turning on or shutting off the gas supply to the appliance, except to a pilot(s) provided with independent shutoff valves.
- (i) **Manual Shutoff.** A manually operated valve in a fuel line for the purpose of completely turning on or shutting off the fuel supply to an appliance.
- (j) **Safety Shutoff.** A valve that is automatically closed by the safety control system or by an emergency device. Such a valve may be of the automatically or manually opened type.
- (k) **Semi-Automatic.** A valve that is opened manually and closed automatically, or vice versa.
- (l) **With Valve Seal Overtravel Interlock.** A Safety Shutoff valve which incorporates two valve closure members (seals) and a proof of closure switch that monitors the first closure member. It utilizes overtravel of this closure member to accommodate switch differential and wear.

VENT LIMITER. A means which limits the flow of gas from the atmospheric diaphragm to the atmosphere in the event of a diaphragm rupture. This may be either a limiting orifice or a limiting device.

4 Construction

4.1 General Construction

4.1.1

The heater shall be constructed entirely of new, unused parts and material. 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 the standard or not, shall be in accordance with reasonable concepts of safety, substantiality and durability.

All provisions 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.

4.1.2

Asbestos shall not be used in the construction of a heater.

4.1.3

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

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

4.1.4

The construction of the heater shall be such that it will prevent the dropping of incandescent particles from the heater.

4.1.5

Non-metallic tubing used in an appliance shall be suitable for the application and the temperatures to which exposed in service and shall not show evidence of deterioration when operated as specified in 5.17, Wall, Floor (Optional), Ceiling, Electrical Equipment And Wiring Temperatures. If the non-metallic tubing is connected to the atmospheric side of a component that can introduce fuel gas into the tubing under a failure condition, the amount of gas released into the tubing shall not exceed a flow rate of 2.5 ft³/hr (19.6 cm³/s) for natural gas, and 1.0 ft³/hr (7.9 cm³/s) for propane gas.

4.1.6

All components shall be suitable for the temperatures and climatic conditions to which exposed. Supplementary heating of components meets this requirement provided the heating source does not rely on recirculated room air. (See 4.15.11 and 4.22.2-p.)

4.1.7

The construction of a heater for outdoor installation shall be such as to prevent a collection of water in the heater which could cause an unsafe condition.

4.1.8

A heater shall have means provided to prevent leaves, papers or other objects from being picked up from the outside, ignited and discharged into the heated space. The upper limit of the size of the openings of this means shall be such as to prevent the entrance of a 1 1/8 in (28.6 mm) diameter rod. The lower limit of the size of the openings in this means shall not prevent the entrance of 1/4 in (6.4 mm) rod.

4.1.9

Enclosures for gas trains shall be adequately ventilated.

4.1.10

Thermal or acoustic insulation, that may allow smoke to be discharged to the circulating air in the event of a malfunction either shall comply with the requirements for duct coverings and duct linings in the *Standard for the Installation of Air Conditioning and Ventilation Systems, ANSI/NFPA 90A*, or shall have a flame-spread rating less than 25 and a smoke-developed rating less than 50 when tested in accordance with the *Safety Standard for Tests for Surface Burning Characteristics of Building Materials, ANSI/UL 723* or with the *Method of Surface Burning Characteristics of Building Materials, NFPA 255*.

4.1.11

Insulating materials shall be mechanically or adhesively retained in place. Insulating materials and their internal bonding or adhesive means shall withstand temperatures and air velocities to which subjected in normal operation. If the insulation is such that air impingement on the edges might cause displacement or damage, such edges shall be protected.

4.2 Assembly

4.2.1

The general construction and assembly of a heater shall be done in a neat and professional manner with parts well fitted and bolts or other fasteners drawn up tightly to give rigidity. Any exposed edges of the heater which might be contacted during normal usage or adjustment shall be smooth.

4.2.2

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*.

4.2.3

Fasteners used to attach any part which must be adjusted or removed for servicing shall be of corrosion resistant material or have corrosion-resistant coating.

4.2.4

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

4.3 Accessibility

4.3.1

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 a control(s) intact shall be considered as complying with this provision. Removal of an access panel or door to provide access to a control compartment is acceptable.

4.3.2

Provision shall be made to permit ready observation of the igniter or pilot and a major portion of the flames of each burner with the heater operating during service or start-up activity. An unsealed observation means with a movable cover shall be acceptable provided it does not exceed 4 square inches (25.8 cm²). The cover shall be designed and installed with corrosion resistant mechanism so as to insure that it closes automatically when the inspection port is not in use (i.e. positive gravity or spring).

4.3.3

Any external access door or panel shall require the use of a tool to open.

4.4 Main Burners

4.4.1

Bodies of burners shall be of substantial and durable construction capable of withstanding the conditions to which they are exposed during the tests outlined herein.

4.4.2

Ports shall be machined or otherwise accurately made.

4.4.3

Joints, when used in the pressure zone or in the burner head of a burner assembly, shall be gas-tight and shall not depend for mechanical strength nor primarily for tightness on cement or other sealing material, except where such joints may be considered part of the port area. Joints shall be securely bolted, screwed, machined, welded, brazed or be of equivalent construction.

4.4.4

Bolt holes shall not intersect gasways unless adequate provision is made to provide permanent gas-tightness.

4.4.5

Burners or burner and support assemblies shall be removable, constructed so 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.

4.4.6

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

4.4.7

The gas burner and combustion system of a heater may be of the single stage input, multiple stage input or modulating input type.

4.4.8

Gauze shall not be used in main burner construction.

4.5 Combustion Air Control

4.5.1

Linkage for operating the fuel and air controls, if used, shall be designed to reliably maintain the correct gas-air ratio and to resist accidental breakage, disengagement or change in setting.

4.5.2

When primary combustion air under pressure is mixed with the gas supply, effective means shall be provided to prevent air from passing back into the gas line, or gas into the air supply.

4.5.3

The gas and air supply shall be suitably controlled to prevent gas from entering the burner(s) until the air supply is available, and in the event of combustion air fan failure, to shut off the gas supply (see 4.14.8).

4.6 Orifices And Orifice Fittings

When provided, main burner gas orifices and orifice holders shall be made of materials having melting points of at least 1450°F (788°C).

4.7 Automatic Gas Ignition Systems

4.7.1

Automatic gas ignition systems (see Section 3, Definitions) and components shall comply with the applicable construction provisions of the *Standard for Automatic Gas Ignition Systems and Components*, ANSI Z21.20 or *Primary Safety Controls for Gas- and Oil-Fired Appliances*, ANSI/UL 372.

When a pilot burner(s) is incorporated in or is part of the main burner(s), it need be evaluated only under the construction and performance specifications of this standard.

4.7.2

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

- a. Provide for ignition of main burner gas by means of a proved ignition source. The ignition source shall be controlled automatically and any pilot gas shall be lighted by an igniter.

If neither the ignition source nor the main burner flame is proved at any time subsequent to obtaining proof of the ignition source, provide for automatic shutoff of gas to all burners.

- b. Provide for ignition of main burner gas by an automatically controlled direct ignition device.

If the main burner flame is not proved at any time following the flame-establishing period, provide for automatic shutoff of gas to all burners.

4.7.3

In addition to the automatic gas ignition system function specified in 4.7.2-a, a system having an interrupted ignition source shall provide for supervision of the main burner flame only following the main burner flame-establishing period. If the presence of the main burner flame is not proved within the flame-establishing period, the system shall provide for automatic shutoff of main burner gas.

4.7.4

Pilot burners shall be of substantial and durable construction. They shall be made of materials having a melting point above 1450°F (788°C).

Alloys of greater than 1.0 percent nickel content, because of catalytic cracking effect, are not acceptable.

4.7.5

Ignition devices shall be positively positioned with respect to the main burner ports. Means shall be provided to prevent incorrect assembly or reversible mounting of any ignition device in relation to the burner being served.

4.7.6

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

4.8 Flame Safeguards

4.8.1

The pilot or main burner flame, or both, shall be supervised by a safety shutoff device capable of deenergizing the main gas safety shutoff valve upon flame failure at the point of supervision. Supervisory systems provided for pilot operation shall be of either the "interrupted," "intermittent" or "continuous" type. (See Section 3, Definitions.)

4.8.2

When pilots are used, the supervisory system and main gas safety shutoff valve(s) shall be arranged so no gas will flow to the main burner(s) until the flame supervisor senses that a pilot flame has been established.

4.8.3

Pilot supervision shall be only at a point where the pilot will effectively ignite the gas at the main burner or group of burners even when the gas supply to the pilot is reduced so the flame is just sufficient to actuate the safety control.

4.8.4

The automatic gas ignition system shall operate in accordance with the following, as applicable:

- a. A flame-establishing period to determine the establishment of a pilot shall not exceed the timing specified in Table I, Maximum Ignition System Timing. If the pilot fails to ignite within the specified period, the pilot gas shall be automatically shut off and the primary safety control shall assume a lockout position and require a manual restart.
- b. Interrupted Pilot. If the pilot flame is proven, the main safety shutoff valve is energized. A main burner flame-establishing period as specified in Table I shall be allowed, then the pilot gas flow shall be interrupted and the flame sensor shall then supervise the main burner flame. If the main burner flame is not established, both the pilot automatic valve and the main gas safety shutoff valve shall be deenergized and the primary safety control shall assume a lockout position and require a manual restart. Supervision of the main burner flame only shall begin at the end of the main burner flame-establishing period.