

American National Standard/
CSA Standard for
**Direct Gas-Fired Process
Air Heaters**

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Preface

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

Nothing in this standard is to be considered in any way as indicating a measure of quality beyond compliance with the provisions it contains. It is designed to allow compliance of direct gas-fired process 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 progress takes 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, or the Chairman of CSA Technical Committee on Gas Appliances and Related Accessories, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6.

Safe and satisfactory operation of direct gas-fired process 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*; the *Natural Gas and Propane Installation Code, CSA B149.1*.

Users of this American National Standard/CSA Standard are advised that the devices, products and activities within its scope may be subject to regulation at the Federal, Territorial, Provincial, 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, Territorial, Provincial, state or local regulation should be followed.

THIS STANDARD IS INTENDED TO BE USED BY THE MANUFACTURING SECTOR AND BY THOSE APPLYING THE EQUIPMENT AND BY THOSE RESPONSIBLE FOR ITS PROPER INSTALLATION. IT IS THE RESPONSIBILITY OF THESE USERS TO DETERMINE THAT IN EACH CASE THIS STANDARD IS SUITABLE FOR AND APPLICABLE TO THE SPECIFIC USE THEY INTEND.

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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 Development Of The Standard For Direct Gas-Fired Process Air Heaters

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

With the onset of the Free Trade Agreement between the United States and Canada on January 2, 1988, significant attention was given to the harmonization of the United States and Canadian safety standards addressing gas-fired equipment for residential, commercial and industrial equipment.

It was believed that the elimination of the differences between the standards would remove potential trade barriers and provide an atmosphere in which North American manufacturers could market more freely in the United States and Canada.

A Z83/CGA joint Subcommittee on Standards for Heavy Duty Heaters was then established, based on memberships of the Z83 subcommittee for Gas-Fired Heavy Duty Forced Air Heaters, and the CGA committees for Unit Heaters/Duct Furnaces, Make-up Air Heaters, and Door Heaters.

Membership on the joint heavy duty heaters subcommittee encompasses representatives from the U.S. and Canadian manufacturing industry, gas suppliers (natural and LP), regulatory authorities and general interest.

To facilitate the reporting structure of joint subcommittees, a CGA Standards Steering Committee on Gas Burning Appliances and Related Accessories was established to parallel Accredited Standards Committees Z21 and Z83.

The first meeting of the Z83/CGA joint heavy duty heaters subcommittee was held on July 14-16, 1992 in Toronto.

The Joint Technical Advisory Group (TAG) on Standards for Heavy Duty Heaters adopted the proposed draft standard for Direct Gas-Fired Process Air Heaters for distribution for review and comment at its May 10, 2006 meeting.

The draft of the proposed harmonized standard was issued for public review in September 2006. All comments relating to the draft were duly considered by the joint heavy duty heaters TAG at its meeting on May 17, 2007. The resulting draft of the proposed harmonized standard was submitted for approval by the Z21/83 Committee and the CGA Technical Committee.

The first edition of the harmonized Z83/CSA Standard for Direct Gas-Fired Process Air Heaters was approved by the Canadian Interprovincial Gas Advisory Council on November 26, 2007, and by the American National Standards Institute, Inc. on January 14, 2008.

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

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American National Standard/CSA Standard For Direct Gas-fired Process Air Heaters

Part I: Construction

1.1 Scope

1.1.1

This standard applies to newly produced, direct gas-fired process air heaters of the recirculating or non-recirculating type, (See Definition), hereinafter referred to as heaters, whose primary purpose is to provide process heating to non-occupied spaces within commercial and industrial buildings and may also include operation as a non-recirculating ventilation air heater, (See Definition) if the heater is operated during periods when the space is occupied.

Heaters covered under this standard are limited to a maximum discharge temperature of 250°F (121°C).

Heaters covered by this standard are not intended for use in any area containing sleeping quarters. The installation shall conform with local codes, or in the absence of local codes, in accordance with the *National Fuel Gas Code, ANSI Z223.1*, or the *Natural Gas and Propane Installation Codes, CAN/CSA B149.1*.

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.

1.1.2

When the heater operates with people present within the space being served by this heater, it shall be configured to ensure the performance window of the heater operation will be in compliance with the applicable provisions associated with the ventilation air heater mode contained in this standard.

1.1.3

When the heater is operated in the bake cycle mode, the combustion by-products generated by the heater have not been defined since it is intended to operate in this mode in the non-occupied condition only.

1.1.4

When the heater is utilized as a paint booth heater, it must be operated as a non-recirculating ventilation air heater during the spraying operation and may be operated as a recirculating heater in the bake or drying mode provided all of the conditions identified in [1.2.11](#), [1.2.12](#), [1.16.3](#), [1.16.12](#), [1.16.13](#), [1.16.14](#), [1.22.12](#), [1.22.13](#), [1.22.14](#), [1.22.15](#), [1.22.16](#), [1.22.17](#), [1.22.18](#), [1.22.19](#) and [1.22.20](#), if applicable, are met.

1.1.5

Process air heaters that operate in the bake cycle mode only (does not operate in the occupied mode) are not required to comply with the following construction provisions: [1.16.5-b](#) and [1.22.1-m3](#).

1.1.6

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.

1.1.7

Items unique to the United States are shown in Exhibit A.

1.1.8

Items unique to Canada are shown in Exhibit B.

1.1.9

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

1.1.10

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

1.2 General Construction

1.2.1

The heater shall be constructed entirely of new, unused parts and materials. 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.

1.2.2

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

1.2.3

Every part of the heater shall be secure against displacement and 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.

1.2.4

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

1.2.5

All components shall be suitable for the temperatures and climatic conditions to which exposed. Supplementary heating of components meets this requirement. (See [1.16.10](#) and [1.23.2-p](#))

1.2.6

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.

1.2.7

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 $1\frac{1}{8}$ in (28.6 mm) diameter rod. The lower limit of the size of the openings in this means shall not prevent the entrance of $\frac{1}{4}$ in (6.4 mm) rod.

1.2.8

Enclosures for gas trains shall be adequately ventilated.

1.2.9

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*, or with Standard for *Surface Burning Characteristics of Building Materials, ULC S102*.

1.2.10

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.

1.2.11

When the heater is operated as a process air heater in a paint booth application or other applications with airborne particulate matter that could be detrimental to the operation of the heater in the recirculating mode, the recirculated air must be filtered to remove particulates from the air. If the filters and filter sections are not supplied with the heater, instructions shall be provided to require that particulate removal filters that are approved by the authority having jurisdiction be installed in the return air duct system. (See [1.22.14](#).)

1.2.12

When the heater is operated as a process air heater in a paint booth application or other applications with airborne particulate matter that could accumulate in the duct system in the recirculation mode, the duct system shall be provided with doors, panels, or other means to facilitate inspection, maintenance, cleaning, and access to fire protection devices. If the return air duct system is not supplied with the heater, instructions shall be provided that require the return air duct system be installed with the proper access means to meet this requirement. (See [1.22.15](#).)

1.3 Assembly

1.3.1

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.

1.3.2

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*.

1.3.3

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.

1.3.4

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.

1.4 Accessibility

1.4.1

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.

1.4.2

Provisions 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 in² (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).

1.4.3

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

1.5 Main Burners

1.5.1

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.

1.5.2

Ports shall be machined or otherwise accurately made.

1.5.3

Joints, when used in the pressure zone or in the burner head of a burner assembly, shall be gastight 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.

1.5.4

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

1.5.5

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.

1.5.6

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.

1.5.7

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

1.5.8

Gauze shall not be used in main burner construction.

1.6 Combustion Air Control

1.6.1

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.

1.6.2

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.

1.6.3

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 1.16.9).

1.7 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).

1.8 Automatic Gas Ignition Systems

1.8.1

Automatic gas ignition systems (see Part IV, Definitions) and components shall comply with the applicable construction provisions of the Standard for *Automatic Gas Ignition Systems and Components*, ANSI Z21.20 or CAN1-6.4 or CAN/CSA-C22.2 No.199, or *Automatic Electrical Controls for Household and Similar Use Part 2: Particular Requirements for Automatic Burner Ignition Systems and Components*, ANSI Z21.20 • CSA C22.2 No. 199 • UL372, 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.

1.8.2

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.

1.8.3

In addition to the automatic gas ignition system function specified in 1.8.2-a, a system having an interrupted ignition source shall provide for supervision of the main burner flame only following the main burner flame-establishing period. If the presence of the main burner flame is not proved within the flame-establishing period, the system shall provide for automatic shutoff of main burner gas.

1.8.4

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.

1.8.5

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.

1.8.6

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.

1.9 Flame Safeguards

1.9.1

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 Part IV, Definitions).

1.9.2

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.

1.9.3

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.

1.9.4

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 Timings](#). 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, Maximum Ignition System Timings](#), 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.
- c. Intermittent Pilot. If the pilot is proven, the main gas safety shutoff valve is energized and the pilot valve remains energized during the entire period that the main burner(s) is firing.
- d. Continuous Pilot. When the pilot is proven, the main gas safety shutoff valve may be energized and the pilot valve remains energized if the flame sequence is not interrupted.

- e. With a direct ignition system, a main burner flame-establishing period as specified in Table I, Maximum Ignition System Timings, shall be allowed. If the main burner flame is not established, the main gas safety shutoff valve shall be deenergized and the primary safety control shall assume a lockout position and require a manual restart.
- f. The primary safety control shall deenergize all main gas safety shutoff valves within the time specified in [Table I, Maximum Ignition System Timings](#), after flame failure. A single trial for reignition may occur but, if it is not successful or is not provided, the primary safety control shall assume a lockout position and shall require a manual restart.
- g. A burner circuit shall be arranged to prevent feedback by a motor, capacitor or similar device from energizing a fuel valve or ignition device after a control functions to shut off the burner.

1.9.5

If any part of the main burner flame length is more than three feet from the point of ignition, the main burner flame shall be supervised. Flame length is determined by the path of the flame. Main flame supervision shall be located as remote as practicable from the source of ignition.

1.10 Valve Trains

1.10.1

Valve trains for gas pressures up to and including 2 psi (13.8 kPa) shall have all components rated at not less than the static supply pressure.

1.10.2

Valve trains for gas pressures in excess of 2 psi (13.8 kPa) shall have all components rated at not less than the static supply pressure or, where the gas pressure in the valve train downstream of the pressure regulators is limited (e.g., by full internal relief in the pressure regulator or by a separate relief valve) to a maximum static pressure of 2 psi (13.8 kPa), the components downstream of the regulators shall be rated as in [1.10.1](#).

1.10.3

Valve trains operated at a static supply pressure in excess of $\frac{1}{2}$ psi (3.5 kPa) measured at the outlet of the gas pressure regulator shall supply a high gas pressure safety cut-out switch connected downstream of all controls. (See [1.16.6](#))

1.11 Manual Gas Valves

1.11.1

Manual gas shut-off valves shall comply with the applicable construction provisions of the Standard for *Manually Operated Valves for Appliances, Appliance Connector Valves and Hose End Valves, ANSI Z21.15 • CGA-9.1, Lever Operated Pressure Lubricated Plug Type Gas Shut-Off Valves, CAN/CGA-3.11, or Lever Operated Non-Lubricated Gas Shut-Off Valves, CGA-3.16, or the Standard for Combination Gas Controls for Gas Appliances, Z21.78 • CSA 6.20*. Disc-type manual gas shut-off valves shall be of the non-displaceable rotor type for both individual and combination type valves.

1.11.2

Manually operated burner, pilot and main shutoff valves shall be of the $\frac{1}{4}$ turn type supplied with a lever handle, clearly indicating the on and off positions, and shall be suitable for the pressure used.

1.11.3

A heater shall either have a manual gas shutoff valve provided in an accessible location for turning on or shutting off the gas to the main burner(s) or an accessible switch on the appliance for manually

interrupting the ungrounded leg of the electrical power to both appliance automatic valves, provided that the heater does not have a continuous pilot ignition system and it has two automatic valves for controlling main burner gas flow.

Either means for shutting off gas to the main burner(s) shall bear a Class III marking clearly indicating the "on" and "off" positions.

1.11.4

A manual gas shut-off valve shall be provided downstream from the last main line gas safety shut-off valve. A test gauge connection shall be furnished between the last main gas safety shut-off valve seat and the manual gas shut-off valve. The connection shall be a $\frac{1}{8}$ in or $\frac{1}{4}$ in NPT plug or cap with cleanly cut taper pipe threads in accordance with the Standard for *Pipe Threads, General Purpose (Inch)*, ANSI/ASME B1.20.1. If the plug is of the slotted type it shall also incorporate square or hex flats, or:

- a. A tapping sealed by a $\frac{1}{8}$ in or $\frac{1}{4}$ in NPT plug or cap as specified above; or
- b. A hose fitting which incorporates a captured sealing means.

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

1.11.5

A manually operated pilot shutoff valve shall be located upstream from all pilot controls and downstream from the main gas supply connection to the heater.

1.12 Gas Supply Lines

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

1.12.1

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

1.12.2

Tapped holes for gas valves, pilots or other branch supply lines shall carry not less than $3\frac{1}{2}$ taper pipe threads in accordance with the Standard for *Pipe Threads General Purpose (Inch)*, ANSI/ASME B1.20.1.

1.12.3

When the pilot gas supply line is taken from the bottom of a horizontal line, means shall be provided to prevent condensate from entering the pilot line. When a pilot gas supply line is taken from a vertical line, the connection shall be ahead of the main burner supply line.

1.12.4

Pilot gas supply lines shall be connected upstream of the main gas pressure regulator when the supply pressure does not exceed 14 in wc (3.48 kPa).

1.12.5

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

1.12.6

When semi-rigid tubing is employed as gas supply line it shall not be less than $\frac{1}{4}$ in (6.4 mm) outside diameter size.

1.12.7

Aluminum semi-rigid tubing shall not be acceptable for use where the tubing passes through insulating material of other than neutral reaction unless the tubing is adequately protected from the insulation. Such tubing shall not be exposed to condensate.

1.12.8

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

1.12.9

Nonferrous semi-rigid tubing employed as gas conduit shall have a wall thickness in accordance with Table II, Minimum Acceptable Wall Thickness For Nonferrous Semi-rigid Tubing.

1.12.10

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

Tubing and fittings used as gas conduit shall not be exposed to temperatures in excess of those specified in Table III, Maximum Tubing and Fitting Temperatures, when the heater is operated as specified in 2.16, Manifold and Control Assembly Capacity.

1.12.11

Type K and L copper tubing shall comply with *Standard Specification for Seamless Copper Tube (Metric)*, ASTM B75.

1.12.12

Aluminum tubing used for pilot gas supply lines shall be Type 1100 or Type 3003 with temper either O (fully annealed) or F (as extruded).

1.12.13

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

1.12.14

Compounds used on threaded joints of gas piping shall be resistant to the action of all fuel gases.

1.12.15

Unions in gas lines on heaters shall be of the ground-joint type or a flanged-joint type including a gasket resistant to the action of all fuel gases and suitable for the temperature to which it is exposed.

1.12.16

A test gauge connection shall be furnished upstream of the gas appliance pressure regulator for measuring gas supply pressure. The connection shall be a $\frac{1}{8}$ in or $\frac{1}{4}$ in NPT plug or cap with cleanly cut taper pipe threads in accordance with the Standard for *Pipe Threads, General Purpose (Inch)*, ANSI/ASME B1.20.1. If the plug is of the slotted type it shall also incorporate square or hex flats, or:

- a. A tapping sealed by a $\frac{1}{8}$ in or $\frac{1}{4}$ in NPT plug or cap as specified above, or
- b. A hose fitting which incorporates a captured sealing means.

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

1.13 Atmospheric Vents And Gas Reliefs Or Bleeds

1.13.1

A pressure regulator(s), pressure switch(es) and all other valve train components requiring atmospheric air pressure to balance a diaphragm or other similar device shall be furnished as follows:

- a. Controls or devices which require venting for proper operation shall be equipped with means for connection of a vent line. Vent lines shall be of sufficient area to accommodate their intended function. When a common manifold is utilized, the cross-sectional area shall not be less than twice the total area of the connected vents.

When controls or devices are installed within a compartment or enclosure which is part of the heater, that portion of each vent which is within the heater compartment or enclosure shall be factory supplied and terminated in a fitting for continuation of the vent(s). (See [1.23.9.](#))

- b. Valve train components shall be considered as complying with the above venting provisions if provided with a recognized vent limiter in lieu of a vent line. In this case, outside venting shall not be necessary.

1.13.2

Gas reliefs or bleeds furnished on regulators, pressure devices or normally open automatic motor or solenoid gas valves that allow gas to escape or discharge as a primary safety or operating function, shall be piped as follows:

- a. All enclosed valve trains shall have all gas reliefs or bleeds piped separately from an atmospheric vent line(s), if furnished, to a point terminating outside of the enclosure. The terminating point of this line(s) on indoor heaters shall be conveniently located for continuation by the installer to the outdoors. (See [1.23.9.](#))
- b. Heaters with an exposed valve train shall be designed to have any gas relief or bleeds piped to the outdoors by the installer. (See [1.23.9.](#))
- c. Relief valves may discharge into common manifolding only with another gas relief or bleed line(s). When a common line is provided, it shall have a cross-sectional area not less than the sum of the cross-sectional area of the largest relief valve discharge line plus 50 percent of the total cross-sectional area of all other relief valve or bleeding discharge lines.

1.13.3

A means shall be connected or supplied for connection to the end of each vent line, gas relief or bleed line to prevent stoppage by foreign material, moisture or insects on all heaters having devices requiring such lines.

1.13.4

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

1.14 Automatic Valves And Safety Shutoff Valves

1.14.1

Automatic valves and safety shutoff valves shall comply with the applicable construction provisions of the Standard for *Automatic Valves for Gas Appliances*, ANSI Z21.21 • CSA 6.5, or other nationally recognized Standards covering such devices. The operating pressure of all gas valves shall not be less than the maximum gas pressure to which the valve train is protected.

1.14.2

The main burner automatic safety shutoff valve(s) shall be supplied and installed downstream of the main gas appliance pressure regulator and upstream of the flow ratio and leak testing valves. Where the main gas appliance pressure regulator is designed to adjust input flow as well as gas pressure, it may be located downstream of the valve(s).

1.14.3

All gas to the main burner(s) shall pass through at least two valves in series which may or may not be in a single control body. Both valves shall be automatic valves (see Part IV, Definitions) and serve as operating valves and safety shutoff valves (see Part IV, Definitions).

One safety shutoff valve incorporating valve seal overtravel (proof of closure) interlock meets this requirement for heaters having an input rate of 10,000,000 Btu/h (2 930 71 W) or less.

1.14.4

A heater having an input rating over 400,000 Btu/hr (117 228 W) shall have provisions for measuring the gas pressure between the valves, except for a heater incorporating a single safety shutoff valve with valve seal overtravel interlock. (See 1.14.3.)

1.14.5

Electrically operated valves shall assume the closed position upon power failure.

1.14.6

Pressure-operated valves shall assume the closed position upon pressure failure.

1.14.7

A permanently installed leak test means shall be provided for heaters in excess of 400,000 Btu/hr. (117 228 W) to check the tightness of each safety shutoff valve. (See 1.22.10.)

1.15 Gas Appliance Pressure Regulators

1.15.1

Gas appliance pressure regulators shall comply with the applicable construction provisions of the Standard for *Gas Appliance Pressure Regulators*, ANSI Z21.18 • CSA 6.3, or the Standard for *Combination Gas Controls for Gas Appliances*, Z21.78 • CSA 6.20, or other nationally recognized standards covering such devices.

1.15.2

A gas pressure regulator which will satisfactorily limit the gas supply pressure shall be supplied with each heater. When a pilot is used, a pilot regulator to control pilot gas flow shall be provided with each heater.

1.16 Discharge Air, Purge, Limit Controls And Interlocks

1.16.1

In the bake cycle mode, a heater design shall include an operating temperature control means to preclude the discharge air temperature from exceeding 250°F (121°C) or the activation point of the high temperature limit control system, whichever is less. The temperature sensing element(s) may be located remote from the heater.

A heater designed to serve as both a process air heater and ventilation air heater shall be equipped with an operating control system to prevent the discharge temperature of the heater, when operating in the ventilation air heater mode, from exceeding the maximum discharge air temperature of 160°F (71°C), or exceeding the maximum temperature rise which demonstrated compliance to the combustion requirements of provision 2.9, Combination. A separate appliance regulator setting used in conjunction with the operating temperature control system or equivalent means is required to demonstrate compliance with this requirement.

1.16.2

A heater which is equipped with a means to reduce the air throughput shall be provided with a means to limit the maximum temperature rise as the air throughput is decreased or demonstrate compliance with the combustion requirements of 2.9.4 at the higher temperature rise at the minimum air throughput.

1.16.3

A heater shall incorporate a thermally activated limit control means to prevent the discharge temperature from exceeding 300 °F (149 °C). or from exceeding the temperature which is determined to cause the maximum temperature rating of the heater component(s) to be reached (see 1.2.5 and 1.19.2), which ever is less. Manual reset with in the control system shall be required to resume burner operation. Power interruption is not an acceptable method of control reset.

The limit control system shall include provisions for the following, if applicable.

- a. Be listed by a national recognized testing certifying agency.
- b. Be provided with a fixed stop, if adjustable, (see Part IV, Definitions) which will limit the outlet air temperature to not more than the maximum allowable temperature. A fixed stop is one that cannot be changed without the use of special tools.
- c. Be marked with the control calibration temperature for fixed setting controls and the temperature range on adjustable setting controls on class III marking materials. (See 1.23.10.)
- d. Act to directly interrupt the power supply to the main safety shutoff valve and, if provided, the pilot shutoff valve.

1.16.4

A heater shall incorporate a low-temperature control system or shall include provisions for the installation of an optional low-temperature control system. If the low temperature control system is not an integral part of the heater, 1.22.1-I shall apply.

1.16.5

A heater shall be equipped with an air flow sensing system(s) which acts to shut off the main burner gas under the following conditions:

- a. Before the air velocity or pressure drop across the burner is reduced to the minimum specified by the manufacturer. (See 2.7.1.)

- b. On heaters where the air velocity or pressure drop across the burner can be increased to the point that exceeds that specified by the manufacturer. (See [2.7.2.](#))

A time delay means not exceeding four minutes may be initiated to retard burner shutdown when the air velocity or pressure drop across the burner is increased above the maximum specified by the manufacturer. If the increased pressure drop still exists after the time delay has expired the equipment shall assume safety shutdown. Power interruption or remote reset is an acceptable means of reset.

- c. Where applicable, whenever there is a failure of a separate combustion air fan. (See [1.6.3](#) and [2.7.4.](#))
- d. Before the air velocity or pressure drop across the burner is reduced to the minimum specified by the manufacturer when the heater is operating in the bake cycle mode provided that this airflow permits compliance with clause [2.10, Burner Operating Characteristics](#), without the formation of carbon deposits. (See [2.7.5.](#))

When applicable, these devices shall be connected electrically in series.

The air flow sensing system shall be either non-adjustable; adjustable but factory calibrated and sealed; or adjustable, such that, any setting of the air flow sensing system shall comply with the above. The manufacturer shall specify the setting (including tolerances) of the air flow sensing system that corresponds to the set point(s) which will permit burner operation with the lowest and, if applicable, the highest air velocity or pressure drop across the burner.

1.16.6

Where applicable, a listed high gas pressure safety cut-out switch shall be provided with the limit setting not to exceed 125 percent of the design manifold pressure. The switch should act to shut off the main burner gas in the event of an overpressure condition. Manual reset within the control system shall be required to resume burner operation. Power interruption is not an acceptable method of control reset. (See [1.10.3.](#))

1.16.7

A heater shall include a fan interlock device which will prevent energizing the gas valve circuit until the fan/motor operation is proven. This device may be a centrifugal switch on the motor or blower, an extra contact of a motor starter where the motor starter is providing overcurrent protection for the motor, or other similar circuit elements which provide equivalent operation.

1.16.8

The burner housing or enclosure and any attached inlet ductwork shall be purged of any explosive vapors before ignition can occur. This purge shall provide a minimum of four air changes through the heater, and, if applicable, all attached inlet ductwork by volume. A purge timer is not necessarily required. (See [1.22.11.](#))

1.16.9

A heater shall be designed so air flow through the heater is proven before the ignition system is activated. The air flow sensing device specified in [1.16.5](#) shall be considered an acceptable air flow proving means.

1.16.10

A heater which is required to supply supplementary heating of control component(s) shall maintain the surrounding environment for the affected control(s) or valve(s) at least 18°F (10°C) above their respective minimum operating temperature ratings.

If the components requiring the supplemental heating system are enclosed in a heated compartment, a low limit temperature control means shall prevent the heater from operating if the temperature within the heated compartment is below the activation point of the thermal interlock means setpoint. An electrically heated compartment shall be equipped with a high limit control that will de-energize the compartment heating system before the temperature within the compartment exceeds 77°F (25°C).

1.16.11

A heater design which includes a gas valve with valve seal overtravel interlock shall:

- a. Prevent burner start and purge when the valve seal overtravel interlock switch verifies that the valve is in the open position; and
- b. Allow the gas valve to be energized during the flame establishing period and while the automatic gas ignition system proves the supervised flame or ignition source.

1.16.12

In a paint booth application, an interlock shall be provided to lock out the paint spraying equipment unless the process heater is operated in the ventilation air mode. Instructions and a wiring diagram shall be provided to show how the interlock shall be connected. (See [1.22.18](#).)

1.16.13

In a paint booth application, an interlock shall be provided to ensure the heater is operated in the ventilation air mode for a minimum of three (3) minutes or a minimum of four air changes of the paint booth volume, whichever is greater, at the start of the bake or drying cycle with the paint spraying equipment locked out. The length of the pre-purge period shall be field adjustable to accommodate the specifics of that particular application. If a pre-purge control system is not an integral part of the heater controls, instructions and a wiring diagram shall be provided to show how the interlock shall be connected. (See [1.22.19](#).)

1.16.14

On process heater applications which are intended to be entered by personnel following a bake or drying cycle, the controls shall include a post purge timer to purge contaminants from the space and cool the products to avoid a burn hazard. The length of the post purge period shall be field adjustable to accommodate the specifics of that particular application. If a post purge control system is not an integral part of the heater controls, instructions and wiring diagrams should be provided that shows the recommended method of connecting a post purge control. (See [1.22.13](#).)

1.16.15

In a paint booth application, an interlock shall be provided to initiate the operation of the heater fan in conjunction with the operation of the exhaust fan. Instructions and a wiring diagram shall be provided to show how the interlock shall be connected. (See [1.22.20](#).)

1.17 Thickness Of Materials

1.17.1

When outside casings are constructed of sheet-iron or steel, they shall be not less than 0.0254 in (0.65 mm) thick.

1.17.2

On a heater for outdoor installation, ferrous materials used in the construction of the outside casing, and in an outside cabinet which is the sole enclosure of current carrying parts shall be protected against corrosion by one of the coatings appropriate to the thickness of the part as outlined in Table IV, Corrosion

Protection of Ferrous Materials Used in the Construction of Outside Casings of Heaters for Outdoor Installation, and the notes applicable thereto, or by other metallic, or nonmetallic coatings or materials which have been shown to give equivalent protection.

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

1.18 Fan Motors

1.18.1

Electric motors shall be designed for continuous duty and shall be provided with overload protection in accordance with the *National Electrical Code, ANSI/NFPA 70* or the *Canadian Electric Code, CSAC22.1*, or the *Standard for Motors With Inherent Overheating Protection, CSA-C22.2 No.77*.

1.18.2

Motors used with suspended type heaters shall be of the totally enclosed type, or located either within the confines of the heater casing or other enclosure, structure or shield.

1.18.3

Motors shall operate at no more than the motor name plate current rating, including the service factor, and at temperatures not in excess of the limits specified in Table A-V, Maximum Allowable Rise Above Room Temperature for Various Component Parts, when operating at any condition within the range of temperature rise and external static pressure specified by the manufacturer.

1.19 Fans

1.19.1

Fans shall be of type suitable for the application and shall be accessible for inspection without dismantling of the heater.

1.19.2

The location of the fan shall be such that there will be no flame impingement thereon and the temperature of the fan and bearings shall not exceed that recommended by the component manufacturer(s).

1.20 Air Filters

Air filters, when provided, shall be of a type suitable for the application and shall be accessible for inspection and replacement without dismantling of the heater.

1.21 Protection Of Service Personnel

1.21.1

An uninsulated live part in a high-voltage or high-tension ignition circuit (see Part IV, Definitions) within the heater cabinet shall be located, guarded or enclosed so as to minimize accidental contact by service personnel performing mechanical (refrigeration or plumbing) service functions which may have to be performed with the equipment energized.

The following shall be considered in determining compliance with this provision:

- a. Mechanical service functions which may have to be performed with the equipment energized, such as (1) adjusting air-flow dampers, (2) operating manual switches, (3) resetting control trip mechanisms, (4) operating valves or connecting fittings which may be necessary during charging or pumpdown, (5) adjusting water control or expansion valves, or (6) adjusting the setting of temperature or pressure controls.

A factory set and sealed control is not considered to be adjustable.

- b. Adjustable or resettable electrical control or manual switching devices may be located or oriented with respect to uninsulated live parts so that manipulation of the mechanism for adjusting, resetting or operation can be accomplished in the normal direction of access if uninsulated live parts are (1) not located in front (in the direction of access) of the mechanism and are (2) not located within 6 in (15.24 cm) on any side or behind the mechanism unless they are guarded.

This provision is not applicable to mechanical service functions which are not normally performed with the equipment energized. Such functions include opening of drain plugs, adjusting or replacing drive belts and replacing refrigerant-containing components.

1.21.2

An electrical control component which may require examination, adjustment, servicing or maintenance while energized shall be located and mounted in respect to other components and with respect to grounded metal parts so it is accessible for electrical service functions without subjecting the serviceman to the likelihood of shock hazard from adjacent uninsulated live parts or to accident hazard from adjacent hazardous moving parts.

The following shall be considered in determining compliance with this provision:

- a. Accessibility and protection from the likelihood of shock and accident hazard may be obtained by mounting the control components in an assembly so unimpeded access is provided to each component through an access cover or panel in the outer cabinet and the cover of the control assembly enclosure with the following arrangement. See Figure 1, Accessibility and Protection.
 - 1. The components are located with respect to the access opening in the outer cabinet so the farthest component in the control assembly is not more than 14 in (35.56 cm) from the plane of this access opening.
 - 2. Uninsulated live parts outside the control assembly's projected clear space or unguarded hazardous moving parts are located not closer than 6 in (15.24 cm) from any side of the access area. The projected clear space is considered to be bounded on the sides by the projection of the smallest rectangular perimeter surrounding the outside edge of the component or control enclosure, when provided. The access area is considered to be bounded on the sides by the projection of the perimeter of the access opening in the outer cabinet to the closest rectangular perimeter surrounding the outside edge of the component or control enclosure.
 - 3. The volume generated by the projected clear space of the control assembly to the access opening in the outer cabinet (within the access area) is completely free of obstructions, including wiring.
 - 4. Access to the components in the control assembly is not impeded in the direction of access by other components or by wiring in this assembly.

5. Extractor-type fuseholders and snap switches mounted through the control assembly enclosure are to be located so there is unimpeded access to these components through the access opening in the outer cabinet and so they are not immediately adjacent to uninsulated live parts outside the control assembly enclosure, unless guarded. (See 1.21.1b.)

Other arrangements of location of components, guarding of components, or both, are also acceptable where electrical components are accessible for service.

- b. The electrical components referred to in the preceding paragraphs include the following: fuses, adjustable or resettable overload relays, manual or magnetic motor controllers, magnetically operated relays, adjustable or resettable pressure or temperature controller, manual switching devices, clock timers, and incremental voltage tap and motor speed tap terminals for variable-speed motors. Such components in a low-voltage circuit (see Part IV, Definitions) are to comply with this provision in their relation to uninsulated live parts in a high-voltage circuit (see Part IV, Definitions) and to hazardous moving parts.
- c. The following are not considered to be uninsulated live parts: coils of controllers, relays and solenoids, and transformer windings, if the coils and windings are provided with recognized insulating overwraps; enclosed motor windings; terminals and splices with recognized insulation; and insulated wire.

1.21.3

If the removal of doors, panels or guards exposes moving parts such as fan blades, blower wheels, pulleys or belts, one of the following shall apply:

- a. The opening or removal of the door, panel or guard shall require the use of tools;
- b. An interlock device shall shut off the mechanism; or
- c. The warning specified in 1.23.8 shall be displayed on the heater.

1.22 Operating And Installation Instructions

1.22.1

Each heater shall be accompanied by printed instructions and diagrams, to be reviewed by the testing agency for accuracy and for compatibility with results of test from a technical standpoint only.

The front cover or the first page of the instructions shall bear the following boxed warnings:

FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Don't touch electrical switches.
3. Extinguish any open flames.
4. Immediately call your gas supplier.



WARNING: Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.

FOR YOUR SAFETY

The use and storage of gasoline and other flammable vapors and liquids in open containers in the vicinity of this appliance is hazardous.

The letters used for the boxed warnings shall be bold-faced type having a minimum uppercase letter height of 0.120 in (3 mm). The minimum vertical spacing between lines of type shall be 0.046 in (1.2 mm).

These instructions shall include:

- a. Clearly defined, legible and complete instructions for start up and shutdown of the heater shall be provided for the user.
- b. Manufacturer's or distributor's name and address, model, type or series number.
- c. Instructions for the proper assembly, installation and safe operation of the heater and all field-installed parts, components, controls and accessories.
- d. Information for installation of the heater (1) in airplane hangars in accordance with the Standard for *Aircraft Hangars*, ANSI/NFPA 409, and (2) public garages in accordance with the Standard for *Parking Structures*, ANSI/NFPA 88A, or the Standard for *Repair Garages*, ANSI/NFPA 30A, and with the *Natural Gas and Propane Installation Codes*, CAN/CSA B149.1.
- e. Information that an electric disconnect switch having adequate ampacity (see marking on the heater for voltage and ampacity), if not provided as part of the heater, shall be installed in accordance with the *National Electrical Code*, ANSI/NFPA 70.
- f. Instructions that adequate relief shall be provided so as to prevent overpressurization when the heating system is operating at its rated capacity. It should be noted that this can be accomplished by taking into account, through standard engineering methods, the structure's designed infiltration rate; by providing properly sized relief openings; or by interlocking a powered exhaust system; or by a combination of these methods.

- g. Identification of the entry location(s) for field-installed wiring and control wiring.
- h. The heater and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of $\frac{1}{2}$ psi (3.5 kPa).

The heater must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than $\frac{1}{2}$ psi (3.5 kPa).
- i. The method of determining the different pressures specified in 1.23.2-c.
- j. A statement to "Refer to the heater rating plate for determining the minimum gas supply pressure for obtaining the maximum gas capacity for which this heater is specified."
- k. Instructions specifying that service personnel shall perform a gas leak check during heater start-up, to verify the gastightness of the heater's components and piping under normal operating conditions.
- l. If the low-temperature control system is not an integral part of the heater, then a recommendation that a low-temperature limit control be installed in areas where freeze-up protection is needed in the event of burner shutdown.
- m. Information to the effect that:
 - 1. The heater inlet shall be located in accordance with the applicable building code or mechanical code provisions for ventilation air.
 - 2. Field constructed intake accessories should be properly designed to minimize the entry of snow and rain.
 - 3. Ventilation air to the heater shall be ducted directly from outdoors when the heater is operated in the ventilation air mode.
 - 4. If in doubt regarding the application, consult the heater manufacturer.
- n. Information covering the cleaning of the burner(s).
- o. If the automatic gas ignition control system is exterior to the heater, a statement that the heater be installed such that the gas ignition control system is not directly exposed to water spray, rain or dripping water.
- p. Provide space for the name, address and telephone number of the dealer, and/or the installing contractor, and/or the service contractor along with the date of installation.
- q. Instructions specifying that bleeds and vents that require venting shall be vented to the out-of-doors.
- r. The installation shall conform with local codes, or in the absence of local codes, in accordance with the *National Fuel Gas Code, ANSI Z223.1 • NFPA 54*, or the *Natural Gas and Propane Installation Codes, CAN/CSA B149.1*.

1.22.2

Electrical diagrams (see Part IV, Definitions) applicable to the heater shall be placed in a suitable pocket and furnished in each of the following forms:

- a. A connection diagram to aid in locating components for field service;

- b. A schematic diagram of the ladder form; and
- c. A cycle chart or printed sequence of switching action.

1.22.3

Electrical diagrams shall conform to the Standard for *Electrical and Electronics Diagrams*, ANSI Y14.15. See Appendix A for reference to pertinent provisions of ANSI Y14.15. The wire color designations specified under 153.11 of ANSI Y14.15 are shown in Appendix B.

1.22.4

It is recommended that the usage of wire colors be as shown in Appendix C.

1.22.5

Unidentified graphical symbols used for electrical diagrams shall conform to the Standard for *Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Class Designation Letters)*, ANSI/IEEE 315 Standard. See Appendix D for preferred symbols of commonly used items, as extracted from ANSI/IEEE 315 Standard. Abbreviations for identified items shall be as shown in Appendix D.

1.22.6

If wire other than that conforming with the temperature limitation for Type TW wire, or equivalent [63°F (35°C) rise], has been specified for use on the heater, the following statement shall appear on all electrical diagrams: "If any of the original wire as supplied with the heater must be replaced, it must be replaced with type ____ wire or its equivalent."

If wire other than that conforming to the temperature limitation of 63°F (35°C) rise has been specified for field-wired connections, the following statement shall appear on all electrical diagrams: "Field-wiring having a temperature rating of at least °C* shall be used and supply circuit wiring shall have a minimum size of ____ *AWG."

1.22.7

Adequate instructions shall be provided for field wiring of equipment, if applicable.

1.22.8

Adequate instructions shall be provided for adjusting profile plates, burner manifold pressure, or other combustion air devices to maintain the specified relationship between fuel and air for proper flame and combustion performance, if applicable. (See 2.3.1.)

1.22.9

Adequate instructions shall be provided for adjusting the pilot flame, if applicable. (See 2.11.2.)

1.22.10

Adequate instructions shall be provided for annual checking the gas tightness of the safety shut-off valve(s).

1.22.11

Adequate instructions shall be provided to address heater installations where a duct work system is attached to the inlet of the heater to purge the volume of the duct system with at least four air changes prior to an ignition attempt.

* These marked values shall conform with those on the label specified in Exhibit A – A.1.18.

1.22.12

Instructions shall specify that if the facility served by a process air heater can be entered by personnel:

- a. The access opening(s) to the heated space shall be equipped with door interlock switch(es) to prevent the operation of the heater during a bake cycle when an access door is opened.
- b. Recommendations to post the following warning markings at each access opening.

“Do not enter this space until the cool down cycle is complete.”

1.22.13

On process heater applications which are intended to be entered by personnel following a bake cycle, the instructions shall specify that the space should be ventilated to purge contaminants from the space and cool the products to avoid a burn hazard. The instructions and wiring diagrams should show the recommended method of connecting a post purge. (See [1.16.14](#).)

1.22.14

When the heater is operated as a process air heater in a paint booth application or other applications with airborne particulate matter that could be detrimental to the operation of the heater in the recirculating mode, instructions shall be provided to require that filters be installed in the return air duct system that are approved by the authority having jurisdiction. (See [1.2.11](#).)

1.22.15

When the heater is operated as a process air heater in a paint booth application or other applications with airborne particulate matter that could accumulate in the duct system in the recirculating mode, instructions shall be provided that require the return air duct system be installed with doors, panels, or other means to facilitate inspection, maintenance, cleaning, and access to fire protection devices. See [1.2.12](#).

1.22.16

When the heater is operated as a process air heater in a paint booth application or other applications with airborne particulate matter that could accumulate in the duct system in the recirculating mode, instructions shall be provided to require the periodic inspection and cleaning of the recirculating air duct system.

1.22.17

Instructions shall be provided to require the gas piping installer to locate a manual emergency shutoff valve in an appropriate location that allows access to this valve to shut off the fuel to the process heater in case of a fire or explosion at the heater.

1.22.18

In a paint booth application, instructions and a wiring diagram shall be provided to show how the interlock shall be connected to lock out the paint spraying equipment unless the process heater is operated in the ventilation air mode. (See [1.16.12](#).)

1.22.19

In a paint booth application, instructions and wiring diagrams shall be provided to ensure the heater is operated in the ventilation air mode for a minimum of three (3) minutes or a minimum of four air changes of the paint booth volume, whichever is greater at the start of the bake or drying cycle with the paint spraying equipment locked out. (See [1.16.13](#).)

1.22.20

In a paint booth application, instructions and a wiring diagram shall be provided to show how the interlock between the exhaust fan and heater fan is to be connected. (See [1.16.15](#).)