Controls and Safety Devices for Automatically Fired Boilers

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ASME Codes and Standards
Installation requirements shall apply to controls, safety devices, and burners on automatically fired boilers covered by this Standard.

For information regarding boiler and/or burner installations, refer to local codes. In the absence of local codes, see NFPA 54/ANSI Z223.1 for gas-fired boilers and NFPA 31 for oil-fired boilers.

For boilers firing liquefied-petroleum gas or LP-gas air mixtures, the requirements pertaining to the storage container, the first and second stage LP-gas pressure regulators, and all components upstream of the point of gas delivery (see CG-700) are covered by NFPA 58, Liquefied Petroleum Gas Code.

Installation of controls, safety devices, and burners shall be in accordance with the manufacturer’s instructions and the applicable requirements of this Standard. Diagrams detailing the wiring and piping connections for the controls and safety devices installed shall be furnished by the unit manufacturer [see CG-510(c)].

Installations shall provide accessibility for removing burners; adjusting, cleaning, and lubricating working parts; and replacing controls, safety devices, and other control components.

For information concerning the location and installation of LP-gas air mixture boilers, refer to local building codes.

When one or more modules of a modular boiler (see CG-700) are replaced, compatibility of all controls and systems shall be ensured. The replacement modules shall comply with the initial listing and shall meet the requirements of this Standard.

Observation ports shall be provided to permit direct visual inspection of the pilot, main burner flame, and boiler furnace, except for boilers using pulse combustion that are labeled and listed by a nationally recognized testing agency.

Guards shall be provided to protect personnel and protect against damage to control equipment. Guarding shall conform to applicable regulations.

Where used, annunciator systems, and their associated test and acknowledgement circuits, shall have all contacts, switches, relays, and lights arranged so that safety control functions are not bypassed.

The requirements of combustion air shall be in accordance with NFPA 54/ANSI Z223.1, National Fuel Gas Code, for gas-fired boilers and with NFPA 31, Standard for the Installation of Oil-Burning Equipment, for oil-fired boilers.

Louvres and grilles shall be fixed in the open position or interlocked with the equipment so that they are opened automatically during equipment operation. The interlock shall be placed on the driven member.

Fans supplying air to the boiler room for combustion shall be interlocked with the burner so that air flow is proven during equipment operation.

Each control and safety device covered by this Standard shall be accepted for the intended service by a nationally recognized testing agency such as, but not limited to, UL, FM, or CSA (see CG-230).

Manufacturers of controls and safety devices requiring periodic service shall furnish detailed instructions covering the procedures and frequency of cleaning [see CG-410].

Manufacturers of boilers and burners covered by this Standard shall furnish detailed instructions for testing both when the boiler is operating and when it is out of service [see CG-510(c)].

Boiler, boiler unit, burner, and control manufacturers’ operation and maintenance instructions furnished with the equipment shall be retained and made available to the boiler operator (see CG-510).

The manufacturer of shop-assembled boilers shall test and report per CG-510(a) on the operation of control systems and safety devices installed in accordance with this Standard. Test conditions shall be as close to specified field conditions as feasible prior to shipment from the manufacturer’s facility. Where production makes it
infeasible to check each shop-assembled boiler unit individually prior to shipment, the manufacturer shall follow a written inspection and quality control procedure by which the intent of this paragraph will be met.

(b) The installing contractor shall test and report per CG-510(b) on the operation of control systems and safety devices installed in accordance with this Standard prior to release to the owner/user.

CG-500 CERTIFICATION AND REPORTING

CG-510 Certification and Reporting

(a) Manufacturers of shop-assembled boiler units covered by this Standard shall maintain a report for each boiler unit or on each category (type, size, or model) for boiler units. For boiler units less than or equal to 400,000 Btu/hr (117 kW) for gas, or less than or equal to 3 gph (11.4 L/h) for oil, a report shall be maintained on each category (type, size, or model).

This report shall list

(1) each control and safety device installed in accordance with this Standard

(2) name of the manufacturer and model number of each control and safety device

(3) operational test performed (see CG-440)

CG-510(b) through (3) shall be verified by the signature of an authorized representative of the manufacturer on this report. An example of an acceptable report form is contained in Nonmandatory Appendix C.

This report shall be made available to the authorized inspection agency or the inspector for action as required by the local jurisdiction.

(b) Installing contractors shall maintain or obtain from the manufacturer a report for each installation completed. The report shall list

(1) each control and safety device installed in accordance with this Standard

(2) name of the manufacturer and model number of each control and safety device

(3) operational test performed (see CG-440)

CG-510(b) through (3) shall be verified by the signature of an authorized representative of the installing contractor on this report. An example of an acceptable report form is contained in Nonmandatory Appendix C.

This report shall be made available to the authorized inspection agency or the inspector for action as required by the local jurisdiction.

(c) Installing contractors shall obtain from the boiler manufacturer pertinent operating, testing, servicing, and cleaning instructions for the controls and safety devices (see CG-410, CG-420, and CG-430). It is the responsibility of the installing contractor to deliver these instructions, together with complete wiring and piping diagrams, and a written precaution that the operating, testing, and servicing only be performed by a qualified individual (see CG-700) to the owner/user and to obtain a receipt for the instructions. The receipt shall be filed with the installation report.

CG-600 OPERATION

CG-610 Lockout

The manual procedure required for effecting the restart of the equipment subsequent to a lockout shall be accomplished from a location where the cause of the lockout may be determined so that the necessary corrective action may be performed to ensure that safe operating conditions prevail before restarting the boiler.

Safety control(s) that can electronically reset without local manual intervention, such as when power or control input to the device is interrupted and then restored, shall not be permitted.

CG-700 DEFINITIONS

accepted: a boiler unit, equipment, or device is accepted when listed, labeled, or otherwise determined to be suitable and safe by a nationally recognized testing agency. Field installations are accepted when approved by the authority having jurisdiction.

air change: the quantity of air necessary to completely replace the air contained in the combustion chamber and associated flue passages.

air shutter: an adjustable device for varying the flow of air.

alarm: an audible or visible signal indicating an off-standard or abnormal condition.

alarm circuit: a circuit that includes an alarm.

annunciator: a device that indicates a condition, either normal or abnormal, by visual signals, audible signals, or both.

approved: acceptable to the authority having jurisdiction.

atomizing media: a supplementary medium, such as steam or air, that assists in breaking the fuel oil into a fine spray.

authorized inspection agency: the inspection agency approved by the appropriate authority of a state or municipality of the United States or a province of Canada that has adopted this Standard.

AWG: American Wire Gauge.

bleed line: a section of piping or tubing that conveys the release of gas from a fuel train component, which periodically releases gas pressure to the atmosphere in order to operate properly.

boiler: a closed vessel in which water or other liquid is heated, steam or vapor is generated, steam or vapor is superheated, or any combination thereof, under pressure or vacuum for use external to itself, by the direct
**combustion chamber**: the portion of the boiler enclosure into which the fuel is fed, ignited, and burned (also referred to as furnace or firebox).

**conductor**: a body that may be used to conduct electric current.

**continuous duty**: the design feature of an electrical device, such as a motor, enabling the device to operate at the rated load for an indefinite period.

**control**: a device designed to regulate the fuel, air, water, steam, or electrical equipment. It may be automatic, semiautomatic, or manual.

**control, operating**: an automatic control, safety control, to start or regulate input according to demand and to stop or regulate input on satisfaction of demand.

**control, primary safety**: a control directly responsive to flame properties, sensing the presence of flame and, in event of ignition failure or loss of flame, causing safety shutdown.

**control, safety** (also known as limit): a control responsive to changes in liquid level, pressure, or temperature and set beyond the operating range to prevent the operation beyond designed limits.

**control manufacturer**: an organization that manufactures operating and safety controls for use on boilers.

**CSA**: CSA International.

**damper**: a valve or plate for regulating combustion air or flue gases.

**draft**: the difference in pressure between atmospheric and some other pressure in the furnace or gas passages.

**draft, mechanical**: the draft caused by a mechanical device, such as a forced draft or induced draft fan.

**draft, natural**: the draft caused by the difference in the temperature of the hot flue gases and the outside atmosphere.

**drip**: the container placed at a low point in a system of piping to collect condensate and from which condensate may be removed.

**fan, forced draft**: a fan used to supply air, under pressure, to the fuel-burning equipment of the boiler.

**fan, induced draft**: a fan used to exhaust gases, under suction, from the boiler.

**feedback line**: a section of piping or tubing that normally communicates air pressure from a point of reference to the air pressure side of a diaphragm of fuel train component, but could contain gas under abnormal conditions; or a section of piping or tubing that communicates flue or gas pressure from one point of reference to another point of reference.

**firing rate**: the rate at which air, fuel, or an air-fuel mixture is supplied to a burner, expressed in volume or heat units supplied per unit of time.

**flame failure response time**: the time interval between the loss of flame and deenergizing the safety shutoff valve.

**flue passages (breeching)**: the cavities (e.g., flue, exhaust, or vent system) that convey the products of combustion from the boiler combustion chamber to an approved location.

**FM**: factory mutual approvals.

**fuel train**: a series of valves, regulators, and controls, between the burner and the source of fuel, that regulates and controls the flow of fuel to the burner.

**gas**: one of the following fuel gases: natural gas, liquefied petroleum (LP) gas, LP-air mixture, manufactured gas, or mixed gas.

**gas-pressure regulator, main**: a device for controlling and maintaining a predetermined gas pressure for the main burner.

**gas-pressure regulator, pilot**: a device for controlling and maintaining a predetermined gas pressure for the pilot burner.

**gas-pressure relief line**: a section of pipe or tubing that conveys a release of gas from a gas-pressure relief valve.

**ground**: a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and either the earth or a conducting body that serves in place of the earth.

**grounded**: connected to earth or to some conducting body that serves in place of the earth.

**grounded conductor**: a system or circuit conductor that is intentionally grounded.

**grounding conductor, equipment**: the conductor used to connect noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system-grounded conductor at the service and/or the grounding electrode conductor.

**guarded**: covered, shielded, fenced, enclosed, or otherwise protected by means of covers, casings, barriers, rails, screens, mats, or platforms to prevent contact by persons or objects.

**high fire**: the rate of a burner at or near design maximum fuel input.

**ignition system, direct**: an automatic ignition system that uses an electrically energized device to ignite fuel at a main burner.

**ignition system, hot surface**: an automatic, direct ignition system that uses a hot surface igniter to ignite fuel at a main burner.

**input rating**: the fuel-burning capacity of a burner at sea level in Btu/hr (W) as specified by the manufacturer.

**installing contractor**: an organization that installs a boiler, combustion controls, burners, and protective equipment in the field.
labeled: equipment or materials to which has been attached a label of a nationally recognized testing agency that maintains periodic inspection of production of labeled equipment or materials. Labeling indicates compliance with nationally recognized standards.

liquefied-petroleum gas: fuel gases, including commercial propane; predominantly propane, propylene, or commercial butane; predominantly butane; isobutane; and/or butylene.

listed: equipment or materials included in a list published by a nationally recognized testing agency that maintains periodic inspection of production of listed equipment or materials. Listing indicates compliance with nationally recognized standards.

local: within physical sight and sound of the affected equipment (see also lockout).

lockout: a safety shutdown that requires a local, manual process control having an adjustable set point, the maximum fixed stop limit is the maximum setting to which the control can be adjusted and still perform its intended function (i.e., safety shutdown) but not be exceeded due to a mechanical or electrical stop device.

maximum fixed stop limit: on a temperature or pressure control having an adjustable set point, the maximum fixed stop limit is the maximum setting to which the control can be adjusted and still perform its intended function (i.e., safety shutdown) but not be exceeded due to a mechanical or electrical stop device.


oil: any commercial grade fuel oil as defined by ASTM D396.

pilot: a small burner that is used to light off (ignite) the main burner.

pilot, continuous: also known as a constant burning pilot, a pilot that burns without turndown throughout the entire time the burner assembly is in service, whether the main burner is firing or not.

pilot, intermittent: a pilot that is automatically lighted each time there is a call for heat. It burns during the entire period the main burner is firing.

pilot, interrupted: a pilot that 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.

pilot, proved: a pilot flame supervised by a primary safety control.

pilot flame-establishing period: the interval of time that fuel delivered to a pilot burner before the primary safety control is required to prove the pilot flame.

pilot, lockout: a device that requires a local, manual reset device: a component of a control that requires resetting by hand to restart the burner after safe operating conditions have been restored.

point of gas delivery: for other than undiluted liquefied-petroleum gas systems, the point of gas delivery shall be considered the outlet of the service meter assembly or the outlet of the service regulator or service shut off valve when no meter is provided. For undiluted, liquefied-petroleum gas systems, the point of gas delivery shall be considered the outlet of the service regulator downstream of the gas-pressure regulator.

prepurge period: a period of time on each startup during which air is introduced into the combustion chamber and flue passages in volume and manner as to completely replace the air or fuel-air mixture contained therein prior to initiating ignition.

pressure regulator, LP-gas, first stage: on undiluted LP-gas systems, a pressure regulator designed to reduce pressure from the container to 10.0 psi (70 kPa) or less.

pressure regulator, LP-gas, second stage: a pressure regulator for service on undiluted LP-gas systems designed to reduce first stage regulator outlet pressure to 14.0 in. W.C. (4.0 kPa) or less.
pressure regulator, service: a pressure regulator installed by the serving gas supplier to reduce and limit the service line gas pressure to delivery pressure.

primary safety control system: an automatic labeled and listed control that may integrate the functions of other controls, such as operating control(s), primary safety control(s), safety control(s), and sensing devices. This control system integrates separate labeled and listed components that incorporate feedback so that the failure of any of these sensing devices will result in a safety shutdown and lockout condition of the boiler.

proven prepurge: a provision of the control system for preventing burner operation until prescribed air flow is proven to be established during prepurge.

pulse combustion: a self-aspirating, acoustically resonating combustion system.

qualified individual: a boiler service technician who is engaged in and responsible for installation, replacement, repair, or service of the boiler, fuel-burning system controls, and safety devices and is experienced in such work.

readily accessible: having direct unimpeded access without the need of a ladder or removing or moving any panel, door, or similar covering of the item described.

recycle: the process of sequencing a normal burner start following safety shutdown before the establishment of lockout.

relay: a device that is operative by a variation in the conditions of one electric circuit to start the operation of other devices in the same or another electric circuit, such as pressure or temperature relay.

relight: the action upon loss of main flame to reestablish the ignition source without recycle.

sediment trap: a device in a gas line that collects and prevents solid debris (such as pipe dope, slag, dirt, etc.) from traveling downstream into the gas controls (see Fig. CG-1).

shutdown, normal: shutting off fuel and ignition energy to the burner by means of an operating control.

shutdown, safety: shutting off all fuel and ignition energy to the burner by a safety control (see also lockout).

switch, air flow: a device used to prove the flow of air.

switch, high oil temperature: a temperature-actuated device arranged to stop the flow of fuel to a preheated oil burner or to prevent it from starting when the fuel oil temperature rises above a set point, which shall be the lower end of the viscosity range recommended by the burner manufacturer.

switch, high-pressure: a pressure-actuated device to monitor liquid, steam, or gas pressure and arranged to stop the flow of fluid to the burner at a preset high pressure.

switch, low oil temperature: a temperature-actuated device arranged to stop the flow of fuel to a preheated oil burner or to prevent it from starting when the fuel oil temperature falls below a set point, which shall be the lower end of the viscosity range recommended by the burner manufacturer.

switch, low-pressure: a pressure-actuated device to monitor liquid, steam, or gas pressure and arranged to stop the flow of fluid to the burner at a preset low pressure.

switch, pressure: a pressure-responsive device that makes or breaks an electrical circuit and may be automatically or manually reset.

time delay: a deliberate delay of a predetermined time in the action of a safety device or control.

UL: Underwriters Laboratories, Inc.

upper set point limit: on a temperature or pressure control having an adjustable range of set points, the upper set point limit is the maximum pressure or temperature set point in the range of the control, to which the control can be adjusted and still perform its intended function (e.g., safety shutdown).

valve, automatic: an automatic device consisting essentially of a valve and operator that controls the fuel supply to the burner(s) during normal operation of a boiler. It may be actuated by application of electrical, mechanical, or other means.

valve, lubricated plug type: a valve of the plug and barrel type designed for maintaining a lubricant between the bearing surfaces.

valve, modulating control: a valve designed to regulate fuel input to the burner in response to demand.
(c) Motors shall be provided with running protection by means of integral thermal protection, overcurrent devices, or a combination of both in accordance with manufacturer’s instructions that shall be based on the requirements of NFPA 70, National Electrical Code.

(d) Motors shall be rated for continuous duty and shall be designed for an ambient temperature of 104°F (40°C) or higher.

(e) All motors shall be provided with terminal leads or terminal screws in terminal boxes integral with, or secured to, the motor frames.

**CE-140 Ignition System**

(a) When automatic electric ignition is provided, it shall be accomplished by means of a high-voltage electric spark, a high-energy electric spark, or a hot surface igniter.

(b) Ignition transformers shall conform to requirements of UL 506, Standard for Specialty Transformers.

(c) Ignition cable shall conform to the requirements of UL 814, Gas-Tube-Sign Cable.

**CE-150 Wiring**

(a) All wiring for boilers shall be rated for the maximum operating temperature to which it may be exposed. Such wiring shall be in accordance with NFPA 70, National Electrical Code. All wiring between components shall have copper conductors not less than size No. 18 AWG and constructed in accordance with NFPA 70, National Electrical Code.

(b) All electrical wiring shall have a voltage rating commensurate with the voltage of the power supply.

(c) Conductors shall be protected from physical damage.

(d) Conductors shall be sized on the basis of the rated current of the load they supply.

**CE-160 Bonding and Grounding**

(a) Means shall be provided for grounding the major metallic frame or assembly of the boiler.

(b) Noncurrent-carrying enclosures, frames, and similar parts of all electrical components and devices shall be bonded to the main frame or assembly of the boiler. Electrical components that are bonded by their installation do not require a separate bonding conductor.

(c) When an insulated conductor is used to bond electrical components and devices, it shall show a continuous green color, with or without a yellow stripe.

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**INSERT NEW REQUIREMENT**

**CE-170 Annunciation, Status and Control Wiring to Primary Safety Control Systems**

(a) Connections made to the Primary Safety Control System and connected to an external device for the purpose of annunciation, status indication or any other purpose shall not:

1. Change the intended operation or setting of safety or operating controls.
2. Energize safety related outputs from the Primary Safety Control System.

(b) Connections of any external device as described in CE-170(a) shall be tested and reported in accordance with CG-440(b) by a qualified technician. Testing shall verify safety and operating controls of the primary safety control system are not bypassed and no safety related outputs from the primary safety control system are energized as a result of the external connections.
CW-100 Automatic Low-Water Fuel Cutoff and/or Combined Water Feeding Device

CW-110 General Requirements for Water Level Controls for All Boilers

(a) Each low-water fuel cutoff or combined feeder/cutoff device shall conform to UL 353, Standard for Limit Controls, and be accepted by a nationally recognized testing agency.

(b) Installation diagrams and instructions shall be furnished by the manufacturer.

(c) Low-water fuel cutoffs or combined feeder/cutoff devices shall be located to provide access for servicing, repairing, testing, and inspection.

(d) The low-water fuel cutoff shall have a pressure rating at least equal to the maximum allowable working pressure of the boiler.

(e) In probe-type, low-water fuel cutoffs, an open circuit failure, break, or disconnection of the electrical components or conductors in the safety circuit shall prevent continued operation of the firing mechanism.

(f) Alarms, when used, shall be distinctly audible above the ambient noise level and may be used in conjunction with indicating lights. They shall be located to alert the operator or an individual trained as to what action to take when an alarm indicates a potentially dangerous situation is developing.

(g) Low-water fuel cutoffs of the automatic or manual reset type shall be electrically connected in accordance with CE-110(j).

(h) For vacuum boilers, see the requirements in CW-700.

CW-120 Requirements for Water Level Controls for Low-Pressure Steam or Vapor System Boilers

(a) Each automatically fired, low-pressure steam or vapor system boiler shall have at least two automatic low-water fuel cutoffs, one of which may be a combined feeder/cutoff device. When installed external to the boiler, each device shall be installed in individual chambers (water columns), which shall be attached to the boiler by separate pipe connections below the waterline. A common steam connection is permissible. Each cutoff device shall be installed to prevent startup and to cut off the boiler fuel or energy supply automatically, prior to the fall of the surface of the water below the level of the lowest visible part of the gage glass (see also CW-210).

EXCEPTION: Only one low-water cutoff is required on gravity return units installed in residences, as defined by the authority having jurisdiction.

A water feeding device, when used, shall be constructed and installed so that the water inlet valve cannot feed water into the boiler through the float chamber or its connections to the boiler. The water feeding device shall be located to maintain the operating water level.

(b) The electrical circuit shall be connected in such a manner that either low-water fuel cutoff control will shut off the fuel or energy supply to the boiler when a low-water condition develops. One cutoff control shall be set to function ahead of the other.

(1) With a pumped condensate return, functioning of the lower of the two cutoff controls shall cause safety shutdown and lockout. The manual reset may be incorporated in the lower cutoff control. Where a reset device is separate from the low-water fuel cutoff, a means shall be provided to indicate actuation of the low-water fuel cutoff. The manual reset device may be the instantaneous type or may include a time delay of not more than 3 min after the fuel has been cut off.

(2) With gravity condensate return, the lower of the two cutoff controls shall be electrically connected with the upper cutoff to cause a safety shutdown requiring manual reset only when the upper cutoff has failed to function.

(c) The fuel cutoff device may be inserted internally or attached externally to the boiler. An external cutoff device may be attached to piping connecting a water column to the boiler or combined with a water column. Water column piping and connections shall be at least NPS 1 (DN 25). If the lower water fuel cutoff is connected to the boiler by pipe or fittings, no shutoff valves of any type shall be placed in such piping. A cross, or equivalent fitting, shall be placed in the water piping connection at every right angle to facilitate cleaning and inspection. Fuel cutoff devices embodying a separate chamber shall have a vertical drainpipe and blowoff valve, not less than NPS 3⁄4 (DN 20), located at the lowest point of the chamber or water-equalizing pipe connections so that the chamber and equalizing pipe can be flushed and the device tested.

(d) A low-water fuel cutoff or combined feeder/cutoff device may also be installed in the tapped openings
(d) A system may incorporate a time delay component with the low-water fuel cutoff device to prevent short cycling. This component shall not constrict any connecting piping, and the time delay shall not exceed the boiler manufacturer’s recommended timing, or 90 sec, whichever is less. The device shall cut off the fuel or energy supply when the water falls to the lowest visible part of the gage glass.

**CW-150 Requirements for Operating and Safety Controls for Electrically Heated Boilers**

Electric resistance and electrode boilers shall have a boiler feed control system that shall maintain the operating level in steam boilers and operating water pressure on hot-water boilers. Where uncovering of the electrical element can lead to an unsafe condition, the boiler shall be provided with low-water fuel cutoff(s) in accordance with Part CW. Boiler feed control and low-water fuel cutoff may be common to one control. In the case of electrode-type boilers, where the reduction in water level provides a self-limiting control on input, low-water fuel cutoff controls are not required.

**CW-200 AUTOMATIC FUEL CUTOFF FOR FORCED CIRCULATION BOILERS**

**CW-210 Requirements for Flow or Temperature Sensing Devices for Forced Circulation Boilers**

(a) In lieu of the requirements for low-water fuel cutoffs in CW-100, a boiler, requiring forced circulation to prevent overheating and failure of the heat exchanger (tubes, coils, etc.) shall have one or more of the following means to prevent burner operation at a water flow rate inadequate to protect the boiler unit against overheating at all allowable firing rates:

1. A flow sensing device labeled and listed by a recognized testing agency as a safety control complying with the requirements of CW-110(a). This safety control shall be independent of any other operating controls.

2. A primary safety control system comprised of a labeled and listed primary safety control and temperature sensing devices that function to monitor temperature rise across the boiler unit such that inadequate flow rate can be determined by excessive temperature rise. The listing of the primary safety control system shall comply with the requirements of CW-110(b).

Upon detection of an inadequate flow rate, the means specified in (a)(1) or (a)(2) shall shut down the burner and prevent restarting until an adequate water flow rate is restored. Positive means shall be provided to determine during testing that these controls functioned upon an inadequate flow condition. The positive means shall enable these controls to remain in the running safety lockout circuitry during testing.

The safety control must be automatically restored to service after completion of system testing.

(b) When there is a definitive waterline, a low-water fuel cutoff device complying with the applicable portions of CW-100 shall be provided in addition to controls necessary for meeting the requirements of CW-210(a). Functioning of the low-water fuel cutoff shall cause a safety shutdown and lockout.

**CW-300 PRESSURE CONTROLS**

**CW-310 Requirements for Pressure Controls for Steam Boilers**

(a) Each boiler pressure control shall conform to UL 353, Standard for Limit Controls, and shall be accepted by a nationally recognized testing agency.

(b) Each automatically fired steam boiler or system of commonly connected steam boilers shall have at least one steam pressure control device that will shut off the fuel supply to each boiler or system of commonly connected boilers when the steam pressure reaches a preset maximum operating pressure. This requirement does not preclude the use of additional operating control devices where required.

(c) In addition to the pressure control required in (b) above, each individual automatically fired steam boiler shall have a high steam pressure limit control that will function before the pressure control device setpoint or before the pressure control device cutout setting. This control shall be automatically reset when adequate flow is restored.

In addition to a low-water fuel cutoff as specified in CW-110 and CW-130, a pressure limit control may be incorporated in the primary safety control system. Where the reset device is separate from the pressure limit control, a means shall be provided to protect the boiler unit against overheating and failure of the heat exchanger by excessive temperature rise across the boiler unit such that inadequate flow rate can be determined by excessive temperature rise. The listing of the primary safety control system shall comply with CE-110(j).

EXCEPTION: Lockout is not required for boiler units installed in residences, as defined by the authority having jurisdiction.

(d) A pressure limit control of the automatic or manual reset type shall be electrically connected in accordance with UL 353. A pressure limit control shall enable these controls to remain in the running safety lockout circuitry during testing.

(e) Each pressure control device shall be protected with a siphon, which shall be placed in the high-pressure limit control device and steam pressure control device or between the boiler and steam pressure control device.

(f) Each pressure control device shall be protected with a siphon, which shall be placed in the high-pressure limit control device and steam pressure control device. The minimum size of a siphon shall be NPS 1/4 (DN 8). Tubing suitable for the temperatures and pressures involved, with an inside diameter at least equal to standard pipe sizes, may be substituted for pipe. When a control incorporating a mercury switch is mounted on the siphon, the loop of the siphon shall be in a plane that is 90 deg (1.57 rad) from the plane of the mercury switch.
(g) Steam pressure supply connections to a single pressure control using pipe of nonferrous material shall not be less than NPS \( \frac{1}{2} \) (DN 8) for lengths up to and including 5 ft (1.5 m) and not less than NPS \( \frac{3}{4} \) (DN 20) for lengths over 5 ft (1.5 m). Tubing suitable for the temperatures and pressures involved, having an inside diameter at least equal to that of standard pipe, may be substituted for pipe.

(h) Steam pressure supply connections to a single pressure control using pipe of ferrous material shall not be less than NPS \( \frac{1}{2} \) (DN 15) for lengths up to and including 5 ft (1.5 m) and not less than NPS \( \frac{3}{4} \) (DN 20) for lengths over 5 ft (1.5 m). For manifolds using ferrous material, the manifold and common source connection to the boiler shall not be less than NPS \( \frac{3}{4} \) (DN 20) for lengths up to and including 5 ft (1.5 m) and not less than NPS \( 1\frac{1}{4} \) (DN 32) for lengths over 5 ft (1.5 m). Individual controls are to be piped from the manifold according to the provisions of CW-310(g) and (h).

(i) Pressure controls should have separate pressure connections; however, manifolding is permitted. When multiple controls are fed from a manifold, the manifold and common source connection to the boiler, for pipe of nonferrous material, shall not be less than NPS \( \frac{1}{2} \) (DN 15) for lengths up to and including 5 ft (1.5 m) and not less than NPS \( 1\frac{1}{4} \) (DN 32) for lengths over 5 ft (1.5 m). For manifolds using ferrous material, the manifold and common source connection to the boiler shall not be less than NPS \( \frac{3}{4} \) (DN 20) for lengths up to and including 5 ft (1.5 m) and not less than NPS \( 1\frac{1}{4} \) (DN 32) for lengths over 5 ft (1.5 m). Multiple controls are fed from a manifold, the manifold common source connection to the boiler shall not be less than NPS \( 1\frac{1}{4} \) (DN 32) for lengths over 5 ft (1.5 m). Individual controls are to be piped from the manifold according to the provisions of CW-310(g) and (h).

(j) The upper set point limit or maximum fixed stop limit of the pressure control selected shall not exceed the maximum allowable working pressure of the boiler. The high temperature limit control’s sensing element shall be positioned on the boiler to prevent the boiler water temperature from exceeding the maximum allowable temperature. The upper set point limit or the maximum fixed stop limit of the high temperature limit control shall not exceed the maximum allowable temperature. Functioning of this high temperature limit control shall cause safety shutdown and lockout. The manual reset may be incorporated in the high temperature limit control. Where a reset device is separate from the high temperature limit control, a means shall be provided to indicate actuation of the high temperature limit control. Each high temperature limit control shall have its own reset device.

**CW-400 TEMPERATURE CONTROLS**

(15) CW-410 Requirements for Temperature Controls for Hot-Water Boilers

(a) Each temperature control device shall conform to UL 353, Standard for Limit Controls, and shall be accepted by a nationally recognized testing agency.

(b) Each automatically fired hot-water boiler or each system of commonly connected hot-water boilers shall have at least one operating temperature control.

(1) This control temperature shall have its own sensing element and operating switch. The temperature control’s sensing element shall be positioned so it senses the system water temperature to shut off the fuel or energy supply when the water reaches a preset operating temperature. The sensing element may be remote from the control unit.

(2) This requirement does not preclude the use of additional temperature controls.

(c) In addition to the control requirements in CW-410(b), each individual automatically fired hot-water boiler shall have a high temperature limit control. This temperature control shall have its own sensing element and operating switch. The sensing element shall be positioned on the boiler to prevent the boiler water temperature from exceeding the maximum allowable temperature. The upper set point limit or the maximum fixed stop limit of the high temperature limit control shall not exceed the maximum allowable temperature. Functioning of this high temperature limit control shall cause safety shutdown and lockout. The manual reset may be incorporated in the high temperature limit control. Where a reset device is separate from the high temperature limit control, a means shall be provided to indicate actuation of the high temperature limit control. Each high temperature limit control shall have its own reset device.

**CW-500 SAFETY AND SAFETY RELIEF VALVES**

**CW-510 Requirements for Steam and Hot-Water Heating Boilers**

The safety and safety relief valves of all steam and hot-water heating boilers shall conform to the ASME Boiler and Pressure Vessel Code, Section I or IV, as applicable.
**Table CF-2  400,000 Btu/hr (117 kW) and Smaller (Power Gas Burners, Mechanical Draft Atmospheric Gas Burners, and Pulse Combustion Systems), 3 gph (11.4 L/h) and Smaller (Oil)**

<table>
<thead>
<tr>
<th>Safety Control</th>
<th>Pilot Ignition Gas</th>
<th>Direct Ignition System</th>
<th>Hot Surface Ignition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous Pilot</td>
<td>Intermittent Pilot</td>
<td>Interrupted Pilot</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Purge requirements</strong> [Note (1)]</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Pilot flame-establishing period</strong></td>
<td>None</td>
<td>15-sec maximum</td>
<td>15-sec maximum</td>
</tr>
<tr>
<td><strong>Main burner flame-establishing period</strong></td>
<td>None</td>
<td>None</td>
<td>15-sec maximum</td>
</tr>
<tr>
<td><strong>Flame failure response time</strong> [Note (2)]</td>
<td>180-sec maximum</td>
<td>4-sec maximum</td>
<td>4-sec maximum</td>
</tr>
<tr>
<td><strong>Valve closing time</strong></td>
<td>None</td>
<td>5-sec maximum after de-energization</td>
<td>5-sec maximum after de-energization</td>
</tr>
<tr>
<td><strong>Action on pilot flame failure</strong></td>
<td>Safety shutdown</td>
<td>Safety shutdown [Note (1)]</td>
<td>Safety shutdown [Note (2)]</td>
</tr>
<tr>
<td><strong>Action on main burner flame failure</strong></td>
<td>None</td>
<td>None</td>
<td>Safety shutdown [Note (2)]</td>
</tr>
<tr>
<td><strong>Fuel pressure supervision</strong></td>
<td>Not required</td>
<td>Not required</td>
<td>Not required</td>
</tr>
</tbody>
</table>

**GENERAL NOTE:** Timings shown above represent the maximum primary safety control timings permitted by this Standard. The model designation of the installed primary safety control together with the timings shall be provided in the documentation of the burner/boiler.

**NOTES:**
1. After safety shutdown, wait a minimum 5-min time delay before resetting ignition system (instructional requirement).
2. If ignition system includes a relight feature, one relight attempt shall be initiated within 0.8 sec upon loss of flame.
3. For dampers with a fixed mechanical stop, see CF-210(a)(1) and (a)(2).
<table>
<thead>
<tr>
<th>Safety Control</th>
<th>Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)</th>
<th>Greater Than 2,500,000 Btu/hr (733 kW) and Less Than or Equal to 5,000,000 Btu/hr (1465 kW)</th>
<th>Greater Than 5,000,000 Btu/hr (1465 kW) and Less Than or Equal to 12,500,000 Btu/hr (3663 kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purge requirements</td>
<td>Four air changes in 90 sec, or at 60% damper opening, with both damper opening and air flow proven [Note (1)]</td>
<td>Four air changes at 60% damper opening with both damper opening and air flow proven [Note (1)]</td>
<td>Four air changes at 60% damper opening with both damper opening and air flow proven [Note (1)]</td>
</tr>
<tr>
<td>Instructional requirement: minimum</td>
<td>5-min shutoff before lighting constant pilot</td>
<td>5-min shutoff before lighting constant pilot</td>
<td>5-min shutoff before lighting constant pilot</td>
</tr>
<tr>
<td>Pilot flame type and establishing period</td>
<td>continuous: 15 sec (initial start only)</td>
<td>Not permitted</td>
<td>Not permitted</td>
</tr>
<tr>
<td></td>
<td>interrupted: 10 sec</td>
<td>Not permitted</td>
<td>Not permitted</td>
</tr>
<tr>
<td></td>
<td>intermittent: 15 sec</td>
<td>Not permitted</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Main burner ignition type and establish-ing period</td>
<td>pilot only: 15-sec maximum if interrupted pilot used</td>
<td>Direct ignition system: 4-sec maximum [Note (2)]</td>
<td>Direct ignition system: 4-sec maximum [Note (2)]</td>
</tr>
<tr>
<td></td>
<td>Direct ignition system: 4-sec maximum</td>
<td>Hot surface ignition system: 4-sec maximum [Note (2)]</td>
<td>Hot surface ignition system: 4-sec maximum [Note (2)]</td>
</tr>
<tr>
<td>Flame failure response time</td>
<td>4-sec maximum</td>
<td>4-sec maximum</td>
<td>4-sec maximum</td>
</tr>
<tr>
<td>Valve closing time</td>
<td>5-sec maximum after de-energization</td>
<td>1-sec maximum</td>
<td>1-sec maximum</td>
</tr>
<tr>
<td>Action on flame failure</td>
<td>Safety shutdown and lockout or recycle once</td>
<td>Safety shutdown and lockout [Note (3)]</td>
<td>Safety shutdown and lockout [Note (3)]</td>
</tr>
<tr>
<td>Action on power or control input interrup-tion after safety shutdown and lockout</td>
<td>Manual reset required in accordance with CG-610</td>
<td>Manual reset required in accordance with CG-610</td>
<td>Manual reset required in accordance with CG-610</td>
</tr>
<tr>
<td>Proven low fire start</td>
<td>Not required</td>
<td>See CG-610</td>
<td>See CG-610</td>
</tr>
<tr>
<td>Combustion air proving — action on loss of combustion air</td>
<td>Required: safety shutdown and lockout or recycle</td>
<td>Required: safety shutdown and lockout</td>
<td>Required: safety shutdown and lockout</td>
</tr>
<tr>
<td>Fuel pressure supervision</td>
<td>Not required for ignition systems with pilots. Required for direct ignition and hot surface ignition systems: high and low gas pressure arranged to cause safety shutdown and lockout</td>
<td>Required: high and low gas pressure arranged to cause safety shutdown and lockout</td>
<td>Required: high and low gas pressure arranged to cause safety shutdown and lockout</td>
</tr>
</tbody>
</table>

**GENERAL NOTE:** Timings shown above shall be within the tolerances established by the nationally recognized testing agency where the primary safety controls are labeled and/or listed [see CF-310(c) and CF-510(c)].

**NOTES:**
(1) For dampers with a fixed mechanical stop, see CF-210(a)(1) and (a)(2).
(2) Maximum input at light off shall be less than or equal to 2,500,000 Btu/hr (733 kW).
(3) Pulse combustion not permitted for applications with inputs greater than 2,500,000 Btu/hr (733 kW).
(b) A pressure switch used to monitor high gas positive pressure shall function to cause safety shutdown and lockout before the manifold gas pressure exceeds the boiler/burner manufacturer's specified high gas-pressure switch setting for the listed boilers, or

(1) the boiler/burner manufacturer's specified high gas-pressure switch setting if the setting is not specified

(2) 150% of the boiler/burner's main manifold gas pressure if the setting is not specified

The high gas-pressure switch shall be located downstream of the service pressure regulator and may be located downstream of all main burner gas supply controls.

(c) A pressure switch used to monitor low gas positive pressure shall function to cause safety shutdown and lockout before the manifold gas pressure is less than

(1) the boiler/burner manufacturer's specified low gas-pressure switch setting for the listed boilers, or

(2) 50% of the boiler/burner's main manifold gas pressure if the setting is not specified

The low gas-pressure switch shall be located upstream of the safety shutoff valve(s). When the low gas-pressure switch is located upstream of the main gas-pressure regulator, the burner shall be labeled and listed by a nationally recognized testing agency for this arrangement.

(d) For boiler/burner units with zero or negative main gas manifold pressure supplied by a combination gas valve with internal negative gas-pressure regulator function, high gas pressure supervision shall be accomplished by a pressure switch located upstream of the safety shutoff valve(s), and downstream of the boiler/burner unit's gas service pressure regulator. The pressure switch shall function to cause safety shutdown and lockout before the service positive pressure exceeds

(1) the setting of the overpressure protection device in CF-164, if equipped

(2) the boiler/burner manufacturer's specified high gas-pressure switch setting for listed boilers, or

(3) 150% of the boiler/burner's specified maximum gas supply pressure if the setting is not specified

A boiler/burner unit incorporating listed zero governor combination gas valve(s) that cause safety shutdown and lockout if the combination gas valve's gas regulator fails is deemed to meet the intent of the requirements for high gas-pressure supervision.

(e) Pressure test port(s) shall be provided to permit measuring the gas pressure inside the gas boiler/burner at the gas pressure switch setting.

(f) Gas-pressure switches shall be listed by a nationally recognized testing agency.

(g) Gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than 50% above the relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than 50% above the relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than 50% above the relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum relieving pressure of the nearest upstream gas-pressure relief device. Where no relief device is provided, the gas-pressure switches shall be capable of withstanding without damage a pressure not less than the maximum

(h) A bypass to provide for a minimum flame may be installed around a valve used to control input only. A bypass shall not be installed around a safety shutoff valve or a combination input control and safety shutoff valve.

CF-180 Safety Shutoff Valves

(a) Each main burner and pilot burner supply line shall be equipped with a safety shutoff valve(s) that shall comply with the applicable provisions of ANSI Z21.21/CSA 6.5, Automatic Valves for Gas Appliances, ANSI Z21.70/CSA 6.20, Gas Controls for Gas Appliances, or UL 429, Standard for Electrically Operated Valves.

(b) The burner supply line shall be equipped as indicated below for the applicable input classification or any greater input classifications:

(1) For boiler units having inputs less than or equal to 5,000,000 Btu/hr (1,465 kW), the main burner supply line shall be equipped with at least two safety shutoff valves in series that may be in a single valve body or one safety shutoff valve with a valve seal overtravel (proof of closure) interlock function. If the two safety shutoff valves are in a single valve body, the two safety shutoff valve seats shall be in series and shall have independently operated valve mechanisms.

(2) For boiler units having inputs greater than 5,000,000 Btu/hr (1,465 kW) and less than 12,500,000 Btu/hr (3,663 kW), the main burner supply line shall be equipped with at least two safety shutoff valves in series that may be in a single valve body; the two safety shutoff valve seats shall be in series and shall have independently operated valve mechanisms.

(3) The pilot gas supply line shall be equipped with a safety shutoff valve that shall comply with the applicable provisions of ANSI Z21.21/CSA 6.5, Automatic Valves for Gas Appliances, ANSI Z21.70/CSA 6.20, Gas Controls for Gas Appliances, or UL 429, Standard for Electrically Operated Valves.
ATTACHMENT A

If the high gas-pressure switch is located upstream of the main gas pressure regulator, the main gas pressure regulator shall be a zero governor pressure regulator.

A high gas-pressure switch located upstream of the main gas pressure regulator shall cause safety shutdown and lockout when the supply pressure exceeds:

(1) the setting of the overpressure protection device in CF-161, if equipped, or

(2) the boiler/burner manufacturer’s specified high gas-pressure switch setting for listed boilers or burners, or

(3) 150% of the boiler/burner’s specified maximum gas supply pressure if the setting is not specified.

A high gas-pressure switch shall not be required on a boiler unit incorporating a listed shutoff valve with a zero governor pressure regulator that causes safety shutdown and lockout if the zero governor pressure regulator fails due to a ruptured diaphragm.
(3) For single burner boiler units that incorporate a branch supply line to supply gas to a branch burner(s) (e.g. a second stage burner), either of the following shall apply:

   (i) For single burner boiler units having inputs less than or equal to 5,000,000 Btu/hr (1,465,356 W), the safety shutoff valve requirements in CF-180 (b)(1) apply to each branch supply line.

   (ii) For single burner boiler units having inputs greater than 5,000,000 Btu/hr (1,465,356 W) and less than 12,500,000 btu/hr (3,663,389 W),

       (a) the safety shutoff valve requirements in CF-180(b)(2) apply to each branch supply line, or

       (b) at least one safety shutoff valve on the main burner supply line and one safety shutoff valve on each branch supply line shall incorporate a valve seal overtravel (proof of closure) interlock function.

(c) For multiple burner boiler units, the main burner supply line for each burner shall be equipped as indicated below for the applicable input classification or any greater input classifications:

   (1) For multiple burner boiler units having total inputs less than or equal to 5,000,000 Btu/hr (1,465,356 W), the safety shutoff valve requirements in CF-180(b)(1) apply to each individual burner supply line.

   (2) For multiple burner boiler units having total inputs greater than 5,000,000 Btu/hr (1,465,356 W) and less than 12,500,000 Btu/hr (3,663,389 W), either of the following shall apply:

       (i) the safety shutoff valve requirements in CF-180(b)(2) apply to each individual burner supply line, or

       (ii) the safety shutoff valve requirements in CF-180(b)(1) apply to each individual burner supply line and the main burner supply line has at least one safety shutoff valve that incorporates a valve seal overtravel (proof of closure) interlock function.

(d) The valve seal overtravel (proof of closure) interlock, where required, shall prevent boiler ignition if the switch does not prove the safety shutoff valve closed during the startup sequence.
Combination Gas Controls for Gas Appliances, or
UL 429, Standard for Electrically Operated Valves

(d) Safety shutoff valves shall be labeled and listed by a nationally recognized testing agency.

(e) Safety shutoff valves shall have a shutoff time not to exceed that specified in Table CF-1, CF-2, CF-3, or CF-4.

(f) Safety shutoff valves shall be capable of withstanding, without damage, a pressure of not less than 10% above the set point of the nearest upstream overpressure protection device. In case no overpressure protection device is provided, the safety shutoff valves shall be capable of withstanding, without damage, a pressure of not less than the maximum inlet pressure to the nearest upstream gas-pressure regulator.

(g) Provisions shall be made to test independently each safety shutoff valve for seal leakage. Manufacturer’s instructions shall be followed. Any special equipment needed to perform the leak test shall be made available by the boiler/burner manufacturer.

CF-190 Vent Lines, Bleed Lines, Gas-Pressure Relief Lines, Vent Valve Lines, and Feedback Lines for Fuel Train Components

(a) Vent Lines

(1) Gas-pressure regulators, combination gas controls, pressure interlock switches, and all other fuel train components requiring atmospheric air pressure to balance a diaphragm shall have the atmospheric side of the diaphragm connected to a vent line that shall be piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction unless otherwise allowed in CF-190(c) or CF-190(h).

(2) Where there is more than one fuel train component requiring a vent line at a location, each fuel train component shall have a separate vent line piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction unless otherwise permitted by CF-190(f) or CF-190(h).

(b) Bleed Lines

(1) Gas-pressure regulators, combination gas controls, pressure interlock switches, or all other fuel train components that use an atmospheric diaphragm and periodically release gas into the atmosphere in order to properly operate shall have the atmospheric side of the diaphragm connected to a bleed line that shall be piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction unless otherwise permitted in CF-190(c) or CF-190(h).

(2) Where there is more than one fuel train component requiring a bleed line at a location, each fuel train component shall have a separate bleed line piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction unless otherwise permitted by CF-190(f) or CF-190(h).

(c) Components With Vent Limiters. A listed and labeled gas-pressure regulator, combination gas control, pressure interlock switch, or other fuel train component incorporating a vent limiter shall be permitted to vent directly into ambient space.

(d) Gas-Pressure Relief Lines

(1) If an overpressure protection device incorporating a gas-pressure relief valve is installed, the outlet of the gas-pressure relief valve shall be connected to a gas-pressure relief line that shall be piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction.

(2) The gas-pressure relief line shall be sized in accordance with the component manufacturer’s instructions and shall be at least the same size as the outlet connection of the gas-pressure relief valve.

(3) Where there is more than one gas-pressure relief valve at a location, each gas-pressure relief valve shall have a separate relief line piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction unless otherwise permitted by CF-190(f).

(e) Lines From Vent Valves

(1) A vent valve, if installed, shall be connected to a vent valve line that shall be piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction.

(2) The vent valve line shall be at least the same size as the outlet connection of the vent valve.

(3) Where there is more than one vent valve at a location, each vent valve shall be piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction unless otherwise permitted by CF-190(f).

(f) Manifolding of Lines. If approved by the authority having jurisdiction, the manifolding of lines of the same type shall be permitted, and the manifolding of vent lines and bleed lines shall be permitted. In order to minimize backpressure in the event of gas being released through the manifolded line, the manifolded line shall have a cross-sectional area not less than the area of the largest branch line directly piped to the manifolded line plus 50% of the additional cross-sectional areas of the manifolded branch lines. The following manifolding of lines of different types shall not be permitted:

1. the manifolding of gas-pressure relief lines with vent lines, bleed lines, or vent valve lines
2. the manifolding of vent valve lines with vent lines or bleed lines
3. the manifolding of vent lines, bleed lines, gas-pressure relief lines, and vent valve lines of one boiler unit to any lines of another boiler unit

(g) Connecting Lines to Flue Passages. No vent line, bleed line, gas-pressure relief line, or vent valve line shall connect to a boiler’s flue passages.
(15) **CF-310 Primary Safety Control**

(a) Each main burner assembly shall be provided with a primary safety control that will de-energize the main gas shutoff valve(s) and shut off pilot fuel upon loss of flame at the point of supervision as specified in CF-330.

(b) The response time of the primary safety control to de-energize or activate the gas shutoff device shall not exceed the values shown in Tables CF-1 through CF-4.

(c) Primary safety controls shall be labeled and listed by a nationally recognized testing agency.

(d) Primary safety controls shall require local manual intervention by an operator or service technician to reset. Devices that can electronically reset without local manual intervention, such as when power or control input to the device is interrupted and then restored, shall not be permitted.

(e) Supervision of the main burner flame alone shall begin at the end of the main burner flame-establishing period for:

1. Power gas burners and mechanical draft atmospheric gas burners having inputs greater than 2,500,000 Btu/hr (733 kW).

2. All types of burners with modulating or high-low firing having inputs greater than 2,500,000 Btu/hr (733 kW).

3. All types of burners with an interrupted pilot(s).

4. Natural draft atmospheric gas burners having inputs greater than 5,000,000 Btu/hr (1 465 kW).

(f) The main burner flame-establishing period shall not exceed the values shown in Tables CF-1 through CF-4.

(g) For pulse combustion, two methods of flame detection shall be used. One method must be a pressure switch.

(15) **CF-320 Automatic Ignition Devices**

(a) Automatic ignition devices using pilots shall comply with the following:

1. Gas to pilots shall be automatically shut off if the pilot is not proved.

2. The pilot type and flame-establishing period shall meet the provisions shown in Tables CF-1 through CF-4.

3. The flame failure response time for additional pilots used for smooth lightoff shall not exceed 90 sec.

(b) A single direct ignition or hot surface ignition system may be used on a boiler unit that has a natural draft atmospheric gas burner with a total input less than or equal to 2,500,000 Btu/hr (733 kW) and an input less than or equal to 400,000 Btu/hr (117 kW) per ignition system. There shall be no interconnection between combustion zones served by separate ignition systems at any point below the draft hood or, if no draft hood is used, below the flue outlet.

Each direct ignition or hot surface ignition system shall meet the provisions shown in Table CF-1.

(d) A direct ignition or hot surface ignition system may be used on a boiler unit that has a power gas burner or mechanical draft atmospheric gas burner with a total input less than 12,500,000 Btu/hr (3,663 kW) and a maximum input at ignition less than or equal to 2,500,000 Btu/hr (733 kW). This direct ignition or hot surface ignition system shall meet the provisions shown in Table CF-3 if the total input is greater than 400,000 Btu/hr (117 kW). This direct ignition or hot surface ignition system shall meet the provisions shown in Table CF-2 if the total input is less than or equal to 400,000 Btu/hr (117 kW).

### CF-330 Action on Flame Failure (Refer to Tables CF-1 through CF-4)

Gas-fired boiler units shall comply with one of the following for safety shutdown, lockout, recycle, or relight upon loss of flame as applicable:

(a) Loss of flame for power gas burners and mechanical draft atmospheric gas burners having inputs greater than 400,000 Btu/hr (117 kW) and less than or equal to 2,500,000 Btu/hr (733 kW) shall result in a safety shutdown and lockout or recycle, after a minimum 5-min time delay.

(b) Loss of flame for power gas burners and mechanical draft atmospheric gas burners having inputs greater than 2,500,000 Btu/hr (733 kW) shall result in safety shutdown and lockout.

(c) Loss of flame for atmospheric gas burners using natural draft having inputs greater than 400,000 Btu/hr (117 kW) and less than or equal to 12,500,000 Btu/hr (3,663 kW) shall result in safety shutdown and lockout, or recycle, after a minimum 5-min time delay.

(d) Loss of pilot flame for gas-fired boilers using natural draft burners and power gas burners with inputs less than or equal to 400,000 Btu/hr (117 kW) shall result in safety shutdown for a continuous, intermittent, or interrupted pilot. Relight may be applied to the intermittent or interrupted pilot if initiated within 0.8 sec upon loss of pilot flame.

(e) Loss of main flame for gas-fired boilers using natural draft burners and power gas burners with inputs less than or equal to 400,000 Btu/hr (117 kW) shall result in safety shutdown for interrupted pilot direct ignition or hot surface ignition systems. Relight may be applied...
to the interrupted pilot or direct ignition system if initiated within 0.8 sec upon loss of flame.

(f) Loss of flame for pulse combustion systems with inputs less than or equal to 400,000 Btu/hr (117 kW) may allow up to three complete combustion system recycles, each of which shall include preignition purge requirements of Table CF-2. After three recycle attempts, the pulse combustion system shall go into safety shutdown.

(g) Loss of flame for pulse combustion systems with inputs greater than 400,000 Btu/hr (117 kW) and less than or equal to 2,500,000 Btu/hr (733 kW) may allow up to three complete combustion system recycles, each of which shall include the preignition purge requirements of Table CF-3. After three recycle attempts, the pulse combustion system shall go into safety shutdown and lockout. Pulse combustion systems are not permitted for applications with inputs greater than 2,500,000 Btu/hr (733 kW).

CF-400 OIL-FIRED BOILER UNITS, EQUIPMENT

CF-410 Burner Assemblies

(a) Burner assemblies that have a maximum nameplate fuel input rating greater than 3 gph (11.4 L/h) shall comply with the provisions of this section. Burner assemblies, as part of a boiler unit or separately, shall be labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction as complying with the standards referenced below. For a burner provided as an integral part of a boiler unit, the label on the boiler unit may serve as evidence that the burner is in compliance.

(1) UL 296, Standard for Oil Burners
(2) UL 726, Standard for Oil-Fired Boiler Assemblies With Emission Reduction Equipment
(3) UL 2096, Gas and/or Oil Burning Assemblies Operated Valves. A nozzle cutoff valve integral to the fuel unit shall conform to UL 429, Standard for Electrically

CF-420 Fuel Train

See Nonmandatory Appendix B for typical fuel train diagrams.

CF-430 Filters or Strainers

Filters and strainers shall be installed upstream from the safety shutoff valve(s).

CF-440 Relief Valves

(a) A pressure relief valve shall be connected to a fuel line in which pressure greater than system design pressure may build up from the closing of any valve in the burner assembly or from oil heated by a preheater.

(b) The relief line from the relief valve shall discharge into the return line, oil tank, or pump suction line.

CF-450 Pressure and Temperature Switches

(a) All oil supplied to the main burner shall be supervised by a low oil pressure interlock switch for systems greater than 20 gph (75.7 L/h) (except for rotary cup burners), unless the oil pump is integral with the burner’s motor shaft, to cause a safety shutdown and lockout if oil pressure falls below the manufacturer’s design pressure.

(b) Atomizing media (air or steam) shall be supervised by a low-pressure interlock switch to cause safety shutdown and lockout if atomizing media pressure falls below the manufacturer’s design pressure.

(c) A high oil temperature supervisory interlock switch shall be provided for all preheated oil systems to cause a safety shutdown and lockout when the oil temperature exceeds preset limits.

(d) For low oil temperature supervision, an interlock switch shall be provided to cause safety shutdown and allow circulation to re-establish preset oil temperature.

CF-460 Safety Shutoff Valves

(a) Two approved safety shutoff valves or one safety shutoff valve and a nozzle cutoff valve integral to the fuel unit shall be provided. The safety shutoff valves shall conform to UL 429, Standard for Electrically Operated Valves. A nozzle cutoff valve integral to the fuel unit shall conform to UL 343, Standard for Pumps for Oil Burning Appliances.

It is recommended that whenever shutoff valves can trap oil between two valves or between a check valve and safety shutoff valve, a relief valve be used to prevent hydraulic pressure increases in the line, as trapped oil absorbs heat.

(b) A safety shutoff valve responding to pressure variations in a hydraulic or pneumatic remote control system shall close upon failure of pressure in the control system.

(c) The pressure rating of the safety shutoff valve shall not be less than the maximum pump pressure.

(d) Safety shutoff valves shall have a shutoff time not to exceed that shown in Table CF-5.

CF-470 Oil-Fired Boiler Units, Purging
(See Table CF-5)

Oil burners shall provide for purging the firebox and boiler pass, as indicated below, for the applicable input classification.
# Table CF-5  Safety Controls for Automatically Fired Units: Oil-Fired Burners

<table>
<thead>
<tr>
<th>Safety Control</th>
<th>Greater Than 3 gph (11.4 L/h) [approximately 400,000 Btu/hr (117 kW)] and Less Than or Equal to 20 gph (75.7 L/h) [approximately 2,800,000 Btu/hr (821 kW)]</th>
<th>Greater Than 20 gph (75.7 L/h) [approximately 2,800,000 Btu/hr (821 kW)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purge requirements</td>
<td>When oil pump operates independently of the burner, four air changes in 90 sec or at 60% damper opening, with damper opening and air flow proven if total input is in excess of 7 gph (26.5 L/h) [approximately 1,000,000 Btu/hr (293 kW)] [Note (1)]</td>
<td>Four air changes at 60% damper opening with both damper opening and air flow proven [Note (1)]</td>
</tr>
<tr>
<td>Postpurge</td>
<td>Not required</td>
<td>15-sec minimum</td>
</tr>
<tr>
<td>Pilot type and establishing period</td>
<td>Continuous Not permitted</td>
<td>Not permitted</td>
</tr>
<tr>
<td></td>
<td>Intermittent Not permitted</td>
<td>Not permitted</td>
</tr>
<tr>
<td></td>
<td>Interrupted 10-sec maximum if pilot is used</td>
<td>Required: 10-sec maximum</td>
</tr>
<tr>
<td>Main burner ignition type and establishing period</td>
<td>Interrupted pilot, 15-sec maximum</td>
<td>Interrupted pilot only</td>
</tr>
<tr>
<td>Flame failure response time</td>
<td>Greater than 3 gph (11.4 L/h) and less than or equal to 7 gph (26.5 L/h) [approximately 1,000,000 Btu/hr (293 kW)], no purge required. Greater than 7 gph (26.5 L/h) when intermittent direct ignition system, greater than 3 and less than or equal to 20 gph (11.4 L/h to 75.7 L/h), 4-sec maximum</td>
<td>Interrupted pilot or direct ignition system, greater than 3 and less than or equal to 20 gph (11.4 L/h to 75.7 L/h), 4-sec maximum</td>
</tr>
<tr>
<td>Valve closing time</td>
<td>5-sec maximum after de-energization</td>
<td>1-sec maximum</td>
</tr>
<tr>
<td>Action of flame failure</td>
<td>Safety shutdown and lockout or recycle once [Note (3)]</td>
<td>Safety shutdown and lockout</td>
</tr>
<tr>
<td>Proven low fire start</td>
<td>Not required</td>
<td>See CF-610</td>
</tr>
<tr>
<td>Combustion air proving — action on loss of combustion air</td>
<td>Required if fans not integral with burner motor shaft; safety shutdown and lockout or recycle</td>
<td>Required: safety shutdown and lockout</td>
</tr>
<tr>
<td>Fuel pressure supervision</td>
<td>Not required</td>
<td>Required if oil pump not integral with burner motor shaft (see CF-450)</td>
</tr>
<tr>
<td>Low atomizing media supervision</td>
<td>Required unless atomization by air pump integral with burner motor shaft [see CF-450(b)]</td>
<td>Required [see CF-450(b)]</td>
</tr>
<tr>
<td>Oil temperature supervision</td>
<td>High and low temperature supervision required on preheated oil. Excess temperature shall cause safety shutdown and lockout.</td>
<td>High and low temperature supervision required on preheated oil. Excess temperature shall cause safety shutdown and lockout.</td>
</tr>
</tbody>
</table>

**GENERAL NOTE:** Timings shown above represent the maximum primary safety control timings permitted by this Standard. The model designation of the installed primary safety control together with the timings shall be provided in the documentation of the burner/boiler.

**NOTES:**
(1) For dampers with a fixed mechanical stop, see CF-470(a) and (b)(1).
(2) With proven low fire start at a low fire input rate of not more than 20 gph (75.7 L/h), interrupted pilot or direct ignition system allowed. Main burner establishing period: 15-sec maximum.
(3) Recycle permitted when a maximum 4-sec flame failure response time is used.
CF-480 Combustion Air Proving (Refer to Table CF-5)

Oil-fired boiler units having forced or induced draft fans, or both, shall comply with one of the following for safety shutdown and lockout, or recycle, as applicable:

(a) Combustion air proving shall be provided for units having inputs greater than 3 gph (11.4 L/h) [approximately 400,000 Btu/hr (117 kW)] and less than or equal to 20 gph (75.7 L/h), and the air flow rate is at least equivalent to that provided for equal to 60% of the rated high-fire input.

(b) Loss of combustion air shall result in safety shut-down and lockout, or recycle, for units having inputs greater than 3 gph (11.4 L/h) [approximately 400,000 Btu/hr (117 kW)] and less than or equal to 20 gph (75.7 L/h), and the fan is not integral with the burner motor shaft.

(c) Loss of combustion air shall result in safety shut-down and lockout for units having inputs greater than 20 gph (75.7 L/h) [approximately 2,800,000 Btu/hr (821 kW)].

CF-500 OIL-FIRED BOILER UNITS, SAFETY CONTROLS

CF-510 Primary Safety Control

(a) Each main burner assembly shall be equipped with a primary safety control that will de-energize the shutoff means upon loss of flame at the point of supervision.

(b) Each primary safety control shall be equipped with a preignition purge of no fewer than four air changes at 60% damper opening with both damper opening and air flow proven.

(c) Loss of main flame shall result in safety shutdown and lockout, or recycle, as applicable:

(1) A preignition purge of no fewer than four air changes at 60% damper opening with both damper opening and air flow proven.

(2) A postpurge of 15 sec

Boiler units less than or equal to 5,000,000 Btu/hr (1,465 kW) input utilizing burners labeled and listed by a nationally recognized testing agency and designed with a fixed mechanical stop to prevent the damper from going below an air flow rate at least equivalent to that provided for equal to 60% of the rated high-fire input are exempt from proving damper opening.

(3) A purge shall provide no fewer than either:

(1) Four air changes, within 90 sec, or

(2) Four air changes at not less than 60% damper opening with both damper opening and air flow proven.

CF-520 Automatic Ignition Devices

(a) Where automatically ignited pilots are used, the pilot flame shall be proved prior to energizing the main fuel supply means. Fuel to pilots shall be automatically shut off if the pilot is not proved.

(b) A purging of no fewer than four air changes at 60% damper opening with both damper opening and recycle as applicable: Boiler units having inputs greater than 20 gph (75.7 L/h) and using an interrupted pilot or direct ignition system.

(c) The application of direct spark ignition systems is limited to boiler units having initial inputs less than or equal to 20 gph (75.7 L/h).

(d) The fuel train to pilots shall meet the applicable provisions of this Standard.

CF-530 Action on Flame Failure (Refer to Tables CF-2 and CF-5)

Loss of main flame shall result in safety shutdown for all oil-fired boiler units. In addition, oil-fired boiler units shall also comply with one of the following for relight, recycle, or lockout as applicable:

(a) Relight, if initiated within 0.8 sec upon loss of flame, is permitted for units having inputs less than or equal to 3 gph (11.4 L/h) [approximately 400,000 Btu/hr (117 kW)] and using an interrupted pilot or direct ignition system.

(b) Lockout is required for units having inputs greater than 3 gph (11.4 L/h) [approximately 400,000 Btu/hr (117 kW)] and less than or equal to 20 gph (75.7 L/h). However, recycle is permitted, if a maximum 4-sec flame failure response time is used.

(c) Lockout is required for units having inputs greater than 20 gph (75.7 L/h) [approximately 2,800,000 Btu/hr (821 kW)].

CF-600 LOW FIRE START, GAS- OR OIL-FIRED BOILER UNITS

CF-610 Low Fire Start

Boiler units having inputs greater than 2,500,000 Btu/hr (733 kW) (gas-fired) or a maximum nameplate fuel input rating greater than 20 gph (75.7 L/h) (oil-fired) shall be equipped with an inter- locked damper to provide for low fire starts. However,
TYPICAL FUEL TRAINS

Fig. B-1 Typical Atmospheric Gas Fuel Train [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)]

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer's instructions.

NOTE:
(1) Alternate arrangement — T may be used in place of two S-type valves.
Fig. B-2  Typical Gas Fuel Train [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)]

A = manual valve
B = firing rate valve
C = orifice
F = gas filter or strainer (if required)
G = relief valve (if required)
J = leakage test valve
M = pipe cap
R_1 = main gas pressure regulator
R_2 = pilot gas pressure regulator
S = safety shutoff valve
T = safety shutoff valve with proof of closure
V = main gas pressure regulator/safety shutoff combination valve
W = main gas pressure regulator/safety shutoff combination valve with proof of closure

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTES:
(1) Alternate arrangement — T may be used in place of two S-type valves.
(2) Alternate arrangement — W may be used in place of an S- and V-type valve.
(3) Alternate arrangement — R_1 may be downstream of two S-type valves or a T-type valve.
Fig. B-3  Typical Gas Fuel Train [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)] Direct Ignition System

A = manual valve  
B = firing rate valve  
C = orifice  
D = high gas pressure switch  
E = low gas pressure switch  
F = gas filter or strainer (if required)  
G = relief valve (if required)  
J = leakage test valve  
M = pipe cap  
R₁ = main gas pressure regulator  
R₂ = pilot gas pressure regulator  
S = safety shutoff valve  
T = safety shutoff valve with proof of closure  
V = main gas pressure regulator/safety shutoff combination valve  
W = main gas pressure regulator/safety shutoff combination valve with proof of closure

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer's instructions.

NOTES:
(1) Alternate arrangement — T may be used in place of two S-type valves.
(2) Alternate arrangement — W may be used in place of an S- and V-type valve.
(3) Alternate arrangement — R₁ may be downstream of two S-type valves or a T-type valve.
Fig. B-4  Typical Gas Fuel Train [Greater Than 2,500,000 Btu/hr (733 kW) and Less Than or Equal to 5,000,000 Btu/hr (1465 kW)]

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTES:
(1) Alternate arrangement — T may be used in place of two S-type valves.
(2) Alternate arrangement — W may be used in place of an S- and V-type valve.
(3) Alternate arrangement — $R_1$ may be downstream of two S-type valves or a T-type valve.
Fig. B-5  Typical Gas Fuel Train [Greater Than 5,000,000 Btu/hr (1465 kW) and Less Than 12,500,000 Btu/hr (3663 kW)]

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTE:
(1) Alternate arrangement — $R_1$ may be downstream of an $S$- and $T$-type valve.
## NONMANDATORY APPENDIX B
### TYPICAL FUEL TRAINS

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<th>Fuel</th>
<th>Burner Pressure</th>
<th>Input Range Btu/Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>Atmospheric</td>
<td>Piloted</td>
<td>Gas</td>
<td>Positive</td>
<td>400,000 &lt; Input ≤ 2,500,000</td>
</tr>
<tr>
<td>B-2</td>
<td>Power</td>
<td>Piloted</td>
<td>Gas</td>
<td>Positive</td>
<td>400,000 &lt; Input ≤ 2,500,000</td>
</tr>
<tr>
<td>B-3</td>
<td>Power</td>
<td>Direct</td>
<td>Gas</td>
<td>Positive</td>
<td>400,000 &lt; Input ≤ 2,500,000</td>
</tr>
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<td>B-4</td>
<td>Power</td>
<td>Piloted</td>
<td>Gas</td>
<td>Positive</td>
<td>2,500,000 &lt; Input ≤ 5,000,000</td>
</tr>
<tr>
<td>B-5</td>
<td>Power</td>
<td>Piloted</td>
<td>Gas</td>
<td>Positive</td>
<td>5,000,000 &lt; Input ≤ 12,500,000</td>
</tr>
<tr>
<td>B-6</td>
<td>Power</td>
<td>Piloted</td>
<td>Gas</td>
<td>Negative</td>
<td>400,000 &lt; Input &lt; 12,500,000</td>
</tr>
<tr>
<td>B-7</td>
<td>Power</td>
<td>Direct</td>
<td>Gas</td>
<td>Negative</td>
<td>400,000 &lt; Input &lt; 12,500,000</td>
</tr>
<tr>
<td>B-8</td>
<td>Power</td>
<td>Piloted</td>
<td>Oil</td>
<td>NA</td>
<td>3 GPH &lt; Input ≤ 20 GPH</td>
</tr>
</tbody>
</table>

Fig. B-1 Typical **Atmospheric** Gas Fuel Train with Pilot Ignition System and Atmospheric Burners [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)]

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**GENERAL NOTE:** Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer's instructions.

**NOTE:**
(1) Alternate arrangement — T may be used in place of two S-type valves.
Fig. B-2 Typical Gas Fuel Train with Pilot Ignition System [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)]

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTES:
(1) Alternate arrangement — T may be used in place of two S-type valves.
(2) Alternate arrangement — W may be used in place of an S- and V-type valve.
(3) Alternate arrangement — R₁ may be downstream of two S-type valves or a T-type valve.
Fig. B-3 Typical Gas Fuel Train with Direct Ignition System [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 2,500,000 Btu/hr (733 kW)] Direct Ignition System

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTES:
1. Alternate arrangement — T may be used in place of two S-type valves.
2. Alternate arrangement — W may be used in place of an S- and T-type valve.
3. Alternate arrangement — R₁ may be downstream of two S-type valves or a T-type valve.

G = relief valve (if required)
J = leakage test port (if required)
M = pipe cap
A = manual valve
B = firing gate valve
C = off-
D = high gas pressure switch
E = low gas pressure switch
F = gas filter or strainer (if required)
G = relief valve (if required)
J = leakage test port (if required)
M = pipe cap
R₁ = main gas pressure regulator
R₂ = pilot gas pressure regulator
S = safety shutoff valve
T = safety shutoff valve with proof of closure
V = main gas pressure regulator/safety shutoff combination valve
W = main gas pressure regulator/safety shutoff combination valve with proof of closure
Fig. B-4  Typical Gas Fuel Train with Pilot Ignition System [Greater Than 2,500,000 Btu/hr (733 kW) and Less Than or Equal to 5,000,000 Btu/hr (1 465 kW)]

A = manual valve  G = relief valve (if required)  T = safety shutoff valve with proof of closure
B = firing rate valve  J =  V = main gas pressure regulator/safety shutoff combination valve
C = orifice  M = pipe cap  W = main gas pressure regulator/safety shutoff combination valve with proof of closure
D = high gas pressure switch
E = low gas pressure switch
F = gas filter or strainer (if required)

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTES:
(1) Alternate arrangement — T may be used in place of two S-type valves.
(2) Alternate arrangement — W may be used in place of an S- and V-type valve.
(3) Alternate arrangement — R1 may be downstream of two S-type valves or a T-type valve.

leakage test port (if required)
Fig. B-5 Typical Gas Fuel Train with Pilot Ignition System [Greater Than 5,000,000 Btu/hr (1 465 kW) and Less Than or Equal to 12,500,000 Btu/hr (3 663 kW)]

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTE:
(1) Alternate arrangement — $R_1$ may be downstream of an $S$- and $T$-type valve.
**NEW FIGURE**

**Fig. B-6 Typical Gas Fuel Train with Pilot Ignition System and Negative (Zero Governor) Main Manifold Gas Pressure [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 12,500,000 Btu/hr (3663 kW)]**

A = manual valve
C = orifice
D = high gas pressure switch
   (if required)
E = low gas pressure switch
F = gas filter or strainer (if required)
G = relief valve (if required)
J = leakage test port (if required)
M = pipe cap
R = pilot gas pressure regulator
S = safety shutoff valve
X = combination safety shutoff valve with
   negative pressure (zero governor) regulator

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer's instructions.

NOTE:

(1) Alternate arrangement — Y may be used in place of S- and X-type valve.
**NEW FIGURE**

Fig. B-7 Typical Gas Fuel Train with Direct Ignition System and Negative (Zero Governor) Main Manifold Gas Pressure [Greater Than 400,000 Btu/hr (117 kW) and Less Than or Equal to 12,500,000 Btu/hr (3 663 kW)]

A = manual valve  
D = high gas pressure switch (if required)  
E = low gas pressure switch  
F = gas filter or strainer (if required)  
G = relief valve (if required)  
J = leakage test port (if required)  
M = pipe cap  
S = safety shutoff valve  
X = combination safety shutoff valve with negative pressure (zero governor) regulator  
Y = combination redundant safety shutoff valve with negative pressure (zero governor) regulator

GENERAL NOTE: Since boiler design may vary, ANSI Z21.13/CSA 4.9, Gas-Fired, Low-Pressure Steam and Hot Water Boilers, does not contain a typical fuel train; however, through laboratory testing procedures, ANSI Z21.13/CSA 4.9 does determine that safe lighting of the boiler will be accomplished. This Standard illustrates a typical fuel train for boilers. The specific fuel train diagram for boilers complying with ANSI Z21.13/CSA 4.9 is supplied in the boiler manufacturer’s instructions.

NOTE:  
(1) Alternate arrangement — Y may be used in place of S- and X-type valve.
Fig. B-6  Typical Oil Fuel Train

- Oil supply connection
- Oil return connection

- $P$ = fuel pump
- $R$ = shutoff valve and/or pressure relief valve
- $S$ = fuel strainer
- $T$ = oil temperature interlock switch (if required)
- $U$ = oil pressure interlock switch (if required)
- $V$ = safety shutoff valve
- $W$ = safety shutoff valve (may be three-way for recirculation)
- $Y$ = atomizing media supply pressure interlock switch (if required)
GENERAL NOTES:
(a) $H$ is a manifolded line, and its size is based on $G + 50\%$ of $E + 50\%$ of $F + 50\%$ of $D$. The pipe diameters of $A$ and $B$ are not considered.
(b) $D$ is a branch line to $H$, but it is also a manifolded line for $A$ and $B$. Thus, the diameter of $D$ is $A + 50\%$ of $B$. 

(SEE NEXT PAGE FOR FIGURE)
INSERT NEW FIG. B-10
Typical Gas Fuel Train Safety Shutoff Valve Arrangements for Multiple Burner Boiler Units Complying with CF-180(b)
Multiple Burner Boiler Unit

*Total capacity is 5 Mbtu/hr or less

*Individual burner capacity less than 5 Mbtu/hr
NONMANDATORY APPENDIX D
RECOMMENDED PREVENTIVE MAINTENANCE SCHEDULE

(Operation and maintenance instructions in this safety standard are intended for general applications. For specific operating and maintenance instructions, consult the equipment manufacturer.)

D-1 DAILY
(a) Check gages, monitors, and indicators.
(b) Check instrument and equipment settings.
(c) For high-pressure boilers, test low-water fuel cut-off device(s) and alarms.
(d) Check burner flame.

D-2 WEEKLY
(a) For low-pressure boilers, test low-water fuel cut-off device(s) and alarms.
(b) Check igniter.
(c) Check flame signal strength.
(d) Check flame failure detection system.
(e) Check firing rate control.
(f) Make aural and visual check of pilot and main fuel valves.

D-3 MONTHLY
(a) Check flue, vent, stack, or outlet dampers.
(b) Test low draft, fan air pressure, and damper position interlocks.
(c) Check low-fire start interlock.
(d) Test high and low oil pressure and temperature interlocks.
(e) Test high and low gas pressure interlocks.

D-4 SEMI-ANNUALLY
(a) Recalibrate all indicating and recording gages.
(b) For steam boilers, perform a slow drain test of the low-water fuel cut-off device.
(c) Check flame failure detection system components.
(d) Check firing rate control.
(e) Check piping and wiring of all interlocks and shut-off valves.
(f) Inspect burner components.

D-5 ANNUALLY
(a) Flame failure detection system, pilot turndown test.

(b) Flame failure detection system, test for hot refractory hold-in.
(c) Check dual fuel change over control.
(d) Test high-limit steam pressure control.
(e) Replace vacuum tubes, scanners, or flame rods in accordance with manufacturer’s instructions.
(f) Conduct a combustion test.
(g) Check all coils and diaphragms; test other operating parts of all safety shutoff and control valves.
(h) Test fuel valve interlock switch(es) in accordance with manufacturer’s instructions.
(i) Perform leakage test on pilot and main gas and/or oil fuel valves.
(j) Test purge air switch in accordance with manufacturer’s instructions.
(k) Test safety/shutoff valve proof of closure.
(l) Test air/steam interlock in accordance with manufacturer’s instructions.
(m) Test burner position interlock in accordance with manufacturer’s instructions.
(n) Test rotary cup interlock in accordance with manufacturer’s instructions.
(o) Test low-fire start interlock in accordance with manufacturer’s instructions.

D-6 AS REQUIRED
(a) Recondition or replace low-water fuel cut-off device.
(b) For oil-fired burners, clean atomizers and oil strainers.
(c) For gas-fired burners, check sediment trap and gas strainers.
(d) Flame failure detection system, pilot turndown test.
(e) Flame failure detection system, test for hot refractory hold-in.
(f) Test safety/safety relief valves in accordance with ASME Boiler and Pressure Vessel Code, Sections VI and VII.

(g) For parallel positioning systems, verify actuator to fuel valve couplings and actuator to damper couplings are properly connected.
(h) For combustion air fan variable frequency drive applications, test interlocks wired to the primary flame safety device including drive fault interlocks and improper speed control interlocks.
**Table D-1 Periodic Testing Recommended Checklist (See Manufacturer’s Instructions)**

<table>
<thead>
<tr>
<th>Frequency [Note (1)]</th>
<th>Component/Item</th>
<th>Recommended Test</th>
<th>Accomplished By</th>
</tr>
</thead>
<tbody>
<tr>
<td>D W M S/A A A/R</td>
<td>Gages, monitors, and indicators</td>
<td>Make visual inspection and record readings in boiler log.</td>
<td>X ...</td>
</tr>
<tr>
<td>... ... X ... ...</td>
<td>Gages, monitors, and indicators</td>
<td>Recalibrate all indicating and recording gages.</td>
<td>... X</td>
</tr>
<tr>
<td>X ... ... ... ...</td>
<td>Instrument and equipment settings</td>
<td>Make visual check against factory-recommended specifications.</td>
<td>X ...</td>
</tr>
<tr>
<td>X ... ... ... ...</td>
<td>Low-water fuel cut-off devices (high-pressure boilers)</td>
<td>Test low-water fuel cut-off devices according to manufacturer’s instructions.</td>
<td>X ...</td>
</tr>
<tr>
<td>... X ... ... ...</td>
<td>Low-water fuel cut-off devices (low-pressure boilers)</td>
<td>Test low-water fuel cut-off devices according to manufacturer’s instructions.</td>
<td>X ...</td>
</tr>
<tr>
<td>... ... X ... ...</td>
<td>Low-water fuel cut-off devices (steam boilers)</td>
<td>For steam boilers, perform a slow drain test in accordance with ASME Boiler and Pressure Vessel Code, Section VI.</td>
<td>... X</td>
</tr>
<tr>
<td>... ... ... X ...</td>
<td>Low-water fuel cut-off device</td>
<td>Recondition or replace low-water fuel cut-off device.</td>
<td>... X</td>
</tr>
<tr>
<td>... ... X ... ...</td>
<td>Operating and/or limit controls</td>
<td>Test high-limit and operating temperature or steam pressure controls.</td>
<td>... X</td>
</tr>
<tr>
<td>... ... ... X ...</td>
<td>Safety/safety relief valves</td>
<td>Test safety/safety relief valves in accordance with ASME Boiler and Pressure Vessel Code, Sections VI and VII.</td>
<td>... X</td>
</tr>
<tr>
<td>... ... X ... ...</td>
<td>Flue, vent, stack, or outlet dampers</td>
<td>Make visual inspection of linkage, and check for proper operation.</td>
<td>X ...</td>
</tr>
<tr>
<td>X ... ... ... ...</td>
<td>Burner flame</td>
<td>Make visual inspection of burner flame [Note (2)].</td>
<td>X ...</td>
</tr>
<tr>
<td>... X ... ... ...</td>
<td>Igniter</td>
<td>Make visual inspection, and check flame signal strength if meter-fitted.</td>
<td>X ...</td>
</tr>
<tr>
<td>... X ... ... ...</td>
<td>Flame signal strength</td>
<td>If flame signal meter is installed, read and log. For both pilot and main flames, notify service organization if readings are very high, very low, or fluctuating (refer to manufacturer’s instructions).</td>
<td>X ...</td>
</tr>
<tr>
<td>... X ... ... ...</td>
<td>Flame failure detection system</td>
<td>Close manual fuel supply for (1) pilot, (2) main fuel cock, and/or (3) valve(s). Check safety shutdown timing, and log.</td>
<td>X ...</td>
</tr>
</tbody>
</table>

*Note (1): Frequency varies depending on the component and the frequency noted for each component.*

*Note (2): Inspect burner flame visually.*