Controls and Safety Devices for Automatically Fired Boilers

DRAFT DATE: 10/2020
Part CG
General

CG-100 GENERAL REQUIREMENTS

CG-110 Scope

The rules of this Standard cover requirements for the assembly, installation, maintenance, and operation of controls and safety devices on automatically operated boilers directly fired with gas, oil, gas–oil, or electricity, subject to the service limitations, exclusions, and acceptance of other listings in CG-120, CG-130, and CG-140, respectively. Burner or burner assemblies installed on boilers or as a replacement burner shall comply with the requirements of CF-110 and CF-410 for gas and oil firing, respectively. The use of a gaseous or oil fuel not listed in the definitions has not been evaluated, and special considerations may be required.

CG-120 Service Limitations

The rules of this Standard are applicable to the following service:

(a) all automatically fired boilers and burner assemblies, regardless of fuel input ratings subject to the exclusions and acceptance to other listings of CG-130 and CG-140, respectively

(b) burners field-installed in automatically fired boilers

CG-130 Exclusions

The following are excluded from the requirements of this Standard:

(a) boilers with fuel input ratings greater than or equal to 12,500,000 Btu/hr (3 663 kW), falling within the scope of NFPA 85, Boiler and Combustion Systems Hazard Code

(b) water heaters (see CG-700)

(c) direct gas-fired swimming pool heaters that are labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction as complying with ANSI Z21.56/CSA 4.7, Standard for Gas-Fired Pool Heaters

CG-140 Acceptance of Other Listings

The following other listings are acceptable:

(a) automatically operated boilers fired with gas having inputs of 400,000 Btu/hr (117 kW) or less that

(1) comply with Part CW, CE-110(a), CE-110(b), and CE-110(j)

(2) are labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction as complying with ANSI Z21.13/CSA 4.9, Standard for Gas-Fired Low Pressure Steam and Hot Water Boilers; meet the remaining requirements of this Standard (see Nonmandatory Appendix A)

(b) automatically operated boilers fired with oil having inputs of 3 gph (11.4 L/h) or less that

(1) comply with Part CW, CE-110(a), CE-110(b), and CE-110(j)

(2) are labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction as complying with UL 726, Standard for Oil-Fired Boiler Assemblies; meet the remaining requirements of this Standard

(c) automatically operated, electrically heated boilers having inputs of 115 kW or less that

(1) comply with Part CW, CE-110(a), and CE-110(b)

(2) are labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction as complying with UL 834, Standard for Heating, Water Supply, and Power Boilers — Electric; meet the remaining requirements of this Standard

CG-150 Jurisdictional Adoption of ASME CSD-1

Adoption of ASME CSD-1 by a jurisdiction shall not preclude the jurisdiction adopting and accepting boilers listed or certified to other safety standards or codes acceptable to the jurisdiction beyond the limitations contained in CG-140. Where other such safety codes and/or standards are adopted/accepted and overlap with the scope of ASME CSD-1, it shall be the responsibility of the jurisdiction to define the application of this Standard and those other codes and/or standards.

CG-160 Metric (SI) Units

This edition of the Standard uses U.S. Customary units. The acceptable equivalent SI units are shown in parentheses for information only and have been directly converted from the U.S. Customary units.
The manufacturer and/or the installing contractor, as applicable, shall make a testing report available as required by sections CG-441, CG-442, CG-443, CG-444, and CG-510.

CG-441 Shop-Assembled Boilers — New Installations

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

CG-440 Operational Testing

(a) 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-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)

   Items (1) through (3) shall be verified by the signature of an authorized representative of the manufacturer. An example of an acceptable data 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)

   Items (1) 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 taken. If the suitability of the installation permits, physical lockout shall be accomplished from a location where the cause of the lockout may be determined so that the necessary corrective action may be taken. If the possibility 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.

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(b) The manufacturer’s representative or installing contractor shall, as part of commissioning the unit, test and report per CG-510(a) on the operation of all control systems and safety devices installed in accordance with this Standard prior to release to the owner/user.

**CG-442 Shop-Assembled Boilers — Existing Installations**
After replacing burners or controls, installing audible or visual alarms, status, or control wiring to primary flame safety controls, or after the boiler unit is moved from its original installation location, the installing contractor shall test and report per CG-510(a) on the operation of all control systems and safety devices installed in accordance with this Standard prior to release to the owner/user.

**CG-443 Field-Assembled Boilers — New Installations**
During commissioning of a new installation, manufacturers, their representatives, or installing contractors shall test and report per CG-510(b), as applicable, on the operation of all control systems and safety devices installed in accordance with this Standard prior to release to the owner/user.

**CG-444 Field-Assembled Boilers — Existing Installations**
After replacing burners or controls or after the boiler unit is moved from its original installation location, the installing contractor shall test and report per CG-510(b) on the operation of all control systems and safety devices installed in accordance with this Standard prior to release to the owner/user.
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 application of heat from the combustion of fuels or from electricity.

boiler, automatically fired: a boiler that cycles automatically in response to a control system.

boiler, high-pressure: a boiler in which steam or vapor is generated at a pressure greater than 15 psig (100 kPa gage).

boiler, hot-water: a hot-water heating boiler, supply boiler, or high-temperature water boiler.

boiler, hot-water heating: a boiler in which no steam is generated and from which hot water is circulated for heating purposes, then returned to the boiler operating at a pressure less than or equal to 160 psig (1100 kPa gage) or a temperature less than or equal to 250°F (120°C) at or near the boiler outlet.

boiler, hot-water supply: a boiler that furnishes hot water to be used externally to itself at a pressure less than or equal to 160 psig (1100 kPa gage) or a temperature less than or equal to 250°F (120°C) at or near the boiler outlet.

boiler, low-pressure: a boiler in which steam or vapor is generated at a pressure less than or equal to 15 psig (100 kPa gage).

boiler, miniature: a boiler that does not exceed any of the following limits:
(a) 16 in. (405 mm) inside diameter of shell
(b) 20 ft² (1.86 m²) heating surface
(c) 5 ft³ (0.14 m³) gross volume,¹ exclusive of casing and insulation

boiler, power: a power boiler, or hot water heating assembly consisting of a grouping of individual boilers called modules intended to be installed as a unit with no intervening stop valves. Modules may be under one jacket or individually jacketed. The individual modules shall be limited to a maximum input of 400,000 Btu/hr (117 kW) (gas), 3 gph (11.4 L/h) (oil), or 115 kW (electric).

boiler manufacturer: an organization that manufactures pressure parts for boilers or that shop-assembles parts into completed boilers.

boiler system: a system comprised of the boiler(s); its controls, safety devices, and interconnected piping; vessels; valves; fittings; and pumps.

boiler unit: a complete assembly comprised of the boiler, the apparatus used to produce heat, and associated controls and safety devices.

branch burner: a burner that takes off from the main burner supply line but does not have its own primary safety control, but rather uses the main burner as its source of ignition and safety control (e.g., second stage line burner or pipe burner) installed adjacent to the main burner and acting as the ignition source of the adjacent line burner is considered to be a branch of a single-burner assembly.

branch circuit: that portion of the wiring system between the final overcurrent device protecting the circuit and utilization equipment.

branch line: a section of pipe or tubing directly connected to a boiler.

boiler, high-temperature water: a water boiler intended for operation at pressures in excess of 160 psig (1100 kPa gage) and/or temperatures in excess of 250°F (120°C).

boiler, high-temperature water supply: a boiler that furnishes hot water to be used externally to itself at a pressure less than or equal to 160 psig (1100 kPa gage) and/or temperatures in excess of 250°F (120°C).

boiler, high-temperature water heating: a water boiler intended for operation at pressures in excess of 160 psig (1100 kPa gage) and/or temperatures in excess of 250°F (120°C).

¹The gross volume is intended to include such gas passages as are integral with the assembled pressure parts. Gross volume is defined as the volume of a rectangular or cylindrical enclosure into which all the pressure parts of the boiler in their final assembled positions could be fitted. Projecting nozzles or fittings need not be considered in the volume.
burner assembly: a burner that is factory-built as a single assembly or as two or more subassemblies that include all essential parts necessary for its normal function when installed as intended.

burner tip: a termination point that directs gas into a flame of a pilot or into the combustion chamber.

combined feeder/cutoff: a device that regulates makeup water to a boiler in combination with a low-water fuel cutoff.

combustion: the rapid oxidation of fuel, producing heat or heat and light.

combustion air: the air required for combustion of the fuel. This does not include the air used for atomization.

combustion chamber: the portion of the boiler enclosure into which the fuel is fed, ignited, and burned (also referred to as furnace or firebox).

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 diaphragm of a fuel train component, or a tubing that communicates flue or gas pressure from one point of reference to another, at which air, fuel, or an air-fuel mixture is admitted, expressed in volume or heat units of time.

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

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

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 non-current-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 laboratory indicates compliance with nationally recognized standards.

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 procedure to restart the equipment (see also shutdown, safety).

low fire start: the light-off ignition of a burner with the fuel controls in a low fire position. In a system with guaranteed low fire start, interlocks are used to prevent startup if the burner is not in the low fire position.

low-water fuel cutoff: a device that shuts off the fuel when the boiler water falls to an unsafe level.

LP-gas air mixture: liquefied-petroleum gases distributed at relatively low pressures and normal atmospheric temperatures that have been diluted with air to produce a desired heating value and utilization characteristic.

main burner flame-establishing period: the interval of time when the main burner is firing or not. The main burner assembly is in service, whether the main burner is firing or not.

main manifold, gas: the conduit of an appliance that supplies gas to the individual burners.

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

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.

may: indicates an action is permissive, not required; or indicates an alternative means to accomplish the specified task.

multiple-burner boiler unit: a boiler unit with one common combustion chamber and more than one burner assembly, each of which has its own primary safety control.


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 is permitted to be delivered to a pilot burner before the primary safety control is required to prove the pilot flame.

pilot manifold gas pressure: the gas pressure measured at a location that is specified by the burner/boiler unit manufacturer and is taken downstream of the pilot gas-pressure regulator.

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 shutoff valve when no meter is provided. For undiluted liquefied-petroleum gas systems, the point of gas delivery shall be considered the outlet of the first stage LP-gas-pressure regulator.
pool heater: an appliance designed for heating nonpotable water stored at atmospheric pressure, such as water in swimming pools, spas, hot tubs, and similar applications.

postpurge period: a period of time after the fuel valves close, during which the burner motor or fan continues to run to supply air to the combustion chamber and flue passages.

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, gas, main: a device for controlling and maintaining a predetermined gas pressure to the gas manifold.

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.

pressure regulator, zero governor: a main gas pressure regulator that is normally adjusted to deliver gas at atmospheric pressure within its flow rating.

primary safety control system: an automatic labeled and listed control that may integrate the functions of other controls, such as operating 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 monitors pressure, position, temperature, or similar variable and responds with an action, such as energizing a coil or energizing a switch.

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 Figure CG-1).

shall: indicates an action that is mandatory and required to accomplish the specified task.

should: indicates a preferred but not mandatory means to accomplish the specified task.

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 means of a safety control or primary 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 upper 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 fuel 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 (i.e., 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.

valve, proof-of-closure: a safety shutoff valve equipped with an interlock switch that will be actuated only after the valve has fully closed.

valve shaft: the movable part of the sealing mechanism of a safety shutoff valve. The valve shaft may also be referred to as the valve stem.

vent limiter: a means that limits the flow of gas from the atmospheric diaphragm chamber to the atmosphere in the event of diaphragm rupture. This may be either a limiting orifice or device.

vent line: a section of piping or tubing that conveys the release of gases from fuel train components.

vent valve: a normally open, power-closed valve piped between the two safety shutoff valves and vented to a safe point of discharge.

vent valve line: a section of piping that conveys the release of gas from an automatic or manually operated vent valve.

water heater: a vessel, which is closed except for openings through which water can flow, that includes the apparatus by which heat is generated and on which all controls and safety devices necessary to prevent pressures greater than 160 psig (1100 kPa gage) and water temperatures greater than 210°F (99°C) are provided, in which potable water is heated by the combustion of fuels, electricity, or any other heat source and withdrawn for external use.
Part CE
Electrical

CE-100 ELECTRICAL REQUIREMENTS

CE-110 General

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 70.

(a) A disconnecting means capable of being locked in the open position shall be installed at an accessible location at the boiler so that the boiler can be disconnected from all sources of potential. This disconnecting means shall be an integral part of the boiler or adjacent to it.

(b) A manually operated remote shutdown switch or circuit breaker shall be located just outside the boiler room door and marked for easy identification.

(1) Consideration should be given to the type and location of the remote shutdown switch to safeguard against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a remote shutdown switch located at each door.

(2) Activation of the remote shutdown switch or circuit breaker shall immediately shut off the fuel or energy supply.

(c) All uninsulated live metal parts and all rotating or moving parts that may cause injury shall be guarded to avoid accidental contact.

(d) The electrical equipment shall be arranged so that failure of this equipment will cause the fuel supply to be shut off.

(e) The power supply to the electrical control system shall be from a two-wire branch circuit that has a grounded conductor; otherwise, an isolation transformer with a two-wire secondary shall be provided. When an isolation transformer is provided, one side of the secondary winding shall be grounded. Control voltage shall not exceed 150 nominal volts, line to line.

(1) One side of all coils shall be electrically located in the grounded side of the circuit. All switches, contacts, and overcurrent devices shall be electrically located in the ungrounded or “hot” side of the circuit.

(2) All electrical contacts of every safety device installed in the same control circuit shall be electrically connected in series.

(f) All electrical components and devices shall have a voltage rating commensurate with the supply voltage of the control system.

(g) All electrical components and devices shall be provided with an electrical enclosure that is at least NEMA Type 1 (General Purpose). Where electrical components and devices shall be subject to dripping moisture, the enclosures shall be of a type tested and approved by a nationally recognized testing agency. Enclosures shall be such that the electrical circuits shall be such that there shall be no interruption of fuel supply to combustion units.

(h) Automatic resetting devices, controls, or switches shall be installed in accordance with the instructions of the combustion safeguard control manufacturer. No automatic resetting device, control, or switch shall be installed in the wiring between the load side (terminal) of the primary or programming control and the main or ignition fuel valve or valves. This does not preclude the installation of manually operated test switches for the purposes of testing tight closure of individual fuel valves.

CE-120 Overcurrent Protection

(a) Conductors for interconnecting wiring that is smaller than the supply conductors shall be provided with overcurrent protection based on the size of the smallest interconnecting conductors external to any control box.

(b) Overcurrent protection for interconnecting wiring shall be located at the point where the smaller conductors connect to the larger conductors. However, overall overcurrent protection is acceptable if it is sized on the basis of the smallest conductors of the interconnecting wiring.

(c) Overcurrent protection devices shall be accessible, and their function shall be identified.

CE-130 Motors

(a) Motors exposed to dripping or spraying oil or water shall be of drip-proof construction. All motors shall be fully guarded as installed.
Part CW
Steam and Waterside Control

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 and shall be accepted by a nationally recognized testing agency.

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

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

(d) All low-water fuel cutoffs 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 Boilers

(a) Each automatically fired, low-pressure steam 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 through the float chamber or its connections to the operating water level. The water feeding device shall be connected in such a manner that the low-water fuel cutoff control will shut off the boiler when a low-water condition exists. One cutoff control shall be the higher.

EXCEPTION: When a gravity 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.

(b) 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 available for attaching a water gage glass directly to a boiler.
CW-130 Requirements for Water Level Controls for Nonferrous Tees or Wyes Not Less Than NPS 1/2 (DN 15) provided the connections are made to the boiler with nonferrous tees or wyes not less than NPS 3/4 (DN 20), located at the lowest point of the chamber of water equalizing pipe connections, so that the chamber and equalizing pipe connections can be flushed and the device tested.

(e) 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. Supply water shall not be interrupted for any length of time, except during testing. The time delay component shall not interfere with normal water gage glass operations. Each cutoff device shall be installed to prevent startup and cut off the boiler fuel or energy supply automatically when the surface of the water falls to a level not lower than the lowest visible part of the gage glass. One control shall be set to function ahead of the other. Each miniature boiler shall have at least one low-water fuel cutoff device (see also CW-210).

CW-140 Requirements for Water Level Controls for High-Pressure Steam Boilers

(a) Each automatically fired, high-pressure steam boiler, except miniature boilers, shall have at least two automatic low-water fuel cutoff devices. 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 lowest visible part of the gage glass. Each cutoff device shall be installed to prevent startup and cut off the boiler fuel or energy supply automatically when the surface of the water falls to a level not lower than the lowest visible part of the gage glass. One control shall be set to function ahead of the other. Each miniature boiler shall have at least one low-water fuel cutoff device (see also CW-210).

(b) Each automatically fired, high-pressure, miniature steam boiler shall have at least one low-water fuel cutoff device which shall cause safety shutdown and lockout and shall be equipped with a manual reset.

(c) Functioning of the lower of the two 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 of the instantaneous type or may include a time delay of not more than 3 min after the fuel has been cut off.

(d) The fuel cutoff device may be inserted internally or attached externally to the boiler. An external low-water fuel cutoff device shall be installed to prevent startup and cut off the boiler by separate pipe connections below the lowest visible part of the gage glass.

(e) A means shall be provided for testing the operation of the low-water fuel cutoff without resorting to draining the entire system. Such means shall not render the device inoperative. If the means temporarily isolates the device from the boiler during this testing, it shall automatically return to its normal position.

Outlet piping shall be installed onto the blowoff (drain) valve for externally mounted low-water fuel cut off devices and routed to a safe point of discharge, as acceptable to the authority having jurisdiction.


**(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**

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 protect the boiler unit against overheating at all allowable firing rates:

(a) A flow sensing device labeled and listed by a recognized testing agency as a safety control complying with the requirements of UL 353. This safety control shall be independent of any other operating controls and may be automatically reset when adequate flow is restored.

(b) In addition to a low-water fuel cutoff as specified in CW-110 and CW-130, 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. This control may allow the boiler to recycle.

Upon detection of an inadequate flow rate, the means specified in (a) or (b) shall shut off the fuel or energy supply. 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 lock circuitry during testing.

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

(c) 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 (a) or (b). 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 prevent generation of steam pressure greater than the maximum allowable working pressure. Functioning of this control shall cause safety shutdown and lockout. The manual reset may be incorporated in the pressure limit control. Where the reset device is separate from the pressure limit control, a means shall be provided to indicate actuation of the pressure limit control. Each limit and operating control shall have its own sensing element and operating switch.

**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 CE-110(j).

(e) No shutoff valve of any type shall be placed in the steam pressure connection between the boiler and 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, or equivalent means of maintaining a water seal, that will prevent steam from entering the control. 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 3/4 (DN 8) for lengths up to and including 5 ft (1.5 m) and not less than NPS 1/2 (DN 15) 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 3/4 (DN 20) for lengths up to and including 5 ft (1.5 m) and not less than NPS 1 (DN 25) 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.

(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 3/4 (DN 15) for lengths up to and including 5 ft (1.5 m) and not less than NPS 1 (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 1/2 (DN 20) for lengths up to and including 5 ft (1.5 m) and not less than NPS 1 3/4 (DN 32) for lengths over 5 ft (1.5 m). Individual controls are to be piped from the manifold according to the provisions of (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.

**CW-400 TEMPERATURE CONTROLS**

(a) Each automatically fired hot-water boiler or each system of commonly connected hot-water boilers shall have at least two temperature-control devices that conform to UL 353 and shall be labeled and listed by a nationally recognized testing agency. This requirement does not preclude the use of additional temperature control devices that are not labeled and listed to UL 353.

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

(c) In addition to the operating temperature control requirements in (b), each individual automatically fired hot-water boiler shall have at least one high-temperature limit control. The high-temperature limit control's sensing element shall be positioned on the boiler to cut off the fuel supply at or below 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 sensing element and operating switch. The sensing element may be remote from the control unit.

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

(d) Requirements in (b) and (c) may be fulfilled by accepted integrated controls with multiple sensors and operating switches. The integrated control's multiple sensors may be individually packaged or integrated into a single package.

(e) Each high-temperature limit and operating temperature control shall have its own sensing element and operating switch, unless the boiler temperature and limit control functions are performed by a primary safety control system meeting all the requirements of CW-210. The sensing element(s) may be remote from their control unit(s).

(f) Each required control of the automatic or manual reset type shall be electrically connected in accordance with CE-110(j).

(g) No shutoff valve or isolation device of any type shall be placed between the boiler and the boiler’s controls as required in (b) and (c).

**EXCEPTION:** A shutoff valve or isolation device may be installed between the boiler and the operating temperature control(s) specified in (b) provided

(a) an accepted safety control is installed to monitor for sufficient water flow in the system and is interlocked with the boiler control to prevent firing if the water flow is insufficient as determined by the boiler manufacturer, or

(b) an accepted valve position supervisory device ensures the valve is open and is interlocked with the boiler control to prevent firing if the isolation valve is not fully open

**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 Section IV, as applicable.
CW-520 Requirements of Hot-Water Supply Boilers

(a) Each hot-water supply boiler shall have at least one officially rated safety relief valve mounted directly on the boiler and set to relieve at or below the maximum allowable working pressure of the boiler. The required steam-relieving capacity in Btu/hr (W) shall equal or exceed the maximum Btu/hr (W) output rating of the boiler.

(b) Each hot-water system consisting of a hot-water supply boiler and hot-water storage tank served by a hot-water supply boiler that is designed to operate at or below 210°F (99°C) shall have a temperature relief valve installed and set to relieve at or below 210°F (99°C). This valve shall be installed either in combination with that required in (a) or within the top 6 in. (150 mm) of the system's hot-water storage tank.

(c) Safety relief valves shall be installed and tested in accordance with the ASME Boiler and Pressure Vessel Code. Temperature relief valves shall be rated, tested, and installed in accordance with ANSI Z21.22/CSA 4.4 and combination pressure-temperature relief valves in accordance with ANSI Z21.22/CSA 4.4 for temperature and the ASME Boiler and Pressure Vessel Code for pressure.

CW-600 MODULAR BOILERS

CW-610 Water Level Controls for Modular Steam Heating Boilers

Modular steam heating boilers shall comply with CW-120, with the following differences:

(a) Each module shall be equipped with an automatic low-water fuel cutoff.

(b) The assembled modular steam boiler shall have a second low-water fuel cutoff mounted on a water column attached to the manifolds, or may be mounted on one of the modules, where the return piping is below the lowest safe waterline and all modules will drain equally. Operation of this low-water fuel cutoff shall shut off the fuel or energy supply to all modules.

CW-620 Pressure Controls for Modular Steam Heating Boilers

Modular steam heating boilers shall comply with CW-310, with the following differences:

(a) The assembled modular boiler shall have a pressure control that complies with CW-310(c). Operation of this control shall shut off the fuel or energy supply to all modules.

(b) Each module shall have a pressure control that complies with CW-310(b).

CW-630 Water Level Controls for Modular Hot-Water Boilers

Modular hot-water boilers shall comply with CW-130, with the following differences:

(a) The assembled modular boiler shall be protected by a low-water fuel cutoff located in the system piping such that it will detect a low-water condition before the level falls below the lowest safe waterline in any module.

(b) Operation of the low-water fuel cutoff shall shut off the fuel or energy supply to all modules.

CW-640 Temperature Controls for Modular Hot-Water Heating Boilers

Modular hot-water boilers shall comply with CW-410, as follows:

(a) The assembled modular boiler shall have a high-temperature limit control that complies with CW-410(c). Operation of this control shall shut off the fuel or energy supply to all boiler modules.

(b) Each boiler module shall have an operating temperature control that complies with CW-410(b).

CW-700 VACUUM BOILERS

CW-710 Requirements for Vacuum Boilers

Vacuum boilers complying with ASME Boiler and Pressure Vessel Code, Section IV, Mandatory Appendix 5 shall be permitted to have the safety limit controls meeting the requirements identified in (a), (b), (c), and (d) in lieu of all other requirements in Part CW.

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

(b) Each boiler shall have a pressure control that interrupts the burner operation in response to boiler pressure. This pressure control shall be set from 2.5 psig (17 kPa) vacuum to 14.7 psig (100 kPa) vacuum.

(c) Each boiler shall have two temperature controls responsive to boiler temperature that interrupt burner operation. One shall operate at a temperature below 210°F (99°C). The other shall operate at a temperature not exceeding 210°F (99°C) and shall cause a safety shutdown and lockout.

(d) Each boiler shall have a properly sized safety valve. The safety valve shall

1. have no test lever
2. be set at a maximum pressure of 7.1 psig (49 kPa)
3. conform to the ASME Boiler and Pressure Vessel Code, Section IV
Part CF
Combustion Side Control

CF-100 Gas-Fired Boiler Units, Equipment

CF-110 Burner Assemblies and Boiler Units

(a) Burner assemblies for boiler units having inputs in excess of 400,000 Btu/hr (117 kW) shall comply with the provisions of this Part. Burner assemblies (including pulse combustion), 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 795
(2) ANSI Z21.13/CSA 4.9 (see Nonmandatory Appendix A)
(3) ANSI Z21.56/CSA 4.7

(b) Boiler units having inputs of 400,000 Btu/hr (117 kW) or less, with field-installed gas burner assemblies, and boiler units that do not comply with ANSI Z21.13/CSA 4.9 shall comply with the provisions for

(1) purging, safety control timing, action on flame failure, loss of combustion air, combustion air proving, and fuel supervision given in Table CF-1 or Table CF-2, as applicable
(2) safety shutoff valve requirements per CF-180(b)(1)

(c) Field-installed, oil-fired assemblies having inputs of 400,000 Btu/hr (117 kW) or less shall be labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction as complies with ANSI Z21.17/CSA 2.7. The units on which they are installed shall comply with the provisions of this Standard.

(d) Boilers firing liquefied-petroleum gases or LP-gas air mixtures that do not comply with ANSI Z21.13/CSA 4.9, which are installed indoors, shall be equipped with safety shutoff devices of the complete shutoff type. A safety shutoff device of the complete shutoff type is one that will shut off the gas flow to both the main and pilot burner(s) in the event of main flame, pilot flame, or ignition failure.

(e) The provisions of this Part are intended to apply to equipment supplied with gas pressures not in excess of the following:

(1) 10 psig (70 kPa gage) for boilers firing gas-air mixtures within the flammable range (i.e., 5% to 15% by volume natural gas in air and 2.15% to 9.6% by volume propane in air)
(2) 20 psig (140 kPa gage) for boilers firing liquefied-petroleum gas
(3) 60 psig (410 kPa gage) for all other boilers

CF-120 Fuel Train

(a) See Nonmandatory Appendix B for typical fuel train diagrams. Fuel train designs other than those pictured in Nonmandatory Appendix B, but meeting the requirements of this Standard, shall be permitted.

(b) Thread-sealing compounds used on threaded joints of gas piping shall be resistant to the action of liquefied-petroleum gases.

CF-130 Filters or Strainers

Fuel cleaning equipment such as filters or strainers are recommended for use in the main gas supply line to the unit.

CF-140 Sediment Traps and Drips

(a) A sediment trap shall be installed upstream of the gas control(s). When a vertical section of piping supplied by the manufacturer is on the upstream side of the gas control(s), a sediment trap shall be installed. When a vertical section of piping is not supplied, installation instructions supplied by the manufacturer shall specify that a sediment trap be installed as close to the gas control(s) as practical at the time of the boiler’s installation.

(b) For other than dry gas conditions, a drip shall be provided at any point in the line of pipe where condensate could collect.

CF-150 Manually Operated Gas Shutoff Valves

(a) Unless provided as part of a labeled and listed boiler or burner assembly, each manually operated gas shutoff valve shall comply with the applicable provisions of ANSI Z21.15/CSA 9.1, UL 842, or a nationally recognized standard, and be suitable for the intended use.

(b) Manually operated main shutoff and pilot shutoff valves shall be ball or lubricated plug type, with stops.
function to cause safety shutdown and lockout before the main manifold gas pressure exceeds
(-a) the boiler/burner manufacturer’s specified high gas-pressure switch setting for the listed boilers or burners, or
(-b) 150% of the boiler/burner’s main manifold gas pressure if the setting is not specified
(2) 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
(-a) the setting of the overpressure protection device in CF-161, if equipped,
(-b) the boiler/burner manufacturer’s specified high gas-pressure switch setting for listed boilers or burners, or
(-c) 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.

(c) A pressure switch used to monitor low gas pressure shall function to cause safety shutdown and lockout before the main manifold gas pressure is less than
(1) the boiler/burner manufacturer’s specified low gas-pressure switch setting for the listed boilers or burners, 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 or boiler unit shall be labeled and listed by a nationally recognized testing agency for this arrangement.

(d) Pressure test port(s) shall be provided to permit measuring the gas pressure(s) to confirm compliance with the requirements of this paragraph.

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

(f) Gas-pressure switches shall be capable of withstanding without damage a pressure not less than 50% above its upper set point limit or 5 psig (34.5 kPa), whichever is greater.

(g) Gas-pressure switches of the automatic or manual reset type shall be electrically connected in accordance with CE-110(j).

CF-170 Control Valves

(a) An automatic input, complete closure, control valve may be combined with a safety shutoff valve.

(b) 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 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, ANSI Z21.78/CSA 6.20, or UL 429.

(b) For single-burner boiler units, the main burner supply line shall be equipped as follows for the applicable input classification or any greater input classifications:

(1) For single-burner 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 seat 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 shafts.

(2) For single-burner 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 as follows for the applicable input classification or any greater input classifications:

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:

(-a) for single-burner boiler units having inputs less than or equal to 5,000,000 Btu/hr (1,465 kW), the safety shutoff valve requirements in (b)(1) apply to each branch supply line

(-b) for single-burner 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),
(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 (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.

(h) Points of Discharge: Outdoor Requirements, Special Exceptions, and Prohibited Practices

(1) Unless otherwise terminated as permitted by (2) or (4), vent lines, bleed lines, gas-pressure relief lines, or vent valve lines shall have provisions to be piped by the installer to the outdoors at a safe point of discharge as determined by the authority having jurisdiction. A means shall be provided at the point of discharge to prevent stoppage of the lines by foreign material, moisture, or insects.

(2) A combination gas control integrating an internal (within the valve) gas bleed line shall be permitted to discharge its bleed line back into the valve body, provided that the construction of the combination gas control is such that when it is in the closed position, a damaged diaphragm will not allow gas to flow through the bleed line to the main burner.

(3) At locations where a point of discharge may be submerged during floods, a special antiflood-type breather vent fitting shall also be installed at the point of discharge, or the line shall be extended above the height of the expected floodwaters.

(4) A bleed line or a vent line shall be permitted to discharge into a continuous pilot, provided that the line is not manifolded and the point of discharge uses a burner tip.

(5) A bleed line or a vent line shall not discharge into a positive-pressure-type combustion chamber.

(i) Clearances for Points of Discharge. The point of discharge from a vent line, bleed line, gas-pressure relief line, or vent valve line that is piped by the installer to the outdoors shall have clearances as determined by the authority having jurisdiction, and the point of discharge shall extend above the boiler and adjacent structures to prevent gaseous discharge from being drawn into combustion air intakes, ventilating systems, mechanical air intakes, or windows of a boiler room or of an adjacent building.

(j) Burner Tips

(1) Burner tips, when required by (b)(4), shall be made of metal having a melting point greater than 1,450°F (788°C), and its length shall extend from the location as defined in (3) to the outer wall of the combustion chamber.

(2) The installer shall demonstrate compliance to (1) with the documentation accompanying the boiler.

(3) Burner tips shall be securely held so that the ports are in a fixed position in relation to the pilot flame.

(4) Gas will be readily ignited by the pilot flame, and the burner tips shall be located so that the escaping gas will be purged with a spheric gas burner shall provide for preignition purging of 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.

A boiler units less than or equal to 5,000,000 Btu/hr (1465 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 opening, shall have the following applied:

CF-200 GAS-FIRED BOILER UNITS, PURGING

CF-200 Automatic Stack Dampers

When an automatic stack damper is used, the following criteria shall apply:

(a) The automatic stack damper shall be labeled and listed for the intended application by a nationally recognized testing agency.

(b) A means shall be provided to open such automatic stack damper to the high fire position before each light-off cycle is initiated, and before the prepurge period begins.

(c) If a postpurge period is required or implemented, a means shall be provided to open the automatic stack damper to the high fire position or maintain the automatic stack damper in the previous firing position.

CF-210 Preignition Purging

Preignition purging of the combustion chamber and flue passages shall be provided (see Table CF-3 or Table CF-4).

(a) Power gas burners and mechanical draft atmospheric gas burners shall provide for preignition purging of 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.

Boiler units less than or equal to 5,000,000 Btu/hr (1465 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 opening, shall have the following applied:
Oil-fired boiler units, purging

(b) Atomizing media (air or steam) shall be supervised by a low-pressure interlock switch to cause safety shut-down 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. A nozzle cutoff valve integral to the fuel unit shall conform to UL 343.

(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

Preignition purging and postpurge of the combustion chamber and flue passages shall be provided as follows (see Table CF-5): 

(a) For boiler units that have a maximum nameplate fuel input rating greater than 3 gph (11.4 L/h) and less than or equal to 7 gph (26.5 L/h), no purge is required.

(b) For boiler units that have a maximum nameplate fuel input rating greater than 7 gph (26.5 L/h) and less than or equal to 20 gph (75.7 L/h), where the oil pump is driven independently of the burner fan motor, a purge shall provide no fewer than either

1. four air changes within 90 sec,
2. four air changes at not less than 60% damper opening with both damper opening and air flow proven

(c) For boiler units that have a maximum nameplate fuel input rating greater than 20 gph (75.7 L/h), a purge shall provide

1. four air changes at not less than 60% damper opening with both damper opening and air flow proven and
2. a minimum postpurge of 15 sec

(d) Boiler units that have a minimum nameplate fuel input rating less than or equal to 35.7 gph (132.6 L/h) 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 combustion at 60% of the rated high-fire input are exempt from proving damper opening.

CF-480 Combustion Air Proving

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 (refer to Table CF-5):

(a) Combustion air proving shall be provided for units having inputs greater than 3 gph (11.4 L/h) and less than or equal to 20 gph (75.7 L/h), if the fan is not integral with the burner motor shaft.

(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) and less than or equal to 20 gph (75.7 L/h).

(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).

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) The response time of the primary safety control to deenergize or deactivate the shutoff device shall not exceed the values shown in Table CF-5.

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

(d) The main burner flame-establishing period shall not exceed the values shown in Table CF-5.

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

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) The pilot type and flame-establishing period shall meet the provisions shown in Table CF-5.
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).

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

CF-530 Action on Flame Failure

Loss of main flame shall result in safety shutdown for all oil-fired boiler units (refer to Table CF-2 and Table CF-5). 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) 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) 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).

CF-540 Automatic Stack Dampers

When an automatic stack damper is used, the following criteria shall apply:

(a) The automatic stack damper shall be labeled and listed for the intended application by a nationally recognized testing agency.

(b) A means shall be provided to open such automatic stack damper to the high fire position before each light-off cycle is initiated, and before the prepurge period begins.

(c) If a postpurge period is required or implemented, a means shall be provided to open the automatic stack damper to the high fire position or maintain the automatic stack damper in the previous firing position.

CF-600 LOW FIRE START, 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 interlocked damper to provide for low fire starts. However, boiler units that are labeled and listed by a nationally recognized testing agency shall be accepted without such interlocking controls.

CF-700 COMBINATION GAS- AND OIL-FIRED UNITS

CF-710 Burner Assemblies

Burner assemblies having gas inputs greater than 400,000 Btu/hr (117 kW) and oil inputs that have a maximum nameplate fuel input rating greater than 3 gph (11.4 L/h) shall comply with the provisions of Part CF. Burner assemblies, as part of a boiler unit or separately, shall be labeled and listed by a nationally recognized testing agency or other certifying organization that is acceptable to the authority having jurisdiction as complying with

(a) UL 795
(b) UL 296 or UL 726

CF-800 ELECTRICALLY HEATED BOILERS

CF-810 General

Electrically heated boilers for steam or hot-water service in sizes greater than 115 kW (approximately 400,000 Btu/hr) shall comply with the following provisions:

(a) Electric resistance-type boilers shall be listed by a nationally recognized testing agency as complying with UL 834.

(b) Electrode-type boilers shall conform to the requirements of NFPA 70. Electrical supply to the boiler electrodes shall be required phase, four-wire where fault currents do not pass through the pressure vessel containing the electrodes, and all exposed non-current-carrying metal parts including the pressure vessel, supply and return piping are grounded.

CF-910 Gas Modular Boilers

The modules of gas modular boilers shall comply with CG-140(a).

Boiler units with field-installed gas burner assemblies and boiler units that do not comply with ANSI Z21.13/CSA 4.9 shall comply with the provisions for purging, safety control timing, action on flame failure, loss of combustion air, combustion air proving, and fuel supervision given in Table CF-1 or Table CF-2, as applicable.

CF-920 Oil Modular Boilers

The modules of oil modular boilers shall comply with CG-140(b).

Boiler units with field-installed oil burner assemblies and boiler units that do not comply with UL 726 shall comply with the provisions for purging, safety control timing, action on flame failure, loss of combustion air, combustion air proving, and fuel supervision given in Table CF-5.

CF-930 Electric Modular Boilers

The modules of electric modular boilers shall comply with CG-140(c).

CF-1000 ATTACHMENT CF-1000 on next page.
ATTACHMENT CF -1000

CF – 1000 Requirements for the Use of Variable Frequency Drives (VFD)

CF-1010 VFD used on Combustion Air Fan

Boiler units that use a Variable Frequency Drive (VFD) to vary the speed of the combustion air fan or blower shall comply with the following provisions:

a) During pre-purge and post purge, the fan or blower shall provide the full purge requirement as specified in Tables CF-2, CF-3 and/or CF-5, and
b) If the VFD is used to modulate the fan or blower speed in response to changing fuel inputs, the VFD shall respond to the combustion control system as part of the fuel-air-ratio control system, and
c) An independent feedback signal shall be used to verify the fan or blower speed.
d) The independent feedback signal and the Fuel-Air-Ratio control system shall be labeled and listed for the VFD application by a nationally recognized agency.
d) Direct Coupled fan or blower arrangements may use motor speed as a measure of the fan/blower speed.
d) Errors between the directed fan or blower speed signal and the independent feedback signal of actual speed or air flow shall result in a safety shutdown.
e) VFD’s shall not be used in applications where the combustion air fan or blower motor is used to operate other fuel burning support equipment such as the oil pump or the atomizing air compressor.

Exceptions:
1) CF-1000 does not apply to modulating controls that are certified as part of boiler units that are labeled and listed by a nationally recognized testing agency or other organization that is acceptable to the authority having jurisdiction.
2) CF-1000 does not apply to ratio-regulator controls.
3) CF-1000 does not apply to VFD applications that do not vary fan or blower speed in relation to firing rate or changes in firing rate
NONMANDATORY APPENDIX A
COMPARISON OF THIS STANDARD AND ANSI Z21.13/CSA 4.9

Where permitted in ASME CSD-1, boilers listed and labeled as in compliance with ANSI Z21.13/CSA 4.9 meet the requirements of this Standard when additional trim equipment is installed.

ANSI Z21.13/CSA 4.9 is a performance-based standard for gas-fired, low-pressure steam, and hot water boilers that requires testing and design certification of boiler burner units by an approved testing laboratory. One of the major differences between the two standards is the automatic ignition, maximum safety control timing table. The ignition timing table as shown in ANSI Z21.13/CSA 4.9 reflects a wide range of ignition controls and timing options, providing the greatest flexibility in design. Most boiler burner units must comply with the performance tests to obtain certification. These performance tests include testing under normal and abnormal operating conditions (e.g., delayed ignition, temperature ranges, voltage variations, etc.). As a result, most boiler burner units listed as in compliance with ANSI Z21.13/CSA 4.9 generally have shorter ignition timings than the maximum times allowed by ANSI Z21.13/CSA 4.9. All boiler burner units listed and labeled under ANSI Z21.13/CSA 4.9 must be accompanied with installation instructions referring the installer to ASME CSD-1 where jurisdictions require that the installation conform to this Standard. The instructional requirements of ANSI Z21.13/CSA 4.9 are a mandatory part of the standard.

ASME CSD-1 is a design-based standard for controls and safety devices for automatically fired boilers, which includes high- and low-pressure boilers that are gas, oil, or electrically fired. The automatic ignition and maximum safety control timings are generally shorter, as no laboratory certification testing of the boiler unit is required. ASME CSD-1 requires the manufacturers of controls and safety devices to provide detailed instructions for testing, maintenance, and service procedures of controls and safety devices installed on boiler units covered by this Standard. ASME CSD-1 requires the operation of control systems and safety devices be tested by the installing contractor prior to release to the owner/user. All controls and safety devices covered by ASME CSD-1 must be accepted and listed for the intended service by a nationally recognized testing agency, such as, but not limited to, CSA, FM, or UL.
Figure B-9 Example for Sizing of Manifolded Lines

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 $B$.

Figure B-10 Typical Gas Fuel Train Safety Shutoff Valve Arrangements for Multiple-Burner Boiler Units Complying With CF-180(b)

GENERAL NOTE: Multiple-burner boiler unit is shown. Total capacity is 5 MBtu/hr or less; individual burner capacity is less than 5 MBtu/hr.