tubesheet thickness, except that when tube thicknesses are equal to or greater than 0.150 in. (4 mm), the bevel or recess may exceed *T*/3**.** Where the hole is beveled or recessed, the projection of the tube beyond the tubesheet shall not exceed a distance equal to the tube wall thickness [see Fig. PFT-12.1, illustrations (f) and (g)].

PFT-12.2.1.3 On types of welded attachment shown in Fig. PFT-12.1, illustrations (c) and (e), the tubes shall be expanded before and after welding. On types shown in illustrations (f) and (g), the tubes may be expanded.

PFT-12.2.2 Expanding of tubes by the Prosser method may be employed in combination with any beaded or seal welded attachment method [see Fig. PFT-12.1, illustration (b)].

PFT-12.2.3 After seal welding as shown by Fig. PFT-12.1, illustrations (c) and (e), a single hydrostatic test of the boiler shall suffice.

PFT-12.2.4 The inner surface of the tube hole in any form of attachment may be grooved or chamfered.

PET-12.2.5 The sharp edges of tube holes shall be taken off on both sides of the plate with a file or other tool.

PFT-12.2.6 Welded tube attachments as shown by Fig. PFT-12.1, illustration (h), may be made with partial or no insertion of the tube into the flat tubesheet. The

following requirements shall be met for these attachments:

(a) The tube and tubesheet materials shall be restricted

to P-No. 1, P-No. 3, or P-No. 4 materials.

(b) The maximum design temperature at the weld joint shall not exceed 700°F (370°C).

(c) The weld shall be a full-penetration weld made from the I.D. of the tube. The throat of the weld shall be equal to or greater than the thickness of the tube. The root pass shall be made using the GTAW process.

(d) PWHT per PW-39 is mandatory. The exemptions to PWHT noted in Table PW-39 shall not apply.

(e) In addition to meeting the performance qualification requirements of Section IX, before making a production weld each welder and welding operator shall demonstrate his or her ability to achieve complete weld penetration and minimum thickness by successfully welding six test pieces. The test pieces shall be welded in a mockup of the production weld. The mockup shall be of identical position, dimensions, and materials as that of the production weld. The test pieces shall be visually examined to verify complete penetration and sectioned to verify minimum weld thickness. The results shall be recorded and maintained with the performance qualification record.

(f) Each weld surface on the tube I.D. shall receive either a magnetic particle or liquid penetrant examination in accordance with A-260 or A-270 of Appendix A, as applicable. In addition, a visual examination of the weld surface on the tube O.D. shall be performed. The maximum practicable number of these welds, but in no case fewer than 50%, shall be visually examined. Visual examination shall show complete penetration of the joint root and freedom from cracks.

COMBUSTION CHAMBERS

PFT-13 COMBUSTION CHAMBER TUBESHEET

PFT-13.1 The maximum allowable working pressure on a tubesheet of a combustion chamber, where the crown sheet is not suspended from the shell of the boiler, shall be determined by the following equation:

(US. Customary Units)

$$P = 27{,}000\,\frac{t(D-d)}{WD}$$

(SI Units)

$$P = 186 \frac{t(D - d)}{WD}$$

where

D = least horizontal distance between tube centers on a horizontal row

d = inside diameter of tubes

P = maximum allowable working pressure

t = thickness of tubesheet

W = distance from the tubesheet to opposite combustion chamber sheet

Where tubes are staggered, the vertical distance between the center lines of tubes in adjacent rows must not be less than

$$1/2 \sqrt{2dD + d^2}$$

Example: Required the maximum allowable working pressure of a tubesheet supporting a crown sheet stayed by crown bars. Horizontal distance between centers, 4 1/8 in.; inside diameter of tubes, 2.782 in.; thickness of tubesheets 11/16 in.; distance from tubesheet to opposite combustion-chamber sheet, 34¼ in.; measured from outside of tubesheet to outside of back plate; material, steel. Substituting and solving the following equation:

$$P = \frac{(4.125 - 2.782) \times 0.6875 \times 27{,}000}{34.25 \times 4.125} = 176 \text{ psi}$$

PFT-13.2 Sling stays may be used in place of girders in all cases covered in PFT-13.1, provided, however, that when such sling stays are used, girders or screw stays of the same sectional area shall be used for securing the bottom of the combustion chamber to the boiler shell.

PFT-13.3 When girders are dispensed with and the top and bottom of combustion chambers are secured by sling stays, the sectional area of such stays shall conform to the requirements of rules for stayed surfaces.

PFT-14 GENERAL

PFT-14.1 Furnaces may be constructed using seamless pipe, electric resistance welded pipe within the limitations of PG-9.5, or fusion welded plate of the double welded butt type. **A** sample of the longitudinal weld, made with the addition of filler metal, of each section of a furnace shall be subjected to a bend test in accordance with PW-53. No radiography of the longitudinal or circumferential welds is required.

PFT-14.2 When the longitudinal joint will be subjected to complete radiographic examination in accordance with PW-51, the individual bend test for each section of the furnace is not required.

PFT-15 PLAIN CIRCULAR FURNACES

PFT-15.1 Plain circular furnaces may be made up to any length, using sections where desired. The thickness may not be less than 5/16 in. (8 mm).

PFT-15.2 The maximum allowable working pressure shall be determined in accordance with PFT-5 1.

DOORS AND OPENINGS

PFT-40 WELDED DOOR OPENINGS

Arc or gas welding may be used in the fabrication of door holes provided the sheets are stayed around the opening in accordance with the requirements of PFT-27.6 and PFT-27.7.

No calculations need be made to determine the availability of compensation for door openings spanning between the plates of waterlegs. The required thickness of circular access openings shall be determined in accordance with PFT-5 1. The required thickness of door openings of other than circular shape shall be calculated using eq. (1) of PG-46, using 2.1 or 2.2 for the value of *C,* depending on the plate thickness, and a value of p equal to the waterleg inside width. Radiography of the joining welds is not required.

PFT-41 OPENINGS IN WRAPPER SHEETS

Openings located in the curved portion of the wrapper sheet of a locomotive type

boiler shall be designed in accordance with the rules in PG-32.

PFT-42 FIRESIDE ACCESS OPENINGS

The minimum size of an access or fire door opening, in which the minimum furnace dimension is 24 in. (600 mm), shall be not less than 12 in, × 16 in. (300 mm × 400 mm) or equivalent area, 11 in. (280 mm) to be the least dimension in any case. A circular opening shall be not less than 15 in. (380 mm) in diameter.

For furnace dimensions less than 24 in. (600 mm), the opening should be 2¾ in. × 3½ in. (70 mm × 89 mm) or larger where possible. In cases where the size or shape of the boiler prohibits an opening of that size, two openings with a minimum size of 1 in. (25 mm) may be used, preferably opposite each other, to permit inspection and cleaning of the furnace. If the burner is removable so as to permit inspection and cleaning through the burner opening, a separate access opening need not be provided.

The bonnet or smoke hood of a vertical flue or tubular boiler shall be provided with an access opening at least 6 in. × 8 in. (150 mm × 200 mm) for the purpose of inspection and cleaning the top head of the boiler.

PFT-43 REQUIREMENTS FOR INSPECTION OPENINGS

All firetube boilers shall have sufficient inspection openings, handholes, or washout plugs with a minimum of four openings to permit inspection of the waterside of the tubesheets, furnaces, and tubes and to permit flushing of loose scale and sediment from the boiler. Except where space restrictions would prohibit entry to the boiler, a manhole shall be provided in the upper portion of the shell. All openings shall meet the requirements of PG-32 through PG-44. Where washout plugs are used, the minimum size shall be NPS 1½ (DN 40), except for boilers 16 in. (400 mm) or less in inside diameter, the minimum size shall be NPS 1 (DN 25).

PBT-44 OPENING BETWEEN BOILER AND SAFETY VALVE

The opening or connection between the boiler and the safety valve shall have at least the area of the valve inlet.

After the boiler Manufacturer provides for the opening required by the Code, a bushing may be inserted in the opening in the shell to suit a safety valve that will have the capacity to relieve all the steam that can be generated in the boiler and which will meet the Code requirements. The minimum size of the connection and opening for the safety valve shall be not less than NPS ½ (DN 15).

No valve of any description shall be placed between the required safety valve or safety relief valve or valves and the boiler, or on the discharge pipe between the safety valve or safety relief valve and the atmosphere. When a discharge pipe is used, the cross-sectional area shall be not less than the full area of the valve outlet or of the total of the areas of the valve outlets discharging thereinto and shall be as short and straight as possible and so arranged as to avoid undue stresses on the valve or valves.

DOMES

PFT-45 REQUIREMENTS FOR DOMES

PFT-45.1 The longitudinal joint of a dome may be butt welded or the dome may be made without a seam of one piece of steel pressed into shape. The dome flange may be double full fillet lap-welded to the shell if all welding complies fully with the requirements for welding in Part PW. Radiographic examination of the fillet welds may be omitted. The opening shall be reinforced in accordance with PG-32 through PG-44.

PFT-45.3 When a dome is located on the barrel of a locomotive-type boiler or on the

shell of a horizontal-return tubular boiler, the outside diameter of the dome shall not exceed six-tenths the inside diameter of the shell or barrel of the boiler unless the portion of the barrel or shell under the dome (the neutral sheet) is stayed to the head or shell of the dome by stays which conform in spacing and size to the requirements given in PG-46. With such stayed construction the outside diameter of a dome located on the barrel or shell of a boiler is limited to eight-tenths of the barrel or shell inside diameter.

PFT-45.4 All domes shall be so arranged that any water can drain back into the boiler.

PFT-45.5 Flanges of domes shall be formed with a comer radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. (25 mm) in thickness or less, and at least three times the thickness of the plate for plates over 1 in. (25 mm) in thickness.

PFT-45.6 In a locomotive-type boiler with a dome on a tapered course, the maximum allowable diameter of the dome shall be based on that diameter of the tapered course which intersects the axis or center line of the dome.

PART PEB
REQUIREMENTS FOR ELECTRIC BOILERS

GENERAL

PEB-1 GENERAL

The rules in Part PEB are applicable to electric boilers and parts thereof and shall be used in conjunction with the general requirements in Part PG as well as with the special requirements in the applicable Parts of this Section that apply to the method of fabrication used.

PEB-2 SCOPE

PEB-2.1 This Part contains special rules for construction of electric boilers, both of the electrode and immersion resistance element type. This Part does not include electric boilers where the heat is applied externally to the boiler pressure vessel by electric resistance heating elements, induction coils, or other electrical means. These types of electric boilers shall be constructed in accordance with other applicable Parts of this Section.

PEB-2.2 Electric boilers and parts thereof that do not exceed the diameter, volume, or pressure limits of PMB-2 may be constructed using the applicable paragraphs of Part PMB in conjunction with this Part.

PEB-2.3 An electrode type boiler is defined as an electric boiler in which heat is generated by the passage of an electric current using water as the conductor.

PEB-2.4 An immersion resistance element type boiler is defined as an electric boiler in which heat is generated by the passage of an electric current through a resistance heating element immersed in water.

PEB-3 OPTIONAL REQUIREMENTS FOR THE BOILER PRESSURE VESSEL

The boiler pressure vessel may be constructed in compliance with the ASME Pressure Vessel Code Section VIII, Division 1, rules for unfired steam boilers [UW-2 (c)] subject to the conditions specified in PEB-3.1 through PEB-3.4.

PEB-3.1 The Manufacturer who certifies and stamps the completed boiler shall specify to the "U" stamp holder all additional requirements of Part PEB, which are not requirements of Section VIII, Division 1, and shall ensure that these requirements are satisfied.

PEB-3.2 These additional requirements are

PEB-3.2.1 The materials of construction shall comply with the requirements of PEB-5.1 and PEB-5.3.

PEB-3.2.2 Inspection openings shall comply with the requirements of PEB-10.

PEB-3.3 The boiler pressure vessel shall be stamped with the ASME Code "U" symbol and the letters "UB," and be documented with the ASME U-1 or U-1A Data Report.

PEB-3.4 The master Data Report P-2A for the Electric Boiler shall indicate "Boiler pressure vessel constructed to Section VIII, Division 1 as permitted by Part PEB."

MATERIALS

PEB -5 GENERAL

PEB-5.1 Unless specifically permitted elsewhere in this section, materials used in the construction of pressure parts for electric boilers shall conform to one of the specifications in Section II and shall be limited to those permitted by PG-6, PG-7, PG-8, and PG-9 for which allowable stress values are given in Tables 1A and 1B of Section II, Part D. Miscellaneous pressure parts shall conform to the requirements of PG- 11.

PEB-5.2 Seamless or welded shells, plates, or heads of electric boilers shall not be less than 3/16 in. (5 mm) in thickness.

PEB-5.3 Electric boilers of the immersion element type may be fabricated of austenitic stainless steel type 304, 304L, 316, 316L, and 347 of any material specification listed in PG-6 and PG-9, provided that a precautionary statement indicating that the boiler shall be operated using only deionized water, having a maximum conductance of 1 microSiemen per cm (1 μS/cm) [minimum specific resistivity of 1 megohm per cm (1 MΩ/cm)], is clearly marked on the boiler in a visible location.

DESIGN

PEB-8 GENERAL

PEB-8.1 The rules in the following paragraphs apply specifically to the design of electric boilers and parts thereof. They shall be used in conjunction with the general requirements for design in Part PG, any applicable requirements in Part PMB for miniature boilers, and with the specific requirements for design in applicable Parts of this Section that apply to the method of fabrication used.

PEB-8.2 Responsibility of design of electric boilers to be marked with the "E" symbol shall be that of the holder of the "E" stamp.

PEB-9 WELDING

Electric boilers may be constructed by fusion welding in accordance with all the requirements of this Section except that postweld heat treatment, radiography of the welded joints, and the nondestructive examinations described in PG-93.1 are not required when the limitations in PMB-2.1 are not exceeded.

PEB-10 INSPECTION OPENINGS

PEB-l0.l Electric boilers of a design employing a removable cover, or removable internal electric heating elements that will permit access for inspection, and cleaning and having an internal volume (exclusive of casing and insulation) of not more than 5 ft^3 (0.14 m^3) need not be fitted with washout or inspection openings.

PEB-10.2 Electric boilers of more than 5 ft^3 (0.14 m^3) not provided with a manhole, shall have an inspection opening or handhole located in the lower portion of the shell or head. The inspection opening shall not be smaller than NPS 3 (DN go). In addition, electric boilers of the resistance heating element type designed for steam service shall have an inspection opening or handhole at or near the normal waterline.

PEB-11 FEEDWATER SUPPLY

PEB-11.1 The feedwater source to electric boilers shall be capable of meeting the applicable requirements of PG-61.

Feedwater connections to an electric boiler shall not be smaller than NPS ½ (DN 15), except as permitted by PMB-11.

PEB-11.2 Electric boilers that do not exceed the diameter, volume, or pressure limits of PMB-2, may have the feedwater delivered through the blowoff opening if desired.

PEB-12 BLOWOFF

PEB-12.1 The blowoff piping for each electric boiler pressure vessel having a normal water content not exceeding 100 gal (380 L) is required to extend through only one valve.

PEB-12.2 The minimum size of blowoff pipes and fittings shall be NPS 1 (DN 25), except that for boilers of 200 kW input or less the minimum size of pipe and fittings may be NPS ¾ (DN 20). Electric boilers that do not exceed the diameter, volume, or pressure limits of PMB-2 may have blowoff connections in accordance with PMB-12.

PEB-13 WATER LEVEL INDICATORS

PEB-13.1 Electric boilers of the electrode type shall have at least one gage glass. The gage glass shall be located as to indicate the water levels both at startup and under maximum steam load conditions as established by the Manufacturer.

PEB-13.2 Electric boilers of the resistance element type shall have at least one gage glass. The lowest visible water level in the gage glass shall be at least 1 in. (25 mm) above the lowest permissible water level as determined by the Manufacturer. Each electric boiler of this type shall also be equipped with an automatic low-water cutoff on each boiler pressure vessel so located as to automatically cut off the power supply to the heating elements before the surface of the water falls below the visible level in the gage glass.

PEB-13.3 Tubular gage glasses on electric boilers shall be equipped with protective rods or shields.

PEB-14 PRESSURE GAGES

Pressure gages shall meet the requirements of PG-60.6.

PEB-15 SAFETY VALVES

PEB-15.1 Each electric boiler shall have at least one safety valve or safety relief valve. Electric boilers with a power input more than 1,100 kW shall have two or more safety valves or safety relief valves.

PEB-15.2 The minimum safety valve or safety relief valve relieving capacity for electric boilers shall be 3½ lb/hr/kW (1.6 kg/hr/kW) input. The pressure setting shall be not higher than the MAWP stamped on the completed boiler (see PEB-18.3.2).

PEB-15.3 Safety and safety relief valves shall be mounted in accordance with PG-71.2 with the spindle vertical. Electric boilers that do not exceed the diameter, volume, or pressure limits of PMB-2, may have a spring-loaded safety or safety relief valve(s) installed in other than the vertical position, provided that

(a) the valve design is satisfactory for such position

(b) the valve is not larger than NPS ¾ (DN 20)

(c) the maximum angle of deviation from vertical does not exceed 30 deg

(d) the nozzle location is such that no material that could interfere with the operation of the valve can accumulate at the valve inlet

(e) the discharge opening of the valve body and discharge piping is oriented so that drainage is adequate

PEB-16 AUTOMATIC DEVICES

Electric boilers shall be provided with pressure and/or temperature controls and an automatic low-water fuel cutoff. No low-

water cutoff is required for electrode type boilers.

PEB-17 HYDROSTATIC TEST

PEB-17.1 Each electric boiler pressure vessel shall be hydrostatically tested at completion of fabrication in accordance with PG-99 or PMB-21, as applicable.

PEB-17.2 In addition to the above, after assembly of the boiler pressure vessel and the mechanically assembled boiler external piping and trim, the completed electric boiler shall be given a final hydrostatic test at a pressure not less than the safety valve setting.

PEB-17.3 When the electric boiler is to be marked with the "E" symbol, the symbol shall be applied after completion of the hydrostatic test of PEB-17.2.

PEB-18 INSPECTION AND STAMPING OF BOILERS

PEB-18.1 Inspection of electric boilers shall be as required by PG-90.1 and PG-90.3. Witness by the Authorized Inspector of the hydrotest required in PEB-17.2 for the completed boiler may be omitted for electric boilers that meet all the following limitations:

(a) 800 kW maximum per vessel

(b) 600 V maximum

(c) mechanically assembled boiler external piping (BEP) only

When the Authorized Inspector does not perform a final inspection of the completed boiler, the Manufacturer or Assembler shall make an equivalent examination. The equivalent examination shall be in accordance with a quality control procedure meeting the requirements of PEB-18.2 and PEB-18.5.

PEB-18.1.1 Electric boilers exceeding the size limitations specified in PEB-18.1, and having only mechanically assembled external piping (BEP) and trim, shall have a final inspection by the Authorized Inspector, who shall also witness the hydrostatic test called for in PEB-17.2.

PEB-18.1.2 For electric boilers having welded or brazed boiler external piping (BEP) or trim, the inspection requirements of PG-90.1 and the hydrostatic test requirements of PG-99 apply.

PEB-18.2 Each electric boiler Manufacturer shall comply with the applicable requirements of PG-104 and PG-105.

PEB-18.2.1 An electric boiler Manufacturer or Assembler applying for or renewing the "E" stamp shall have its facilities and organizations subject to a joint review by its Authorized Inspection Agency and the legal jurisdiction involved (see last paragraph of PG-105.4).

PEB-18.2.2 A Manufacturer or Assembler assembling units where the final shop inspection by the Authorized Inspector is not mandatory (see PEB-18.1), shall be subject to periodic review by its Authorized Inspection Agency. The review shall be conducted on a quarterly basis or more frequently if deemed necessary by the Authorized Inspection Agency. The frequency of this review may be reduced subject to written agreement between the Manufacturer or Assembler and its inspection agency and the written approval of the appropriate legal jurisdiction. However, in no case shall the review be less than once every 6 months.

PEB-18.3 The stamping of electric boilers shall conform to the requirements of PG-106. Completed electric boilers shall be marked with the "S" or "M" symbol by the Manufacturer of the boiler pressure vessel except when the boiler pressure vessel is constructed under the provisions of PEB-3 (see PEB-18.4). When the trim, fixtures and fittings (such as valves), threaded boiler external piping, and appurtenances are connected to an electric boiler by a Manufacturer or Assembler not authorized

to apply the "S" or "M" stamp, the boiler assembler shall apply an "E" stamp to the completed assembly. "E" stamp holders are limited to the use of assembly methods that do not require welding or brazing.

PEB-18.3.1 The stamping of the boiler pressure vessel shall be located as called for in PG-111.8 and need not indicate the kW input or the maximum designed steaming capacity.

PEB-18.3.2 The stamping of the complete electric boiler shall be on a separate metallic plate and shall be in accordance with PG-106.4. The MAWP shall be that established by the completed boiler assembler holding the "S," "M," or "E" stamp, but in no case higher than the MAWP stamped on the boiler shell. The MAWP shall be listed on Part II of Form P-2A, Manufacturers' Data Report for All Types of Electric Boilers. This plate shall be located on the assembly so that it is readily visible from the operating floor.

PEB-18.3.3 The stamping required by PEB-18.3.2 need not be done in the presence of the Authorized Inspector for electric boilers that do not receive final inspection by the Authorized Inspector (see PEB-18.1).

PEB-18.4 For boiler pressure vessels constructed under the provisions of PEB-3, the inspection and stamping requirements of Section VIII, Division 1, UG-116 (c) for special service pressure vessels (UB), shall be followed.

PEB-18.5 Those Manufacturers and Assemblers providing an equivalent examination of completed electric boilers when final inspection is not witnessed by the Authorized Inspector (see PEB- 18.1), shall provide oversight by a Certified Individual (CI).

PEB-18.5.1 A Certified Individual (CI) shall be an employee of the Manufacturer or Assembler and shall be qualified and certified by the Manufacturer or Assembler. Qualifications shall include as a minimum

(a) knowledge of the requirements of this Section for the application of Code symbols

(b) knowledge of the Manufacturer's quality program

(c) training commensurate with the scope, complexity, or special nature of the activities to which oversight is to be provided

The Manufacturer or Assembler shall maintain a record containing objective evidence of the Certified Individual's qualifications, training, and certification.

PEB-18.5.2 The duties of a Certified Individual (CI) shall be to assure that each use of the Code symbol as permitted in PEB-18.3.3 is in accordance with the requirements of this Section and is documented on the Certificate of Conformance on Form P-2A, Manufacturers' Data Report for All Types of Electric Boilers. The CI shall also

(a) verify that each electric boiler, to which a Code symbol is applied, meets all applicable requirements of this Section

(b) sign the Certificate of Conformance, Form P-2A, prior to release of control of the boiler

PEB-19 MANUFACTURER'S DATA REPORT FOR ELECTRIC BOILERS

PEB-19.1 This form consists of two parts. Part I is to be completed by the Manufacturer of the boiler pressure vessel who is the holder of the "S" or "M" stamp and his inspection agency. Part II is to be completed by the Manufacturer or Assembler responsible for the completed electric boiler who shall be authorized to use any of the "S," "M," or "E" stamps.

PEB-19.2 When the boiler pressure vessel is constructed by a "U" stamp holder and certified on a U-1 or U-1A Data Report, Part 1 shall be completed by the "S," "M," or " E stamp holder to the extent indicated in Guide A-351.1.

FORM P-4A MANUFACTURER'S DATA REPORT FOR FABRICATED PIPING
As Required by the Provisions of the ASME Code Rules, Section I

1. Manufactured by _____ (1) _____ Order No. _____ (1) _____ P-4A ID No. _____ (23) _____
(Name and address of manufacturer)

2. Manufactured for _____ (2) _____ Order No. _____ (2) _____
(Name and address of purchaser)

3. Location of installation _____ (3) _____ Boiler Registration No. _____ (3a) _____

4. Identification _____ (4) _____ Piping Registration No. _____ (4a) _____
(Main steam, boiler feed, blow-off, or other service piping — state which)

5. Design Conditions of Piping _____ (5) _____ _____ (5) _____ . Specified by _____ (6) _____
(Pressure) (Temperature) (Name of Co.)

Code Design by _____ (7) _____

6. The chemical and physical properties of all piping meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The construction and workmanship conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE _____ .
(Year)

Addenda to _____ , and Code Cases _____ (8) _____ .
(Date) (Numbers)

7. Description of Piping (include material identifications by ASME specification or other recognized Code designation) (9)

8. Shop Hydrostatic Test _____ (10) _____ .

9. Remarks _____

CERTIFICATE OF SHOP COMPLIANCE

We certify the statement in this data report to be correct and that all details of design, material, construction, and workmanship of the described piping conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. _____ (12) _____ to use the (S) or (PP) Symbol _____ (12) _____ Expires _____ (12) _____ .

Date _____ (11) _____ Signed _____ (11) _____ by _____ (11) _____
(Manufacturer or Fabricator) (Authorized Representative)

(13) CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of _____ (14) _____ and employed by _____ have inspected the piping described in this Manufacturer's Data Report and state that, to the best of my knowledge and belief, the manufacturer has constructed this piping in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____

_____ Commissions _____ (15) _____
(Authorized Inspector) [Nat'l Board (incl. endorsements), State, Province, and No.]

FORM P-4A

P-4A ID No. (23)

10. Description of Field Fabrication (16)

11. Field Hydrostatic Test (17) .

(18) **CERTIFICATE OF FIELD FABRICATION COMPLIANCE**

We certify the statement in this data report to be correct and that all details of design, material, construction, and workmanship of the described piping conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. (19) to use the (S) or (PP) Symbol expires (19) .

Date (18) Signed (18) (Authorized Representative) Name (18) (Fabricator)

(18) **CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE**

We certify that the field assembly of the described piping conforms with the requirements of Section I of the ASME BOILER AND PRESSURE VESSEL CODE. Our Certificate of Authorization No. (19) to use the (A), (S), or (PP) Symbol expires (19) .

Date (18) Signed (18) (Authorized Representative) Name (18) (Assembler)

(20) **CERTIFICATE OF FIELD ASSEMBLY INSPECTION**

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of (14) and employed by

have compared the statements in this Manufacturer's Data Report with the described piping and state that the parts referred to as Data Items (21) , not included in the Certificate of Shop Inspection, have been inspected by me and that, to the best of my knowledge and belief, the manufacturer and/or assembler has constructed and assembled this piping in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described piping was inspected and subjected to a hydrostatic test of (22) .

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date

(Authorized Inspector) Commissions (15) [Nat'l Board (incl. endorsements), State, Province, and No.]

A-354.1 GUIDE FOR COMPLETING MANUFACTURER'S DATA REPORT, FORM P-4A (See PG-112.2.5)

Any quantity to which units apply shall be entered on the Manufacturer's Data Report with the chosen unit.

(1) Name and address of manufacturer or fabricator of Code piping including order identifying number.

(2) Name and address of purchaser and/or owner and his identifying order number.

(3) Name and address of location where piping is to be installed, if known.

(3a) Include the registration number of the boiler where the piping is to be installed, if known (e.g., National Board No., Canadian Design Registration No., or other jurisdictionally required registration numbers).

(4) Identify each section of boiler external piping (e.g., main steam, blow-off, boiler feed), including the section's identification number, if assigned.

(4a) Include the piping registration number, if assigned (e.g., National Board No., Canadian Design Registration No., or other jurisdictionally required registration numbers).

(5) Show the maximum design pressure and temperature of the section of pipe (see ASME B31.1).

(6) Name of the organization that established the design pressure and temperature.

(7) The organization that made the calculations and selected the pipe schedules for the working conditions.

(8) Refer to the requirements of ASME B31.1.

(9) Describe each section of piping, size, thickness, schedule, etc. Show the complete ASME Material Specification No. and Grade as listed in the appropriate stress allowance table in the Appendix of Section I (e.g., "SA-106"). Exception: A specification number for a material not identical to an ASME Specification may be shown *only* if such material meets the criteria in the Foreword of this Section. When material is accepted through a Code Case, the applicable Case number shall be shown. Identify the organization that will receive this piping and the identification number of the boiler.

(10) Piping fabricated in a shop show test pressure if hydro-applied in the shop (see PG-99) and witnessed by Authorized Inspector.

(11) The name of the piping manufacturer or fabricator, signature of authorized representative and date signed.

(12) Show ASME Authorization number, kind of symbol, and date of expiration.

(13) This certificate to be completed by the Authorized Inspection Agency representative who performs the in-shop inspection.

(14) To determine what goes in this space, you should be guided by the following:

National Board Stamped Fabricated Piping (see Form P-4A Line 4)
After "and/or State or Province" in the certification blocks —

If the Inspector has a valid commission for the state or province where the Manufacturer's shop is located, insert the name of that state or province. If the Manufacturer is located in a non-Code state or province, insert the name of the state or province where the Inspector took his original examination to obtain his National Board Commission, provided he still has a valid commission for that state or province. Otherwise, if no valid commission, show the name of the state or province where he has a valid commission authorizing him to make the shop inspection.

Fabricated Piping Not Stamped National Board
Follow the above procedure. However, in this case do not list any National Board Commission number after the Inspector's signature at the bottom of the block.

(15) The Inspector's National Board commission number must be shown when the fabricated piping is stamped National Board; otherwise, show only his/her state or province commission number (See (14) above).

(16) Describe sections of piping to be joined, design of welded joint, procedure to be followed, number passes, preheat, postheat, etc. (see ASME B31.1).

(17) Show test pressure used during field hydrostatic test (see PG-99) and witnessed by the Authorized Inspector.

(18) Signed by an authorized representative of the organization responsible for the field fabrication or field assembly (assembler, manufacturer, fabricator), or both, and the date signed.

(19) Show ASME authorization number, kind of symbol, and date of expiration.

(20) This certificate to be completed by the Authorized Inspection Agency representative who performs the field assembly inspection.

(21) Only list those piping sections and welds inspected in the field.

(22) Show field hydrostatic test pressure (see PG-99).

(23) The Certificate Holder shall assign a unique identifying number for this Form. To be shown on all pages of Form P-4A.

(24) Show page number and total number of pages of Form P-4A.

FORM P-4B MANUFACTURER'S DATA REPORT FOR FIELD INSTALLED MECHANICALLY ASSEMBLED PIPING
As Required by the Provisions of the ASME Code Rules, Section I

1. Manufactured by _____ (1) _____ Order No. _____ (1) _____ P-4B ID No. _____ (18) _____
(Name and address of manufacturer)

2. Manufactured for _____ (2) _____ Order No. _____ (2) _____
(Name and address of purchaser)

3. Location of Installation _____ (3) _____ Boiler Registration No. _____ (3a) _____

4. Identification _____ (4) _____ Piping Registration No. _____ (4a) _____
(Main steam, boiler feed, blow-off, or other service piping — state which)

5. Design Conditions of Piping _____ (5) _____ (5) _____ . Specified by _____ (6) _____
(Pressure) (Temperature) (Name of Co.)

Code Design by _____ (7) _____

6. The chemical and physical properties of all piping meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The construction and workmanship conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE _____ (Year) , Addenda to _____ (Date) , and Code Cases _____ (8) _____ (Numbers)

7. Description of Piping (include material identifications by ASME specification or other recognized Code designation)

_____ (9) _____

_____

_____

_____

8. Field Hydrostatic Test _____ (10) _____ .

9. Remarks _____

(11) CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the field assembly of the described piping conforms with the requirements of Section I of the ASME BOILER AND PRESSURE VESSEL CODE. Our Certificate of Authorization No. _____ (12) _____ to use the (A), (S), or (PP) Symbol expires _____ (12) _____ .

Date _____ (12) _____ Signed _____ (Authorized Representative) Name _____ (Assembler)

(13) CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of _____ (14) _____ and employed by _____ have compared the statements in this Manufacturer's Data Report with the described piping and state that the parts referred to as Data Items _____ (15) _____ have been inspected by me and that, to the best of my knowledge and belief, the manufacturer and/or assembler has assembled this piping in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described piping was inspected and subjected to a test of _____ (16) _____ .

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the piping described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date _____

_____ (Authorized Inspector) Commissions _____ (17) _____ [Nat'l Board (incl. endorsements), State, Province, and No.]

A-354.2 GUIDE FOR COMPLETING MANUFACTURER'S DATA REPORT, FORM P-4B (See PG-112.2.5)

Any quantity to which units apply shall be entered on the Manufacturer's Data Report with the chosen units.

(1) Name and address of manufacturer or fabricator of Code piping including order identifying number.

(2) Name and address of purchaser and/or owner and his identifying order number.

(3) Name and address of location where piping is to be installed, if known.

(3a) Include the registration number of the boiler where the piping is to be installed, if known (e.g., National Board No., Canadian Design Registration No., or other jurisdictionally required registration numbers).

(4) Identify each section of piping (e.g., main steam, blow-off, boiler feed), including the section's identification number, if assigned.

(4a) Include the piping registration number, if assigned (e.g., National Board No., Canadian Design Registration No., or other jurisdictionally required registration numbers).

(5) Show the maximum design pressure and temperature of the section of pipe (see ASME B31.1).

(6) Name of the organization that established the design pressure and temperature.

(7) The organization that made the calculations and selected the pipe schedules for the working conditions.

(8) Refer to the requirements of ASME B31.1.

(9) Describe each section of piping, size, thickness, schedule, etc. Show the complete ASME Material Specification No. and Grade as listed in the appropriate stress allowance table in the Appendix of Section I (e.g., "SA-106"). Exception: A specification number for a material not identical to an ASME Specification may be shown *only* if such material meets the criteria in the Foreword of this Section. When material is accepted through a Code Case, the applicable Case number shall be shown.

(10) Piping fabricated in field show test pressure of hydro-applied in the field (see PG-99) and witnessed by Authorized Inspector.

(11) Signed by an authorized representative of the organization responsible for the field assembly and hydrostatic test.

(12) Show ASME authorization number, kind of symbol, and date of expiration.

(13) This certificate to be completed by the Authorized Inspection Agency representative who performs the field assembly inspection.

(14) To determine what goes in this space, you should be guided by the following:

National Board Stamped Fabricated Piping (see Form P-4B Line 4)
After "and/or State or Province" in the certification blocks —

If the Inspector has a valid commission for the state or province where the Manufacturer's shop is located, insert the name of that state or province. If the Manufacturer is located in a non-Code state or province, insert the name of the state or province where the Inspector took his original examination to obtain his National Board Commission, provided he still has a valid commission for that state or province. Otherwise, if no valid commission, show the name of the state or province where he has a valid commission authorizing him to make the shop inspection.

Fabricated Piping Not Stamped National Board
Follow the above procedure. However, in this case do not list any National Board Commission number after the Inspector's signature at the bottom of the block.

(15) Only list those piping sections inspected in the field.

(16) Show test pressure used during field hydrostatic test (see PG-99) and witnessed by the Authorized Inspector.

(17) The Inspector's National Board commission number must be shown when the fabricated piping is stamped National Board; otherwise, show only his state or province commission number.

(18) The Certificate Holder shall assign a unique identifying number for this Form. To be shown on all pages of Form P-4B.

EXCERPTS FROM: ASME BOILER AND PRESSURE VESSEL CODE
SECTION IV - HEATING BOILERS
2007 EDITION

INTRODUCTION

The rules of this Section of the Code cover minimum construction requirements for the design, fabrication, installation, and inspection of steam heating, hot water heating, hot water supply boilers that are directly fired with oil, gas, electricity, coal, or other solid or liquid fuels, and for operation at or below the pressure and temperature limits set forth in this document. Similar rules for potable water heaters are also included.

For Section IV application, the boiler proper or other vessels terminate at the supply and return connections to the system or the supply and feedwater connections of a hot water supply boiler. These connections may be any of the following:

(a) the first circumferential joint for welding end connections

(b) the face of the first flange in bolted flanged connections

(c) the first threaded joint in that type of connection

Included within the scope of the boiler are pressure-retaining covers for inspection openings, such as manhole covers, handhold covers, and plugs; and headers required to connect individual coils, tubes, or cast sections within a boiler.

The rules are divided into four major Parts: Part HG, applying to all materials of construction except as provided for in Part HLW; Part HF, applying to assemblies fabricated of wrought material, except as provided for in Part HLW; Part HC, applying to cast iron assemblies; Part HA, applying to boilers constructed of cast aluminum; and Part HLW, applying to potable water heaters. Part HF is further subdivided into Subpart HW, containing rules for welded construction, and Subpart HB, containing rules for brazed construction.

The Parts and Subparts of this Section are divided into Articles. Each Article is given a number and a title, as for example, Part HG, Article 3, Design. Articles are divided into paragraphs that are given a three-digit number, the first of which corresponds to the Article number. Thus, under Article 3 of Part HG, paragraph HG-307 will be found. Paragraphs are further subdivided into subparagraphs. Major subdivisions of paragraphs are designated by three- or four-digit numbers followed by a decimal point and a digit or digits. Where necessary, further subdivisions are represented by letters and then by numbers in parentheses. Minor subdivisions of the paragraphs are also represented by letters. A reference to one of these paragraphs in the text of the Section includes all of the applicable rules in that paragraph. Thus, reference to HG-307 includes all the rules in HG-307.1 through HG-307.4.

This Section does not contain rules to cover all possible details of design and construction. Where complete details are not given, it is intended that the manufacturer, subject to the acceptance of the Authorized Inspector, shall provide details of design and construction that will be as safe as otherwise required by these rules.

When the strength of any part cannot be computed with a satisfactory assurance of safety, these rules provide procedures for establishing its maximum allowable working pressure.

ARTICLE 1

SCOPE AND SERVICE RESTRICTIONS

HG-100 SCOPE

(a) The rules of Part HG apply to steam heating boilers, hot water heating boilers, hot water supply boilers, and to appurtenances thereto. They shall be used in conjunction with the specific requirements in Part HF, Boilers of Wrought Materials, and Part HC, Cast Iron Boilers, whichever is applicable. The foreword provides the basis for these rules. Part HG is not intended to apply to potable water heaters except as provided for in Part HLW.

(b) This Part contains mandatory requirements, specific prohibitions, and nonmandatory guidance for materials, designs, fabrication, examination, inspection, testing, certification, and pressure relief.

(c) Laws or regulations issued by a municipality, state, provincial, federal, or other enforcement or regulatory body having jurisdiction at the location of an installation, establish the mandatory applicability of these rules, in whole or in part.

HG-101 SERVICE RESTRICTIONS

HG-101.1 Service Restrictions. The rules of this Section are restricted to the following services:

(a) steam boilers for operation at pressures not exceeding 15 psi (100 kPa)

(b) hot water heating boilers and hot water supply boilers for operating at pressures not exceeding 160 psi (1 100 kPa) and/or temperatures not exceeding 250°F (120°C), at or near the boiler outlet, except that when some of the wrought materials permitted by Part HF are used, a lower temperature is specified

HG-101.2 Services in Excess of Those Covered by This Section. For services exceeding the limits specified in HG-101.l, the rules of Section I shall apply.

HG-102 UNITS

Either U.S. Customary, SI, or any local customary units may be used to demonstrate compliance with all requirements of this edition (e.g., materials, design, fabrication, examination, inspection, testing, certification, and overpressure protection).

In general, it is expected that a single system of units shall be used for all aspects of design except where unfeasible or impractical. When components are manufactured at different locations where local customary units are different than those used for the general design, the local units may be used for the design and documentation of that component. Similarly, for proprietary components or those uniquely associated with a system of units different than that used for the general design, the alternate units may be used for the design and documentation of that component.

For any single equation, all variables shall be expressed in a single system of units. When separate equations are provided for U.S. Customary and SI units, those equations must be executed using variables in the units associated with the specific equation. Data expressed in other units shall be converted to U.S. Customary or SI units for use in these equations. The result obtained from execution of these equations may be converted to other units.

Production, measurement and test equipment, drawings, welding procedure specifications, welding procedure and performance qualifications, and other fabrication documents may be in U.S. Customary, SI, or local customary units in accordance with the fabricator's practice. When values shown in calculations and analysis, fabrication documents, or measurement and test equipment are in different units, any conversions necessary for verification of Code compliance and to

ensure that dimensional consistency is maintained shall be in accordance with the following:

(a) Conversion factors shall be accurate to at least four significant figures.

(b) The results of conversions of units shall be expressed to a minimum of three significant figures.

Conversion of units, using the precision specified above shall be performed to assure that dimensional consistency is maintained. Conversion factors between U.S. Customary and SI units may be found in the Nonmandatory Appendix M, Guidance for the Use of U.S. Customary and SI Units in the ASME Boiler and Pressure Vessel Code. Whenever local customary units are used the Manufacturer shall provide the source of the conversion factors, which shall be subject to verification and acceptance by the Authorized Inspector.

Material that has been manufactured and certified to either the U.S. Customary or SI material specification (e.g., SA-516M) may be used regardless of the unit system used in design. Standard fittings (e.g., flanges, elbows, etc.) that have been certified to either U.S. Customary units or SI units may be used regardless of the unit system used in design.

All entries on a Manufacturer's Data Report and data for Code required nameplate marking shall be in units consistent with the fabrication drawings for the component using U.S. Customary, SI, or local customary units. It is acceptable to show alternate units parenthetically. Users of this Code are cautioned that the receiving Jurisdiction should be contacted to ensure the units are acceptable.

ARTICLE 2
MATERIAL REQUIREMENTS

HG-200 GENERAL MATERIAL REQUIREMENTS

HG-200.1 Materials Subject to Pressure Stress. Material subject to stress due to pressure shall conform to one of the specifications given in Section II and shall be limited to those that are permitted in HF-200 for boilers of wrought materials and HC-200 for cast iron boilers.

HG-200.2 Internal Parts Subject to Deterioration. Materials shall not be used for internal parts that are liable to fail due to deterioration when subjected to saturated steam temperatures at or below the maximum allowable working pressure.

HG-200.3 Materials Not Found in Section II. Material not covered by specifications in Section II shall not be used unless authorization to use the material is granted by the Boiler and Pressure Vessel Committee on the basis of data submitted to the Committee in accordance with Appendix A.

HG-200.4 Materials Use Not Limited by Specification Title. The title or scope paragraph of a material specification in Section II with respect to product form or service shall not limit the use of a material, provided the material is suitable for the application and its use is permitted by the rules of this Section.

HG-200.5 Materials Use Not Limited by Method of Production. Materials covered by specifications in Section II are not restricted as to the method of production unless so stated in the Specification, and as long as the product complies with the requirements of the Specification.

HG-200.6 Materials With Thicknesses Exceeding Specification Limits. Materials having thicknesses outside of the limits given in the title or scope clause of a specification in Section II may be used in construction, provided they comply with the other requirements of the Specification and with all thickness requirements of this Code.

HG-200.7 Nonpressure Part Materials. Material for nonpressure parts, such as

skirts, supports, baffles, lugs, clips, and extended heat-transfer surfaces, need not conform to the specifications for the material to which they are attached or to a material specification permitted in HF-200 or HC-200; but, if welded, they shall be of weldable quality. The allowable stress value shall not exceed 80% of the maximum allowable stress permitted for similar material in Tables HF-300.1 and HF-300.2. Satisfactory performance of a specimen in such service shall not make the material acceptable for use in pressure parts of a vessel.

HG-201 SPECIFIC MATERIAL REQUIREMENTS

Specific material requirements for assemblies constructed of wrought materials are given in Part HF, Article 2 and for assemblies constructed of cast iron in Part HC,

Article 2.

ARTICLE 4
PRESSURE RELIEVING DEVICES

HG-400 PRESSURE RELIEVING VALVE REQUIREMENTS

TABLE HG-400.1
MINIMUM POUNDS OF STEAM PER HOUR (kg/hr)
PER SQUARE FOOT (METER) OF HEATING SURFACE

Boiler Heating Surface	Firetube Boilers	Watertube Boilers
Hand fired	5 (24)	6 (29)
Stoker fired	7 (34)	8 (39)
Oil, gas, or pulverized fuel fired	8 (39)	10 (49)
Waterwall heating surface:		
Hand fired	8 (39)	8 (39)
Stoker fired	10 (49)	12 (59)
Oil, gas, or pulverized fuel fired	14 (68)	16 (78)

GENERAL NOTES:

(a) When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/ft^3 (7 400 kJ/m^3), the minimum safety valves or safety relief valve relieving capacity may be based on the values given for hand fired boilers above.

(b) The minimum safety valve or safety relief valve relieving capacity for electric boilers shall be 3½ lb/hr/kW (1.6 kg/hr/kW) input.

(c) For heating surface determination, see HG-403.

(d) For extended heating surface, the minimum lb/hr/sq ft may be determined by the Manufacturer [see HG-403 (d)].

HG-400.1 Safety Valve Requirements for Steam Boilers

(a) Each steam boiler shall have one or more officially rated safety valves that are identified with the V or HV Symbol of the spring pop type adjusted and sealed to

discharge at a pressure not to exceed 15 psi (100 kPa).

(b) No safety valve for a steam boiler shall be smaller than NPS ½ (DN 15) or larger than NPS 4 (DN 100). The inlet opening shall have an inside diameter equal to, or greater than, the seat diameter.

(c) The minimum relieving capacity of valve or valves shall be governed by the capacity marking on the boiler called for in HG-530.

(d) The minimum valve capacity in pounds per hour shall be the greater of that determined by dividing the maximum Btu output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000, or shall be determined on the basis of the pounds (kg) of steam generated per hour per square foot (m^2) of boiler heating surface as given in Table HG-400.1. For cast iron boilers constructed to the requirements of Part HC, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirement

of HG-400.l(e) shall be met.

(e) The safety valve capacity for each steam boiler shall be such that with the fuel burning equipment installed, and operated at maximum capacity, the pressure cannot rise more than 5 psi (35 Kpa) above the maximum allowable working pressure.

(f) When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with HG-400.l (e). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

HG-400.2 Safety Relief Valve Requirements for Hot Water Boilers

(a) Each hot water heating or supply boiler shall have at least one officially rated safety relief valve, of the automatic reseating type, identified with the V or HV Symbol, and set to relieve at or below the maximum allowable working pressure of the boiler.

(b) Hot water heating or supply boilers limited to a water temperature not in excess of 210°F (99°C) may have, in lieu of the valve(s) specified in (a) above, one or more officially rated temperature and pressure safety relief valves of the automatic reseating type identified with the HV symbol, and set to relieve at or below the maximum allowable working pressure of the boiler.

(c) When more than one safety relief valve is used on either hot water heating or hot water supply boilers, the additional valves shall be officially rated and may have a set pressure within a range not to exceed 6 psi (40 kPa) above the maximum allowable working pressure of the boiler up to and including 60 psi (400 kPa), and 5% for those having a maximum allowable working pressure exceeding 60 psi (400 kPa).

(d) No safety relief valve shall be smaller than NPS ¾ (DN 20) nor larger than NPS 4 (DN 100) except that boilers having a heat input not greater than 15,000 Btu/hr (4.4 kW) may be equipped with a rated safety relief valve of NPS ½ (DN 15).

(e) The required steam relieving capacity, in pounds per hour (kg/h), of the pressure relieving device or devices on a boiler shall be the greater of that determined by dividing the maximum output in Btu at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000, or shall be determined on the basis of pounds (kg) of steam generated per hour per square foot (m^2) of boiler heating surface as given in Table HG-400.1. For cast iron boilers constructed to the requirements of Part HC, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirements of HG-400.2 (g) shall be met.

(f) When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and shall be in accordance with HG-400,2(g). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

(g) Safety relief valve capacity for each boiler with a single safety relief valve shall be such that, with the fuel burning equipment installed and operated at maximum capacity, the pressure cannot rise more than 10% above the maximum allowable working pressure. When more than one safety relief valve is used, the overpressure shall be limited to 10% above the set pressure of the highest set valve allowed by HG-400.2 (a).

HG-400.3 Safety and Safety Relief Valves for Tanks and Heat Exchangers

(a) *Steam to Hot Water Supply.* When a hot water supply is heated indirectly by

steam in a coil or pipe within the service limitations set forth in HG-101, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a safety relief valve at least NPS 1 (DN 25), set to relieve at or below the maximum allowable working pressure of the tank, shall be applied on the tank.

(b) *High Temperature Water to Water Heat Exchanger.*[1] When high temperature water is circulated through the coils or tubes of a heat exchanger to warm water for space heating or hot water supply, within the service limitations set forth in HG-101, the heat exchanger shall be equipped with one or more officially rated safety relief valves that are identified with the V or HV Symbol, set to relieve at or below the maximum allowable working pressure of the heat exchanger, and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than 10% above the maximum allowable working pressure of the vessel.

(c) *High Temperature Water to Steam Heat Exchanger.*[14] When high temperature water is circulated through the coils or tubes of a heat exchanger to generate low pressure steam, within the service limitations set forth in HG-101, the heat exchanger shall be equipped with one or more officially rated safety valves that are identified with the V or HV Symbol, set to relieve at a pressure not to exceed 15 psi (100 kPa), and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than 5 psi (35 kPa) above the maximum allowable working pressure of the vessel. For heat exchangers requiring steam pressures greater than 15 psi (100 kPa), refer to Section I or Section VIII, Division 1.

[1] Suggested installation practices for the secondary side of heat exchangers.

HG-401 MINIMUM REQUIREMENTS FOR SAFETY AND SAFETY RELIEF VALVES

HG-401.1 Mechanical Requirements

(a) The inlet opening shall have an inside diameter approximately equal to, or greater than, the seat diameter. In no case shall the maximum opening through any part of the valve be less than ¼ in. (6 mm) in diameter or its equivalent area.

(b) Safety relief valves officially rated as to capacity shall have pop action when tested by steam.

(c) O-rings or other packing devices when used on the stems of safety relief valves shall be so arranged as not to affect their operation or capacity.

(d) The design shall incorporate guiding arrangements necessary to insure consistent operation and tightness. Excessive lengths of guiding surfaces should be avoided. Bottom guided designs are not permitted on safety relief valves.

(e) Safety valves shall have a controlled blowdown of 2 psi to 4 psi (15 kPa to 30 kPa) and this blowdown need not be adjustable.

(f) *Safety valves shall be spring loaded.* The spring shall be designed so that the full lift spring compression shall be no greater than 80% of the nominal solid deflection. The permanent set of the spring (defined as the difference between the free height and height measured 10 min after the spring has been compressed solid three additional times after presetting at room temperature) shall not exceed 0.5% of the free height.

(g) There shall be a lifting device and a mechanical connection between the lifting device and the disk capable of lifting the disk from the seat a distance of at least 1/16 in. (1.5 mm) with no pressure on the boiler.

(h) A body drain below seat level shall be provided by the Manufacturer for all safety valves and safety relief valves, except that the body drain may be omitted when the valve seat is above the bottom of the inside diameter of the discharge piping. For valves exceeding NPS 2½ (DN 65) the drain hole or holes shall be tapped not less than NPS

3/8 (DN 10). For valves NPS 2½ (DN 65) or smaller, the drain hole shall not be less than ¼ in. (6 mm) in diameter. Body drain connections shall not be plugged during or after field installation. In safety relief valves of the diaphragm type, the space above the diaphragm shall be vented to prevent a buildup of pressure above the diaphragm. Safety relief valves of the diaphragm type shall be so designed that failure or deterioration of the diaphragm material will not impair the ability of the valve to relieve at the rated capacity.

(i) In the design of the body of the valve consideration shall be given to minimizing the effects of water deposits.

(j) Valves shall be provided with wrenching surfaces to allow for normal installation without damaging operating parts.

(k) The set pressure tolerances, plus or minus, of safety valves shall not exceed 2 psi (15 kPa), and for safety relief valves shall not exceed 3 psi (20 kPa) for pressures up to and including 60 psig (400 kPa) and 5% for pressures above 60 psig (400 kPa).

(l) Safety valves shall be arranged so that they cannot be reset to relieve at a higher pressure than the maximum allowable working pressure of the boiler.

HG-401.2 Material Selection

(a) Cast iron seats and disks are not permitted.

(b) adjacent sliding surfaces such as guides and disks shall both be of corrosion resistant material.

(c) Springs of corrosion resistant material or having a corrosion resistant coating are required.

(d) Material for seats and disks should be such as to provide a reasonable degree of resistance to steam cutting.

(e) Material for valve bodies and bonnets or their corresponding metallic pressure containing parts shall be listed in Section II**,** except that in cases where a manufacturer desires to make use of materials other than those listed in Section II, he shall establish and maintain specifications requiring equivalent control of chemical and physical properties and quality.

(f) Synthetic disk inserts of O-ring or other types if used shall be compatible with the maximum design temperature established for the valve.

(g) No materials liable to fail due to deterioration or vulcanization when subjected to saturated steam temperature corresponding to capacity test pressure shall be used.

HG-401.3 Manufacture and Inspection

(a) A Manufacturer shall demonstrate to the satisfaction of an ASME designee that his manufacturing, production, and testing facilities and quality control procedures will insure close agreement between the performance of random production samples and the performance of those valves submitted for capacity certification.

(b) Manufacturing, inspection, and test operations including capacity are subject to inspections at any time by an ASME designee.

(c) A Manufacturer may be granted permission to apply the HV Code Symbol to production pressure relief valves capacity certified in accordance with HG-402.3 provided the following tests are successfully completed. This permission shall expire on the fifth anniversary of the date it is initially granted. The permission may be extended for 5 year periods if the following tests are successfully repeated within the 6 month period before expiration.

(1) Two sample production pressure relief valves of a size and capacity within the capability of an ASME accepted laboratory shall be selected by an ASME designee.

(2) Operational and capacity tests shall be conducted in the presence of an ASME designee at an ASME accepted laboratory.

The valve Manufacturer shall be notified of the time of the test and may have representatives present to witness the test.

(3) Should any valve fail to relieve at or above its certified capacity or should it fail to meet performance requirements of this Section, the test shall be repeated at the rate of two replacement valves, selected in accordance with HG-401.3(c)(1), for each valve that failed.

(4) Failure of any of the replacement valves to meet the capacity or the performance requirements of this Section shall be cause for revocation within 60 days of the authorization to use the Code Symbol on that particular type of valve. During this period, the Manufacturer shall demonstrate the cause of such deficiency and the action taken to guard against future occurrence, and the requirements of HG-401.3(c) above shall apply.

(d) Safety valves shall be sealed in a manner to prevent the valve from being taken apart without breaking the seal. Safety relief valves shall be set and sealed so that they cannot be reset without breaking the seal.

HG-401.4 Manufacturer's Testing

(a) Every safety valve shall be tested to demonstrate its popping point, blowdown, and tightness. Every safety relief valve shall be tested to demonstrate its opening point and tightness. Safety valves shall be tested on steam or air and safety relief valves on water, steam, or air. When the blowdown is nonadjustable, the blowdown test may be performed on a sampling basis.

(b) A Manufacturer shall have a well-established program for the application, calibration, and maintenance of test gages.

(c) Testing time on safety valves shall be sufficient, depending on size and design, to insure that test results are repeatable and representative of field performance.

(d) Test fixtures and test drums shall be of adequate size and capacity to assure representative pop action and accuracy of blowdown adjustment.

(e) A tightness test shall be conducted at maximum expected operating pressure, but not at a pressure exceeding the reseating pressure of the valve.

HG-401.5 Design Requirements. At the time of the submission of valves for capacity certification, or testing in accordance with this Section, the ASME Designee has the authority to review the design for conformity with the requirements of this Section, and to reject or require modification of designs that do not conform, prior to capacity testing.

HG-402 DISCHARGE CAPACITIES OF SAFETY AND SAFETY RELIEF VALVES

HG-402.1 Valve Markings. Each safety or safety-relief valve shall be plainly marked with the required data by the Manufacturer in such a way that the markings will not be obliterated in service. The markings shall be stamped, etched, impressed, or cast on the valve or on a nameplate, which shall be securely fastened to the valve.

(a) The markings shall include the following:

(1) the name or an acceptable abbreviation of the Manufacturer

(2) Manufacturer's design or type number

(3) NPS size _____ in. (DN) (the nominal pipe size of the valve inlet)

(4) set pressure _____ psi

(5) capacity _____ lb/hr (kg/hr), or capacity _____ Btu/hr in accordance with HG-402.7 (a)

(6) year built or, alternatively, a coding may be marked on the valves such that the valve Manufacturer can identify the year the valve was assembled and tested, and

(7) ASME Symbol as shown in Fig. HG-402

(b) Nameplates of safety or safety-relief valves may be marked solely in metric units under the following conditions:

(1) The pressure-relief device will be installed in a location where metric units are required or accepted by local authorities, if any.

(2) Metric units shall be those required by the user when not mandated by enforcement authorities.

(3) The Manufacturer's quality control system shall provide for the conversion from U.S. customary units to the metric units that will be marked on the nameplate.

HG-402.2 Authorization to Use ASME Stamp. Each safety valve to which the Code Symbol (Fig. HG-402) is to be applied shall be produced by a Manufacturer and/or Assembler who is in possession of a valid Certificate of Authorization. (See HG-540.) For all valves to be stamped with the HV Symbol, a Certified Individual (CI) shall provide oversight to ensure that the use of the "HV" Code symbol on a safety valve or safety relief valve is in accordance with this Section and that the use of the "HV" Code symbol is documented on a Certificate of Conformance Form, HV-1.

FIG. HG-402 OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS' STANDARD

(a) Requirements for the Certified Individual (CI). The CI shall

(1) be an employee of the Manufacturer.

(2) be qualified and certified by the Manufacturer. Qualification shall include the following as a minimum:

(a) knowledge of the requirements of this Section for the application of the "HV" Code Symbol

(b) knowledge of the Manufacturer's quality program

(c) training commensurate with the scope, complexity, or special nature of the activities to which oversight is to be provided

(3) have a record, maintained and certified by the Manufacturer, containing objective evidence of the qualifications of the CI and the training program provided

(b) *Duties of the Certified Individual (CI).* The CI shall

(1) verify that each item to which the Code Symbol is applied meets all applicable requirements of this Section and has a current capacity certification for the "HV" symbol

(2) review documentation for each lot of items to be stamped, to verify, for the lot, that the requirements of this Section have been completed

(3) sign the Certificate of Conformance Form (HV-1) prior to release of control of the item

(c) *Certificate of Conformance Form (HV-1)* (see Appendix N)

(1) The Certificate of Conformance shall be filled out by the Manufacturer and signed by the Certified Individual. Multiple duplicate pressure relief devices may be recorded on a single entry provided the devices are identical and produced in the same lot.

(2) The Manufacturer's written quality control program shall include requirements for completion of Certificates of Conformance forms and retention by the Manufacturer for a minimum of 5 years.

HG-402.3 Determination of Capacity to Be Stamped on Valves. The Manufacturer of the valves that are to be stamped with the Code symbol shall submit valves for testing to a place where adequate equipment and personnel are available to conduct pressure and relieving-capacity tests which shall be

made in the presence of and certified by an authorized observer. The place, personnel, and authorized observer shall be approved by the Boiler and Pressure Vessel Committee. The valves shall be tested in one of the following three methods.

(a) *Coefficient Method.* Tests shall be made to determine the lift, popping, and blowdown pressures, and the capacity of at least three valves each of three representative sizes (a total of nine valves). Each valve of a given size shall be set at a different pressure. However, safety valves for steam boilers shall have all nine valves set at 15 psig (100 kPa). A coefficient shall be established for each test as follows:

$$K_D = \frac{\text{Actual steam flow}}{\text{Theoretical steam flow}} = \text{Coefficient of discharge}$$

The average of the coefficients K_D of the nine tests required shall be multiplied by 0.90, and this product shall be taken as the coefficient K of that design. The stamped capacity for all sizes and pressures shall not exceed the value determined from the following formulas:

For 45 deg seat,

(US. Customary Units)

$$W = 51.5\,\pi DLP \times 0.707K$$

(SI Units)

$$W = 5.25\,\pi DLP \times 0.707K$$

For flat seat,

(U.S. Customary Units)

$$W = 51.5\,\pi DLPK$$

(SI Units)

$$W = 5.25\,\pi DLPK$$

For nozzle,

(U.S. Customary Units)

$$W = 51.5APK$$

(SI Units)

$$W = 5.25APK$$

where

A = nozzle-throat area

D = seat diameter

K = coefficient of discharge for the design

L = lift

P = (1.10 × set pressure + 14.7) psia or (1.10 × set pressure + 0.101) MPa, for hot water applications or

= (5.0 psi + 15 psi set + 14.7) psia or (0.035 MPa + 0.100 MPa set + 0.101) MPa, for steam boilers

W = weight of steam/hr

NOTE: The maximum and minimum coefficient determined by the tests of a valve design shall not vary more than ±5% from the average. If one or more tests are outside the acceptable limits, one valve of the Manufacturer's choice shall be replaced with another valve of the same size and pressure setting or by a modification of the original valve. Following this test a new average coefficient shall be calculated, excluding the replaced valve test. If one or more tests are now outside the acceptable limits, as determined by the new average coefficient, a valve of the Manufacturer's choice must be replaced by two valves of the same size and pressure as the rejected valve. A new average coefficient, including the replacement valves, shall be calculated. If any valve, excluding the two replaced valves, now falls outside the acceptable limits, the tests shall be considered unsatisfactory.

(b) *Slope Method.* If a Manufacturer wishes to apply the Code Symbol to a design of pressure relief valves, four valves of each combination of pipe and orifice size shall be tested. These four valves shall be set at pressures that cover the approximate range of pressures for which the valve will be used, or that cover the range available at the certified test facility that shall conduct the tests. The capacities shall be based on these four tests as follows:

(1) The slope *(W/P)* of the actual measured capacity versus the flow pressure for each test point shall be calculated and averaged:

$$\text{slope} = W/P = \frac{\text{measured capacity}}{\text{absolute flow pressure, psia}}$$

All values derived from the testing must fall within ±5% of the average value:

minimum slope = 0.95 × average slope

maximum slope = 1.05 × average slope

If the values derived from the testing do not fall between the minimum and maximum slope values, the Authorized Observer shall require that additional valves be tested at the rate of two for each valve beyond the maximum and minimum values with a limit of four additional valves.

(2) The relieving capacity to be stamped on the valve shall not exceed 90% of the average slope times the absolute accumulation pressure:

rated slope = 0.90 × average slope

stamped capacity ≤ rated slope × (1.10 × set pressure + 14.7) psia or (1.10 × set pressure + 101) kPa for hot water applications

(c) *Three-Valve Method.* If a Manufacturer wishes to apply the Code Symbol to steam safety valves or safety relief valves of one or more sizes of a design set at one pressure, he shall submit three valves of each size of each design set at one pressure for testing and the stamped capacity of each size shall not exceed 90% of the average capacity of the three valves tested.

NOTE: The discharge capacity as determined by the test of each valve tested shall not vary by more than ±5% of the average capacity of the three valves tested. If one of the three valve tests falls outside of the limits, it may be replaced by two valves and a new average calculated based on all four valves, excluding the replaced valve.

ARTICLE 6
INSTRUMENTS, FITTINGS, AND CONTROLS

HG-600 GENERAL

All instruments, fittings, and controls described in this Article shall be installed prior to operation.

HG-601 FOR STEAM HEATING BOILERS

HG-602 STEAM GAGES

(a) Each steam boiler shall have a steam gage or a compound steam gage connected to its steam space or to its water column or to its steam connection. The gage or piping to the gage shall contain a siphon or equivalent device that will develop and maintain a water seal that will prevent steam from entering the gage tube. The piping shall be so arranged that the gage cannot be shut off from the boiler except by a cock placed in the pipe at the gage and provided with a tee- or lever-handle arranged to be parallel to the pipe in which it is located when the cock is open. The gage connection boiler tapping, external siphon, or piping to the boiler shall not be less than NPS ¼ (DN 8). Where steel or wrought iron pipe or tubing is used, the boiler connection and external siphon shall be not less than NPS ½ (DN 15). Ferrous and nonferrous tubing having inside diameters at least equal to that of standard pipe sizes listed above may be substituted for pipe.

(b) The scale on the dial of a steam boiler gage shall be graduated to not less than 30 psi (200 kPa) nor more than 60 psi (414 kPa). The travel of the pointer from 0 psi to 30 psi (0 kPa to 200 kPa) pressure shall be at least 3 in. (75 mm).

HG-603 WATER GAGE GLASSES

(a) Each steam boiler shall have one or more water gage glasses attached to the water column or boiler by means of valved fittings not less than NPS ½ (DN 15), with the lower fitting provided with a drain valve of a type having an unrestricted drain opening not less than ¼ in. (6 mm) in diameter to facilitate cleaning. Gage glass replacement shall be possible with the boiler under pressure. Water glass fittings may be attached directly to a boiler.

Boilers having an internal vertical height of less than 10 in. (250 mm) may be equipped with a water level indicator of the Glass Bull's-Eye type provided the indicator is of sufficient size to show the water at both normal operating and low-water cutoff levels.

(b) The lowest visible part of the water gage glass shall be at least 1 in. (25 mm) above the lowest permissible water level recommended by the boiler Manufacturer. With the boiler operating at this lowest permissible water level, there shall be no danger of overheating any part of the boiler.

Each boiler shall be provided at the time of the manufacture with a permanent marker indicating the lowest permissible water level. The marker shall be stamped, etched, or cast in metal; or it shall be a metallic plate attached by rivets, screws, or welding; or it shall consist of material with documented tests showing its suitability as a permanent marking for the application. This marker shall be visible at all times. Where the boiler is shipped with a jacket, this marker may be located on the jacket.

NOTE: Transparent material other than glass may be used for the water gage provided that the material will remain transparent and has proved suitable for the pressure, temperature, and corrosive conditions expected in service.

(c) In electric boilers of the submerged electrode type, the water gage glass shall be so located to indicate the water levels both at startup and under maximum steam load conditions as established by the manufacturer.

(d) In electric boilers of the resistance element type, the lowest visible part of the water gage shall be located at least 1 in. (25 mm) above the lowest permissible water level specified by the Manufacturer. Each electric boiler of this type shall also be equipped with an automatic low-water cutoff on each boiler pressure vessel so located as to automatically cut off the power supply to the heating elements before the surface of the water falls below the visible part of the glass.

(e) Tubular water glasses on electric boilers having a normal water content not exceeding 100 gal (300 l) shall be equipped with a protective shield.

(f) A water level indicator using an indirect sensing method may be used in lieu of an operating water gauge glass; however, a water gauge glass must be installed and operable but may be shut off by valving. The water level indicator must be attached to a water column or directly to the boiler by means of valved fittings not less than NPS ½ (DN 15). The device shall be provided with a drain valve of a type having an unrestricted drain opening not less than ¼ in. (6 mm) in diameter to facilitate cleaning. Service and replacement of internal parts and/or housing shall be possible with the boiler under pressure.

HG-604 WATER COLUMN AND WATER LEVEL CONTROL PIPES

(a) The minimum size of ferrous or nonferrous pipes connecting a water column to a steam boiler shall be NPS 1 (DN 25). No outlet connections, except for damper regulator, feedwater regulator, steam gages, or apparatus that does not permit the escape of any steam or water except for manually operated blowdowns, shall be attached to a water column or the piping connecting a water column to a boiler (see HG-705 for introduction of feedwater into a boiler). If the water column, gage glass, low-water fuel cutoff, or other water level control device is connected to the boiler by pipe and fittings, no shutoff valves of any type shall be placed in such pipe, and a cross or equivalent fitting to which a drain valve and piping may be attached shall be placed in the water piping connection at every right angle turn to facilitate cleaning. The water column drain pipe and valve shall be not less than NPS ¾ (DN 20).

(b) The steam connections to the water column of a horizontal firetube wrought boiler shall be taken from the top of the shell or the upper part of the head, and the water connection shall be taken from a point not above the center line of the shell. For a cast iron boiler, the steam connection to the water column shall be taken from the top of

an end section or the top of the steam header, and the water connection shall be made on an end section not less than 6 in. (150 mm) below the bottom connection to the water gage glass.

HG-605 PRESSURE CONTROL

Each automatically fired steam boiler shall be protected from overpressure by two pressure-operated controls.

(a) Each individual automatically fired steam boiler shall have a safety limit control that will cut off the fuel supply to prevent steam pressure from exceeding the 15 psi (100 kPa) maximum allowable working pressure of the boiler. Each control shall be constructed to prevent a pressure setting above 15 psi (100 kPa).

(b) Each individual steam boiler shall have a control that will cut off the fuel supply when the pressure reaches an operating limit, which shall be less than the maximum allowable pressure.

(c) Shutoff valves of any type shall not be placed in the steam pressure connection between the boiler and the controls described in (a) and (b) above. These controls shall be protected with a siphon or equivalent means of maintaining a water seal that will prevent steam from entering the control. The control connection boiler tapping, external siphon, or piping to the boiler shall not be less than NPS ¼ (DN 8), but where steel or wrought iron pipe or tubing is used, they shall not be less than NPS ½ (DN 15). The minimum size of an external siphon shall be NPS ¼ (DN 8) or 3/8 in. (10 mm) O.D. nonferrous tubing.

HG-606 AUTOMATIC LOW-WATER FUEL CUTOFF AND/OR WATER FEEDING DEVICE

(a) Each automatically fired steam or vapor-system boiler shall have an automatic low-water fuel cutoff so located as to automatically cut off the fuel supply before the surface of the water falls below the lowest visible part of the water gage glass. If a water feeding device is installed, it shall be so constructed that the water inlet valve cannot feed water into the boiler through the float chamber and so located as to supply requisite feedwater.

(b) Such a fuel cutoff or water feeding device may be attached directly to a boiler. A fuel cutoff or water feeding device may also be installed in the tapped openings available for attaching a water glass direct to a boiler, provided the connections are made to the boiler with nonferrous tees or Y's not less than NPS ½ (DN 15) between the boiler and the water glass so that the water glass is attached directly and as close as possible to the boiler; the run of the tee or Y shall take the water glass fittings, and the side outlet or branch of the tee or Y shall take the fuel cutoff or water feeding device. The ends of all nipples shall be reamed to full-size diameter.

(c) Fuel cutoffs and water feeding devices embodying a separate chamber shall have a vertical drain pipe and a blowoff valve not less than NPS ¾ (DN 20), located at the lowest point in the water equalizing pipe connections so that the chamber and the equalizing pipe can be flushed and the device tested.

HG-607 MODULAR STEAM HEATING BOILERS

(a) Each module of a modular steam heating boiler shall

be equipped with

(1) steam gage, see HG-602

(2) water gage glass, see HG-603

(3) a pressure control that will cut off the fuel supply when the pressure reaches an operating limit, which shall be less than the maximum allowable pressure

(4) low water cutoff, see HG-606

(b) The assembled modular steam boiler shall also be equipped with a safety limit

control that will cut off the fuel supply to prevent steam pressure from exceeding the 15 psi (100 kPa) maximum allowable working pressure of the boiler. The control shall be constructed to prevent pressure setting above 15 psi (100 kPa).

HG-610 FOR HOT WATER HEATING OR HOT WATER SUPPLY BOILERS

HG-611 PRESSURE OR ALTITUDE GAGES

(a) Each hot water heating or hot water supply boiler shall have a pressure or altitude gage connected to it or to its flow connection in such a manner that it cannot be shut off from the boiler except by a cock with tee or lever handle, placed on the pipe near the gage. The handle of the cock shall be parallel to the pipe in which it is located when the cock is open.

(b) The scale on the dial of the pressure or altitude gage shall be graduated approximately to not less than 1½ nor more than 3½ times the pressure at which the safety relief valve is set.

(c) Piping or tubing for pressure- or altitude-gage connections shall be of nonferrous metal when smaller than NPS 1 (DN 25).

HG-612 THERMOMETERS

Each hot water heating or hot water supply boiler shall have a thermometer so located and connected that it shall be easily readable. The thermometer shall be so located that it shall at all times indicate the temperature of the water in the boiler at or near the outlet.

HG-613 TEMPERATURE CONTROL

Each automatically fired hot water heating or hot water supply boiler shall be protected from over-temperature by two temperature-operated controls.

(a) Each individual automatically fired hot water heating or hot water supply boiler shall have a high temperature limit control that will cut off the fuel supply to prevent water temperature from exceeding its marked maximum water temperature at the boiler outlet. This control shall be constructed to prevent a temperature setting above the
maximum.

(b) Each individual hot water heating or hot water supply boiler shall have a control that will cut off the fuel supply when the system water temperature reaches a preset operating temperature, which shall be less than the maximum water temperature.

HG-614 LOW-WATER FUEL CUTOFF

(a) Each automatically fired hot water boiler with heat input greater than 400,000 Btu/hr (117 kW) shall have an automatic low-water fuel cutoff that has been designed for hot water service, and it shall be so located as to automatically cut off the fuel supply when the surface of the water falls to the level established in (b) below (see Fig. HG-703.2).

(b) As there is no normal waterline to be maintained in a hot water boiler, any location of the low-water fuel cutoff above the lowest safe permissible water level established by the boiler manufacturer is satisfactory.

(c) A coil-type boiler or a watertube boiler with heat input greater than 400,000 Btu/hr (117 kW) requiring forced circulation to prevent overheating of the coils or tubes shall have a flow-sensing device installed in lieu of the low-water fuel cutoff required in (a) above to automatically cut off the fuel supply when the circulating flow is interrupted.

(d) A means shall be provided for testing the operation of the external low-water fuel cutoff without resorting to draining the

entire system. Such means shall not render the device inoperable except as described as follows. If the means temporarily isolates the device from the boiler during this testing, it shall automatically return to its normal position. The connection may be so arranged that the device cannot be shut off from the boiler except by a cock placed at the device and provided with a tee or lever-handle arranged to be parallel to the pipe in which it is located when the cock is open.

HG-615 MODULAR HOT WATER HEATING BOILERS

(a) Each module of a modular hot water heating boiler shall be equipped with

(1) pressure/altitude gage, see HG-611

(2) thermometer, see HG-612

(3) temperature control that will cut off the fuel supply when the temperature reaches an operating limit, which shall be less than the maximum allowable temperature

(b) The assembled modular hot water heating boiler shall also be equipped with

(1) a safety limit control that will cut off the fuel supply to prevent the water temperature from exceeding the maximum allowable temperature at the boiler outlet. The control shall be constructed to prevent a temperature setting above the maximum. This control shall be located within 3 ft. (1.0 m) of the fitting connecting the last module to the heating supply piping.

(2) low water fuel cutoff, see HG-614.

HG-620 FOR ALL BOILERS

HG-621 INSTRUMENTS, FITTINGS, AND CONTROLS MOUNTED INSIDE BOILER JACKETS

Any or all instruments, fittings, and controls required by these rules may be installed inside of boiler jackets provided the water gage on a steam boiler is accessible without the use of tools and provided the water gage and pressure gage on a steam boiler or the thermometer and pressure gage on a water boiler are visible through an opening or openings at all times.

HG-630 ELECTRIC WIRING

HG-631 ELECTRICAL CODE COMPLIANCE

All field wiring for controls, heat generating apparatus, and other appurtenances necessary for the operation of the boiler or boilers should be installed in accordance with the provisions of the National Electric Code and/or should comply with the applicable local electrical codes. All boilers supplied with factory mounted and wired controls, heat generating apparatus, and other appurtenances necessary for the operation of the boilers should be installed in accordance with the provisions of the nationally recognized standards such as listed in footnote 2 [17]of HG-640.

HG-632 TYPE CIRCUITRY TO BE USED

Whether field or factory wired, the control circuitry shall be positively grounded and shall operate at 150 V or less. One of the two following systems may be employed to provide the control circuit.

(a) *Two-Wire Nominal 120 V System With Separate Equipment Ground Conductor*

(1) This system shall consist of the line, neutral, and equipment ground conductors. The control panel frame and associated control circuitry metallic enclosures shall be electrically continuous and be bonded to the equipment ground conductor.

(2) The equipment ground conductor and the neutral conductor shall be bonded together at their origin in the electrical system as required by the NEC.[1]

[1] See Appendix H.

(3) The line side of the control circuit shall be provided with a time delay fuse sized as small as practicable.

(b) *Two-Wire Nominal 120 V System Obtained By Using an Isolation Transformer*

(1) The two-wire control circuit shall be obtained from the secondary side of an isolation transformer. One wire from the secondary of this transformer shall be electrically continuous and shall be bonded to a convenient cold water pipe. All metallic enclosures of control components shall be securely bonded to this ground control circuit wire. The primary side of the isolation transformer will normally be a two-wire source with a potential of 230 V or 208 V or 440 V.

(2) Both sides of the two-wire primary circuit shall be fused. The hot leg on the load side of the isolation transformer shall be fused as small as practicable and in no case fused above the rating of the isolation transformer.

HG-633 LIMIT CONTROLS

Limit controls shall be wired on the hot or line side of the control circuit.

HG-634 SHUTDOWN SWITCHES AND CIRCUIT BREAKERS

A manually operated remote heating plant shutdown switch or circuit breaker should be located just outside the boiler room door and marked for easy identification. Consideration should also be given to the type and location of the 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 switch located at each door.

(a) For atmospheric-gas burners, and oil burners where a fan is on a common shaft with the oil pump, the complete burner and controls should be shut off.

(b) For power burners with detached auxiliaries, only the fuel input supply to the firebox need be shut off.

HG-640 CONTROLS AND HEAT GENERATING APPARATUS

(a) Oil and gas-fired and electrically heated boilers should be equipped with suitable primary (flame safeguard) safety controls, safety limit switches, and burners or electric elements as required by a nationally recognized standard.[2]

[2] Examples of these nationally recognized standards are:
American National Standard/CSA Standard Z21.13lCSA 4.9 for Gas-Fired Low Pressure Steam and Hot Water Boilers.
American National Standard/CSA Standard Z21.171CSA 2.7 for Domestic Gas Conversion Burners.
Underwriters Laboratories, Inc., UL 296, Standards for Safety, Oil Burners.
Underwriters Laboratories, Inc., UL 726, Standards for Safety, Oil Fired Boiler Assemblies.
Underwriters Laboratories, Inc., UL 795, Standards for Safety, Commercial-Industrial Gas-Heating Equipment.
Underwriters Laboratories, Inc., UL 834, Electric Heating, Water Supply and Power Boilers.

(b) The symbol of the certifying organization[3] that has investigated such equipment as having complied with a nationally recognized standard shall be affixed to the equipment and shall be considered as evidence that the unit was manufactured in accordance with that standard.

[3] A certifying organization is one that provides uniform testing, examination, and listing procedures under established, nationally recognized standards and that is acceptable to the authorities having jurisdiction.

ARTICLE 7
INSTALLATION REQUIREMENTS

HG-700 INSTALLATION REQUIREMENTS, ALL BOILERS

HG-701 MOUNTING SAFETY AND SAFETY RELIEF VALVES

HG-701.1 Permissible Mounting. Safety valves and safety relief valves shall be located in the top or side[1] of the boiler. They shall be connected directly to a tapped

or flanged opening in the boiler, to a fitting connected to the boiler by a short nipple, to a Y-base, or to a valveless header connecting steam or water outlets on the same boiler. Coil or header type boilers shall have the safety valve or safety relief valve located on the steam or hot water outlet end. Safety valves and safety relief valves shall be installed with their spindles vertical. The opening or connection between the boiler and any safety valve or safety relief valve shall have at least the area of the valve inlet.

[1] The top or side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the safety valve be located below the normal operating level and in no case shall the safety relief valve be located below the lowest permissible water level.

HG-701.2 Requirements for Common Connections for Two or More Valves

(a) When a boiler is fitted with two or more safety valves on one connection, this connection shall have a cross-sectional area not less than the combined areas of inlet connections of all the safety valves with which it connects.

(b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas. When the size of the boiler requires a safety valve or safety relief valve larger than 4½ in. (115 mm) in diameter, two or more valves having the required combined capacity shall be used. When two or more valves are used on a boiler, they may be single, directly attached, or mounted on a Y-base.

HG-701.3 Threaded Connections. A threaded connection may be used for attaching a valve.

HG-701.4 Prohibited Mountings. Safety and safety relief valves shall not be connected to an internal pipe in the boiler.

HG-701.5 Use of Shutoff Valves Prohibited. No shutoff of any description shall be placed between the safety or safety relief valve and the boiler, or on discharge pipes between such valves and the atmosphere.

HG-701.6 Safety and Safety Relief Valve Discharge Piping

(a) A discharge pipe shall be used. Its internal cross-sectional area shall be not less than the full area of the valve outlet or of the total of the valve outlets discharging thereinto and shall be as short and straight as possible and so arranged as to avoid undue stress on the valve or valves. A union may be installed in the discharge piping close to the valve outlet. When an elbow is placed on a safety or safety relief valve discharge pipe, it shall be located close to the valve outlet downstream of the union.

(b) The discharge from safety or safety relief valves shall be so arranged that there will be no danger of scalding attendants. The safety or safety relief valve discharge shall be piped away from the boiler to the point of discharge, and there shall be provisions made for properly draining the piping. The size and arrangement of discharge piping shall be independent of other discharge piping and shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the relieving devices below that required to protect the boiler.

HG-701.7 Temperature and Pressure Safety Relief Valves. Hot water heating or supply boilers limited to a water temperature of 210°F (99°C) may have one or more officially rated temperature and pressure safety relief valves installed. The requirements of HG-701.1 through HG-701.6 shall be met, except as follows:

(a) A Y-type fitting shall not be used.

(b) If additional valves are used they shall be temperature and pressure safety relief valves.

(c) When the temperature and pressure safety relief valve is mounted directly on the boiler with no more than 4 in. (100 mm) maximum interconnecting piping, the valve

may be installed in the horizontal position with the outlet pointed down.

HG-703 PIPING[2]

[2] Guidance for the design of piping systems may be found in ASME B31.9, Building Services Piping.

HG-703.1 Provisions for Expansion and Contraction. Provisions shall be made for the expansion and contraction of steam and hot water mains connected to boilers by providing substantial anchorage at suitable points and by providing swing joints when boilers are installed in batteries, so there will be no undue strain transmitted to the boilers. See Figs. HG-703.1(a), HG-703.1(b), and HG-703.2 for typical schematic arrangements of piping incorporating strain absorbing joints for steam and hot water heating boilers.

HG-703.2 Return Pipe Connections

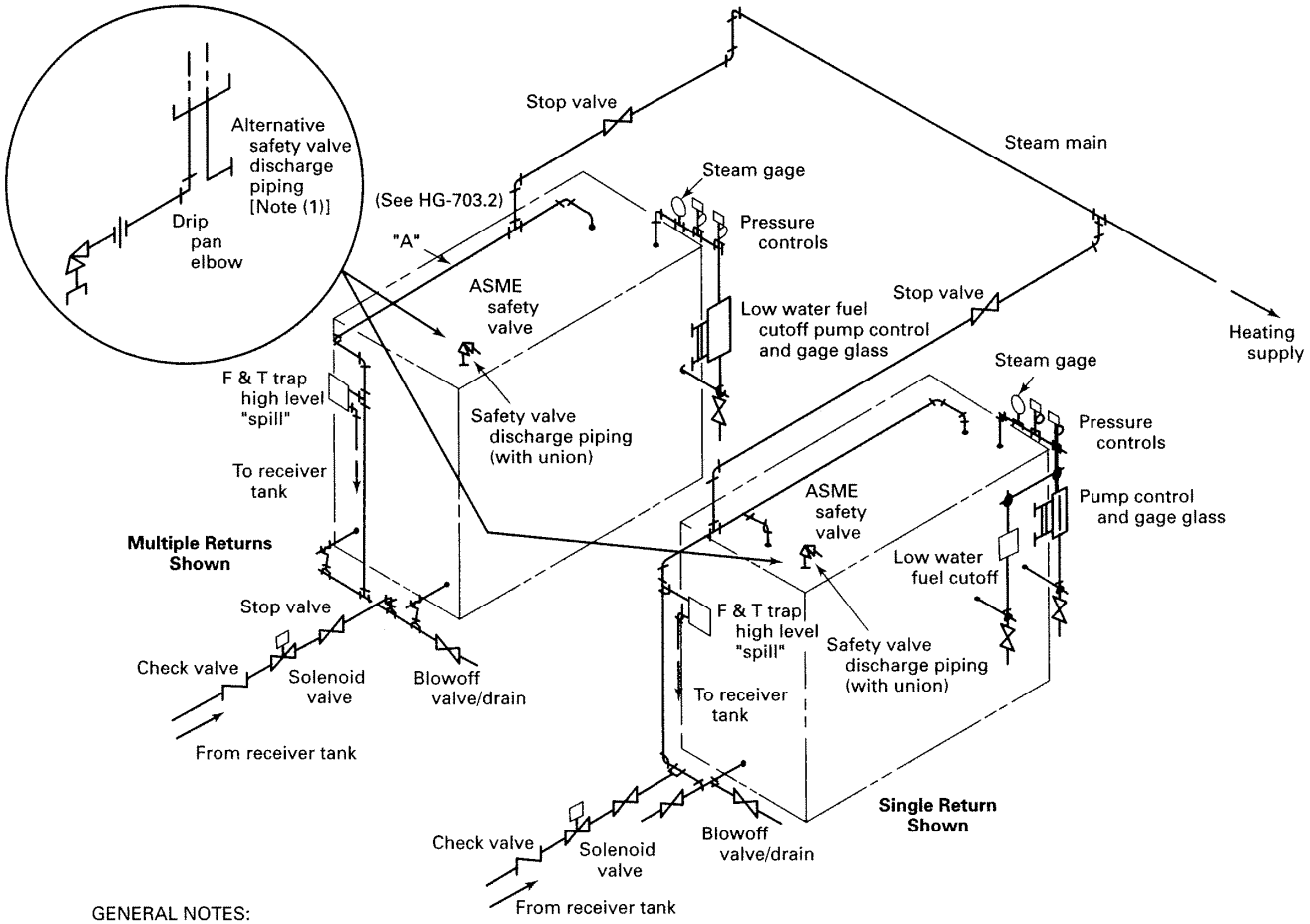
(a) The return pipe connections of each boiler supplying a gravity return steam heating system shall be so arranged as to form a loop substantially as shown in Fig. HG-703.l(b) so that the water in each boiler cannot be forced out below the safe water level.

(b) For hand-fired boilers with a normal grate line, the recommended pipe sizes detailed as "A" in Fig. HG-703.1 are NPS 1½ (DN 40) for 4 ft^2 (0.37 m^2) or less firebox area at the normal grate line, NPS 2½ (DN 65) for areas more than 4 ft^2 (0.37 m^2) up to 14.9 ft^2 (1.4 m^2), and NPS 4 (DN 100) for 15 ft^2 (1.4 m^2) or more.

(c) For automatically fired boilers that do not have a normal grate line, the recommended pipe sizes detailed as "A" in Fig. HG-703.1 are NPS 1½ (DN 40) for boilers with minimum safety valve relieving capacity 250 lb/hr (113 kg/hr) or less, NPS 2½ (DN 65) for boilers with minimum safety valve relieving capacity from 251 lb/hr (114 kg/hr) to 2,000 lb/hr (900 kg/hr), inclusive, and NPS 4 (DN 100) for boilers with more than 2,000 lb/hr (900 kg/hr) minimum safety valve relieving capacity.

(d) Provision shall be made for cleaning the interior of the return piping at or close to the boiler. Washout openings may be used for return pipe connections and the washout plug placed in a tee or a cross so that the plug is directly opposite and as close as possible to the opening in the boiler.

FIG. HG-703.1(a) STEAM BOILERS IN BATTERY — PUMPED RETURN — ACCEPTABLE PIPING INSTALLATION



GENERAL NOTES:

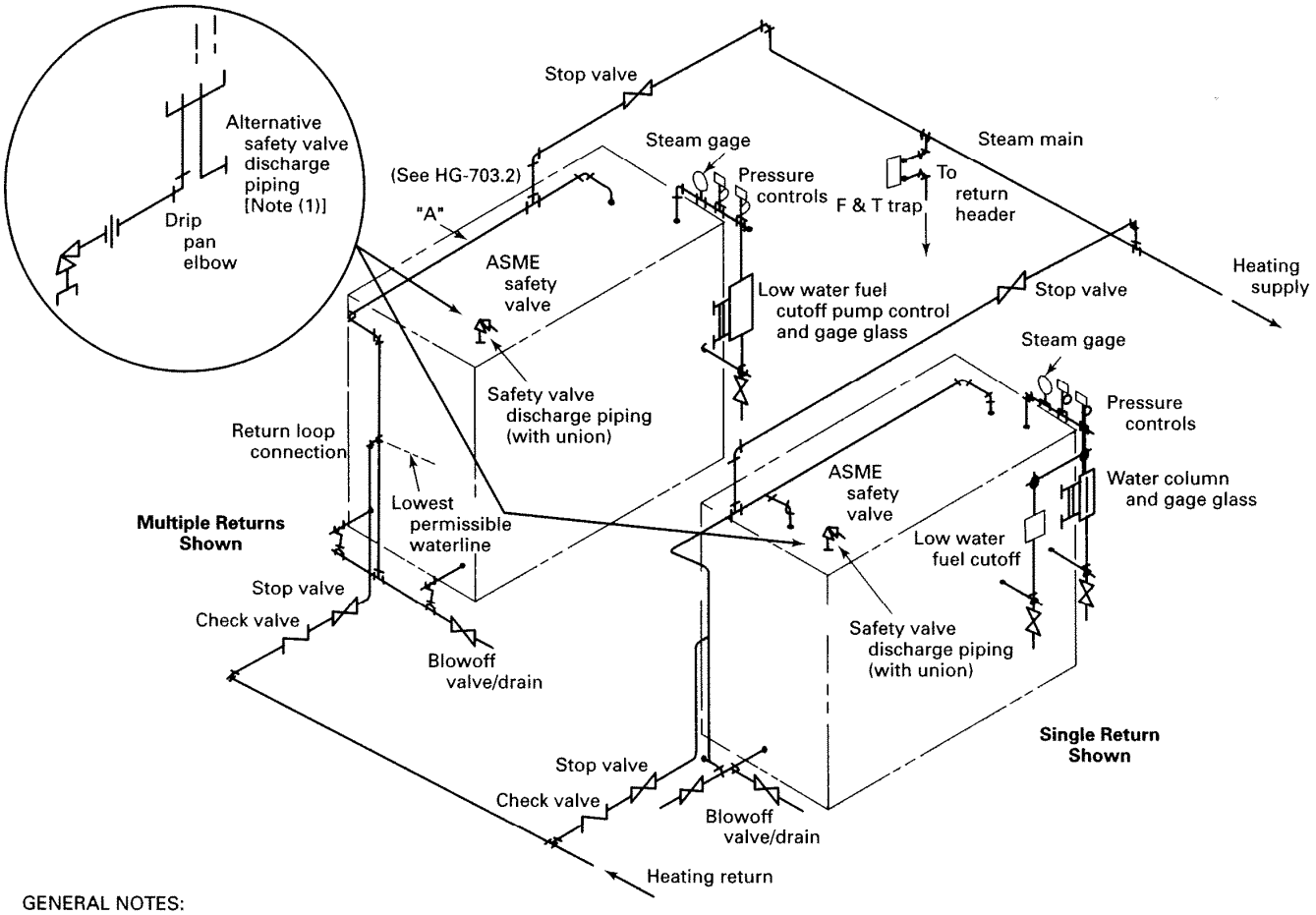
(a) Return connections shown for a multiple boiler installation may not always insure that the system will operate properly. In order to maintain proper water levels in multiple boiler installations, it may be necessary to install supplementary controls or suitable devices.

(b) Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

NOTE:

(1) Recommended for 1 in. (DN 25) and larger safety valve discharge.

FIG. HG-703.1(b) STEAM BOILERS IN BATTERY — GRAVITY RETURN — ACCEPTABLE PIPING INSTALLATION



GENERAL NOTES:

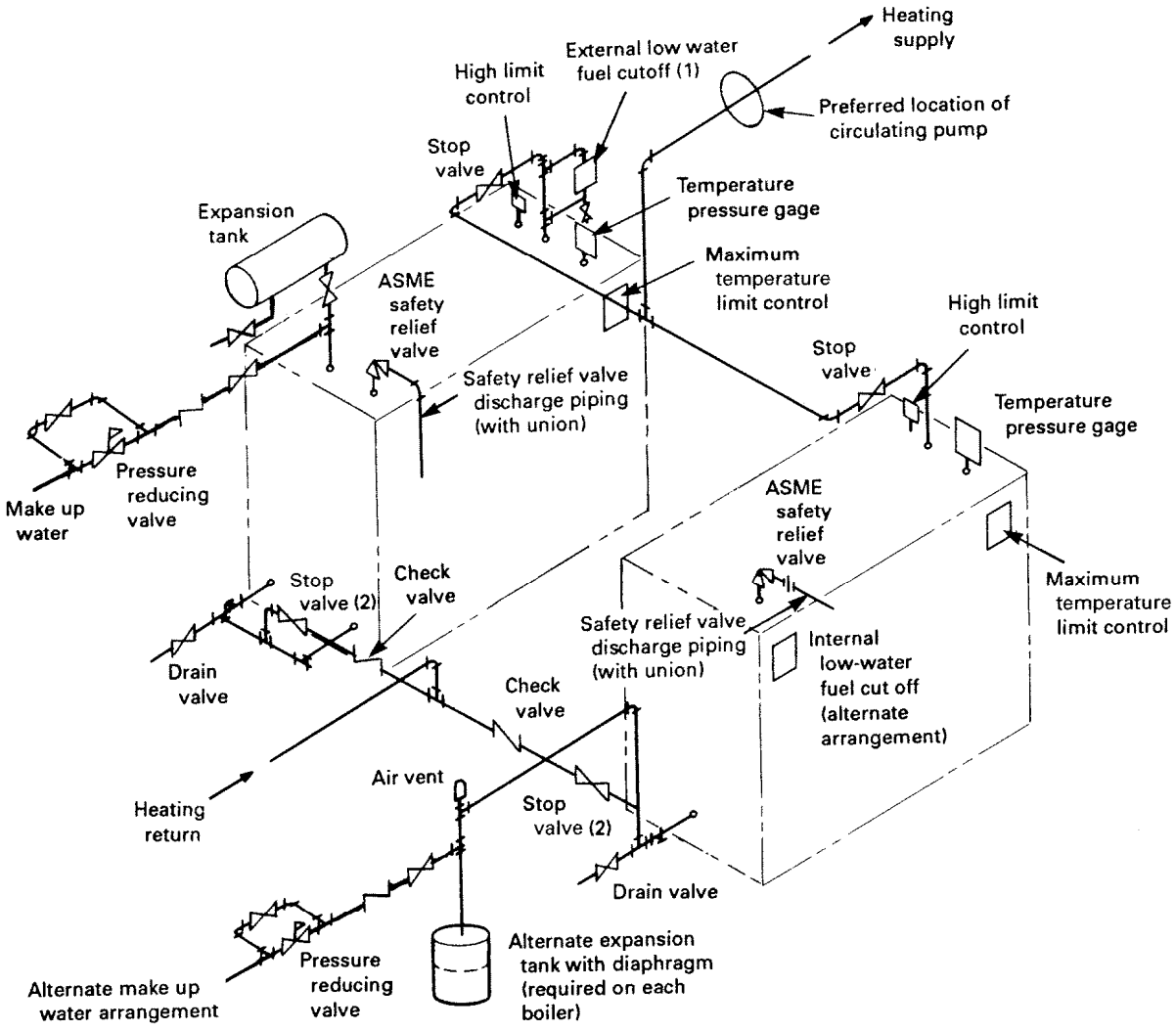
(a) Return connections shown for a multiple boiler installation may not always insure that the system will operate properly. In order to maintain proper water levels in multiple boiler installations, it may be necessary to install supplementary controls or suitable devices.

(b) Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

NOTE:

(1) Recommended for 1 in. (DN 25) and larger safety valve discharge.

FIG. HG-703.2 HOT WATER BOILERS IN BATTERY — ACCEPTABLE PIPING INSTALLATION



GENERAL NOTE: Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

NOTES:

(1) Recommended control. See HG-614. Acceptable shutoff valves or cocks in the connecting piping may be installed for convenience of control testing and/or service.

(2) The common return header stop valves may be located on either side of the check valves.

HG-705 FEEDWATER AND MAKEUP WATER CONNECTIONS

(a) *Steam Boilers.* Feedwater or water treatment shall be introduced into a boiler through the return piping system. Alternatively, feedwater or water treatment may be introduced through an independent connection. The water flow from the independent connection shall not discharge directly against parts of the boiler exposed to direct radiant heat from the fire. Feedwater or water treatment shall not be introduced through openings or connections provided for inspection or cleaning, safety valve, water column, water gage glass, or pressure gage. The feedwater pipe shall be provided with a check valve or a backflow preventer containing a check valve[3] near the boiler and a stop valve or cock between the check valve and the boiler or between the check valve and the return pipe system.

(b) *Hot Water Boilers.* Makeup water may be introduced into a boiler through the piping system or through an independent connection. The water flow from the independent connection shall not discharge directly against parts of the boiler exposed to direct radiant heat from the fire. Makeup water shall not be introduced through openings or connections provided exclusively for inspection or cleaning, safety relief valve, pressure gage, or temperature gage. The makeup water pipe shall be provided with a check valve or a backflow preventer containing a check valve[3] near the boiler and a stop valve or cock between the check valve and the boiler or between the check valve and the piping system.

[3] Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

HG-707 OIL HEATERS

(a) A heater for oil or other liquid harmful to boiler operation shall not be installed directly in the steam or water space within a boiler.

(b) Where an external type heater for such service is used, means shall be provided to prevent the introduction into the boiler of oil or other liquid harmful to boiler operation.

HG-708 STORAGE TANKS FOR HOT WATER SUPPLY SYSTEMS

If a system is to utilize a storage tank that exceeds the capacity exception of HLW-101.2 (c), the tank shall be constructed in accordance with the rules of Part HLW; Section VIII, Division 1; or Section X. For tanks constructed to Section X, the maximum allowable temperature marked on the tank shall equal or exceed the maximum water temperature marked on the boiler.

HG-709 PROVISIONS FOR THERMAL EXPANSION IN HOT WATER SYSTEMS

All hot water heating systems incorporating hot water tanks or fluid relief columns shall be so installed as to prevent freezing under normal operating conditions.

HG-709.1 Heating Systems With Open Expansion Tank. An indoor overflow from the upper portion of the expansion tank shall be provided in addition to an open vent, the indoor overflow to be carried within the building to a suitable plumbing fixture or the basement.

HG-709.2 Closed Heating Systems. An expansion tank shall be installed that will be consistent with the volume and capacity of the system. If the system is designed for a working pressure of 30 psi (200 kPa) or less, the tank shall be suitably designed for a minimum hydrostatic test pressure of 75 psi (520 kPa). Expansion tanks for systems designed to operate above 30 psi (200 kPa) shall be constructed in accordance with Section VIII, Division 1. Alternatively, a tank built to Section X requirements may be used if the pressure and temperature ratings

of the tank are equal to or greater than the pressure and temperature ratings of the system. Provisions shall be made for draining the tank without emptying the system, except for prepressurized tanks.

The minimum capacity of the closed type expansion tank may be determined from Table HG-709.2 or from the following formula where the necessary information is available:

(U.S. Customary Units)

$$V_t = [(0.00041T - 0.0466)V_s]/[(P_a/P_f) - (P_a/P_o)]$$

(SI Units)

$$V_t = [(0.18155T - 8.236)V_s]/[(P_a/P_f) - (P_a/P_o)]$$

where

P_a = atmospheric pressure
P_f = fill pressure
P_o = maximum operating pressure
T = average operating temperature
V_s = volume of system, not including tanks
V_t = minimum volume of tanks

TABLE HG-709.2
EXPANSION TANK CAPACITIES
FOR FORCED HOT WATER SYSTEMS

[Based on average operating water temperature 195°F (90°C), fill pressure 12 psig (83 kPa), and maximum operating pressure 30 psig (200 kPa)]

System Volume, gal (m^3)	Tank Capacities, gal (m^3)	
	Prepressurized Diaphragm Type	Nonpressurized Type
100 (0.38)	9 (0.034)	15 (0.057)
200 (0.76)	17 (0.064)	30 (0.114)
300 (1.14)	25 (0.095)	45 (0.170)
400 (1.51)	33 (0.125)	60 (0.227)
500 (1.89)	42 (0.159)	75 (0.284)
1,000 (3.79)	83 (0.314)	150 (0.568)
2,000 (7.57)	165 (0.625)	300 (1.136)

GENERAL NOTE: System volume includes volume of water in boiler, radiation, and piping, not including the expansion tank. Expansion tank capacities are based on an acceptance factor of 0.4027 for prepressurized types and 0.222 for nonprepressurized types. A procedure for estimating system volume and determining expansion tank sizes for other design conditions may be found in Chapter 12 of the 1996 HVAC Systems and Equipment Volume of the ASHRAE Handbook.

HG-709.3 Hot Water Supply Systems. If a system is equipped with a check valve or pressure reducing valve in the cold water inlet line, consideration should be given to the installation of an airtight expansion tank or other suitable air cushion. Otherwise, due to the thermal expansion of the water, the safety relief valve may lift periodically. If an expansion tank is provided, it shall be constructed in accordance with Section VIII, Division 1 or Section X. Except for prepressurized tanks, which should be installed on the cold water side, provisions shall be made for draining the tank without emptying the system. See Fig. HLW-809.1 for a typical acceptable installation.

HG-710 STOP VALVES

HG-710.1 For Single Steam Boilers. When a stop valve is used in the supply pipe connection of a single steam boiler, there shall be one used in the return pipe connection.

HG-710.2 For Single Hot Water Heating Boilers

(a) Stop valves shall be located at an accessible point in the supply and return pipe connections as near the boiler nozzle as is convenient and practicable, of a single hot water heating boiler installation to permit draining the boiler without emptying the system.

(b) When the boiler is located above the system and can be drained without draining the system, stop valves may be eliminated.

HG-710.3 For Multiple Boiler Installations. A stop valve shall be used in each supply and return pipe connection of two or more boilers connected to a common system. See Figs. HG-703.1 and HG-703.2.

HG-710.4 Type of Stop Valve(s)

(a) All valves or cocks shall conform with the applicable portions of HF-203 and may be ferrous or nonferrous.

(b) The minimum pressure rating of all valves or cocks shall be at least equal to the pressure stamped upon the boiler, and the temperature rating of such valves or cocks, including all internal components, shall be not less than 250°F (120°C).

(c) Valves or cocks shall be flanged, threaded, or have ends suitable for welding or brazing.

(d) All valves or cocks with stems or spindles shall have adjustable pressure type packing glands and, in addition, all plug type cocks shall be equipped with a guard or gland. The plug or other operating mechanism shall be distinctly marked in line with the passage to indicate whether it is opened or closed.

(e) All valves or cocks shall have tight closure when under boiler hydrostatic test pressure.

HG-710.5 Identification of Stop Valves by Tags. When stop valves are used, they shall be properly designated substantially as follows by tags of metal or other durable material fastened to them:

Supply Valve - Number ( )

Do Not Close Without Also Closing Return Valve - Number ( )

Return Valve - Number ( )

Do Not Close Without Also Closing Supply Valve - Number ( )

HG-715 BOTTOM BLOWOFF AND DRAIN VALVES

(a) *Bottom Blowoff Valve.* Each steam boiler shall have a bottom blowoff connection fitted with a valve or cock connected to the lowest water space practicable with a minimum size as shown in Table HG-715. The discharge piping shall be full size to the point of discharge.

TABLE HG-715
SIZE OF BOTTOM BLOWOFF PIPING, VALVES, AND COCKS

Minimum Required Safety Valve Capacity, lb (kg) of steam/hr [Note (1)]	Blowoff Piping, Valves, and Cocks Min. Size NPS (DN)
Up to 500 (225)	¾ (20)
501 to 1,250 (225 to 550)	1 (25)
1,251 to 2,500 (550 to 1 200)	1¼ (32)
2,501 to 6,000 (1 200 to 2 700)	1½ (40)
6,001 (2 700) and larger	2 (50)

NOTE: (1) To determine the discharge capacity of safety relief valves in terms of Btu, the relieving capacity in lb of steam/hr is multiplied by 1,000.

(b) Boilers having a capacity of 25 gal (95 l) or less are exempt from the above requirements, except that they must have an NPS ¾ (DN 20) minimum drain valve.

(c) *Drain Valve.* Each steam or hot water boiler shall have one or more drain connections, fitted with valves or cocks. These shall be connected at the lowest practicable point on the boiler, or to the lowest point on piping connected to the boiler, at the lowest practicable point on the boiler. The minimum size of the drain piping, valves, and cocks shall be NPS ¾ (DN 20). The discharge piping shall be full size to the point of discharge. When the blowoff connection is located at the lowest water containing space, a separate drain connection is not required.

(d) *Minimum Pressure Rating.* The minimum pressure rating of valves and cocks used for blowoff or drain purposes shall be at least equal to the pressure stamped on the boiler but in no case less than 30 psi (200 kPa). The temperature rating of such valves and cocks shall not be less than 250°F (120°C).

HG-716 MODULAR BOILERS

(a) *Individual Modules*

(1) The individual modules shall comply with all the requirements of Part HG, except as specified in HG-607, HG-615, and this paragraph. The individual modules shall be limited to a maximum input of 400,000 Btuh (gas), 3 gal/hr (1 l/hr) (oil), or 115 kW (electricity).

(2) Each module of a steam heating boiler shall be equipped with

(a) safety valve, see HG-701

(b) blowoff valve, see HG-7 15 (a)

(c) drain valve, see HG-715 (c)

(3) Each module of a modular hot water heating boiler shall be equipped with

(a) safety relief valve, see HG-701

(b) drain valve, see HG-715 (c)

(b) *Assembled Modular Boilers*

(1) The individual modules shall be manifolded together at the job-site without any intervening valves. The header or manifold piping is field piping and is exempt from Article 2, Part HG, HF, HB, or HC.

(2) The assembled modular steam heating boiler shall also be equipped with

(a) feedwater connection, see HG-705 (a)

(b) return pipe connection, see HG-703.2

(3) The assembled modular hot water heating boiler shall also be equipped with

(a) makeup water connection, see HG-705 (b)

(b) provision for thermal expansion, see HG-709

(c) stop valves, see HG-710.2

HG-720 SETTING

Boilers of wrought materials of the wet-bottom type having an external width of over 36 in. (900 mm) shall have not less than 12 in. (300 mm) between the bottom of the boiler and the floorline, with access for inspection. When the width is 36 in. (900 mm) or less, the distance between the bottom of the boiler and the floorline shall be not less than 6 in. (150 mm), except that, when any part of the wet bottom is not farther from an outer edge than 12 in. (300 mm), this distance shall be not less than 4 in. (100 mm).

HG-725 METHODS OF SUPPORT

HG-725.1 Loadings

(a) The design and attachment of lugs, hangers, saddles, and other supports shall take into account the stresses due to hydrostatic head in determining the minimum thicknesses required. Additional stresses imposed by effects other than working pressure or static head, which increase the average stress by more than 10% of the allowable working stress, shall also be taken into account. These effects include the weight of the component and its contents, and the method of support.

(b) In applying the requirements of (a) above, localized stresses due to concentrated support loads, temperature changes, and restraint against dilation of the boiler due to pressure shall be provided for. Lugs, hangers, brackets, saddles, and pads shall conform satisfactorily to the shape of the shell or surface to which they are attached or are in contact.

HG-725.2 Boilers Over 72 in. (1 800 mm) in Diameter. A horizontal-return tubular boiler over 72 in. (1 800 mm) in diameter shall be supported from steel hangers by the outside-suspension type of setting, independent of the furnace wall. The hangers shall be so designed that the load is properly distributed.

HG-725.3 Boilers Over 54 in. (1 400 mm) up to 72 in. (1 800 mm) in Diameter. A horizontal-return tubular boiler over 54 in. (1 400 mm) and up to and including 72 in. (1 800 mm) in diameter shall be supported by the outside-suspension type of setting, or at four points by not less than eight steel brackets set in pairs, the brackets of each pair to be spaced not over 2 in. (50 mm)

apart and the load to be equalized between them. [See Fig. HG-725(a).]

HG-725.4 Boilers up to 54 in. (1 400 mm) in Diameter. A horizontal-return tubular boiler up to and including 54 in. (1 400 mm) in diameter shall be supported by the outside-suspension type of setting, or by not less than two steel brackets on each side.

HG-725.5 Supporting Members. If the boiler is supported by structural steel work, the steel supporting members shall be so located or insulated that the heat from the furnace can not impair their strength.

HG-725.6 Lugs or Hangers. Lugs, hangers, or brackets made of materials in accordance with the Code requirements may be attached by fusion welding provided they are attached by fillet welds along the entire periphery or contact edges. Figure HG-725(b) illustrates an acceptable design of hanger bracket with the additional requirement that the center pin be located at the vertical center line over the center of the welded contact surface. The bracket plates shall be spaced at least 2½ in. (64 mm) apart, but this dimension shall be increased if necessary to permit access for the welding operation. The stresses computed by dividing the total load on each lug, hanger, or bracket, by the minimum cross-sectional area of the weld shall not exceed 2800 psi (19 MPa). Where it is impractical to attach lugs, hangers, or brackets by welding, studs with not less than 10 threads/in. (approx. 4 threads/cm) may be used. In computing the shearing stresses, the root area at the bottom of the thread shall be used. The shearing and crushing stresses on studs shall not exceed 8% of the strength given in Table HF-300.1 for bolting materials.

HG-725.7 Settings. Boilers of wrought materials of the wet-bottom type having an external width of over 36 in. (900 mm) shall be supported so as to have a minimum clearance of 12 in. (300 mm), between the bottom of the boiler and the floor, to facilitate inspection. When the width is 36 in. (900 mm) or less, the clearance between the bottom of the boiler and the floorline shall be not less than 6 in. (150 mm), except when any part of the wet bottom is not farther from the outer edge than 12 in. (300 mm). This clearance shall be not less than 4 in. (100 mm). Boiler insulation, saddles, or other supports shall be arranged so that inspection openings are readily accessible.

FIG. HG-725(a) SPACING AND WELD DETAILS FOR SUPPORTING LUGS IN PAIRS ON HORIZONTAL-RETURN TUBULAR BOILER

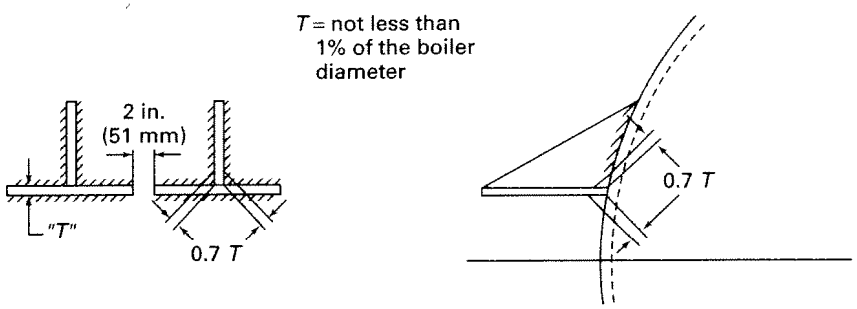


FIG. HG-725(b) WELDED BRACKET CONNECTION FOR HORIZONTAL-RETURN TUBULAR BOILER