Editorial changes included.

Deleted items are designated by strikethrough.
Additions are designated by double underline.

The National Board of Boiler & Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, Ohio 43229-1183
Phone: (614)888-8320
FAX: (614)847-1828
**Editorial Note:** Internal audit requests that the words “ANSI/NB-23, An American National Standard” be added somewhere on the first page/title page.

---

**Editorial Note:** ASME Code “Stamping” referenced throughout the NBIC includes the ASME Boiler and Pressure Vessel Code Symbol Stamps used for conformity assessment prior to the 2010 edition/2011 addendum and the equivalent ASME Certification Mark with Designator required to meet the later editions of the ASME Boiler and Pressure Vessel Code Sections. When other construction codes or standards are utilized for repairs or alterations, stamping shall mean the identification symbol stamp required by that code or standard to indicate conformity assessment.

---

**Proposed revisions to the Code approved by the NBIC Committee are submitted to the American National Standards Institute and published on the National Board Website to invite comments from all interested persons. After the allotted time for public review and final approval, the new edition is published. The Forward, Introduction, Personnel and Index Sections of the NBIC are provided for guidance and informational purposes only and shall not be considered a part of the Code. Theses sections are not approved by the NBIC Committee or submitted to the American National Standards Institute.**

---

**TABLE 7.4-f**

<table>
<thead>
<tr>
<th>Area (US Customary)</th>
<th>Area (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ft²</td>
<td>0.46 m²</td>
</tr>
</tbody>
</table>

Volumes in cubic inches (in.³) were converted to cubic mm (mm³) and volumes in cubic feet (ft³) were converted to cubic meters (m³). See examples in NBIC Parts 1, 2 or 3, Tables 7.4-g and 7.4-h.

---

1.1 **SCOPE**

**NBIC Part 1** This part provides requirements and guidelines for the installation of power boilers, steam heating boilers, hot-water heating boilers, hot-water supply boilers, potable water heaters, pressure vessels and piping.

The proper installation of boilers, pressure vessels, piping, and other pressure-retaining items is essential for safe and satisfactory operation. The owner-user is responsible for ensuring that installations meet all the requirements of the Jurisdiction at the point of installation including licensing, registration, or certification of those performing installations. NBIC Part 1 identifies minimum safety requirements for installing pressure-retaining items when NBIC Part 1 is mandated by a Jurisdiction. Otherwise, the requirements specified in NBIC Part 1 provide information and guidance for installers, contractors, owners, inspectors, and Jurisdictions to ensure safe and satisfactory installation of specified pressure-retaining items. Jurisdictions may require other safety standards, including following manufacturer’s recommendations. When a Jurisdiction establishes different requirements or where a conflict exists, the rules of the Jurisdiction prevail.
Users of NBIC Part 1 are cautioned that other requirements may apply for a particular installation and NBIC Part 1 is not a substitute for sound engineering evaluations.

**NB10-1201**

**Part 1, 1.6**

**1.6 GENERAL REQUIREMENTS**

The following are general requirements for the boilers, heaters and pressure vessels covered in NBIC Part 1, Section 2, NBIC Part 1 Section 3, NBIC Part 1 Section 4, and NBIC Part 1 Supplement 5. Refer to each referenced section for additional requirements specific to the type of equipment covered by each section.

**NB10-1201**

**Part 1, 1.6.1**

**1.6.1 SUPPORTS, FOUNDATIONS, AND SETTINGS**

Each boiler, heater, vessel and its associated piping must be safely supported. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal expansion and contraction), and loadings (including the weight of the fluid in the system during a pressure test) in accordance with jurisdictional requirement, manufactures recommendations, and/or other industry standards, as applicable.

**Editorial**

**NB10-1201**

**Part 1, 1.6.2**

**1.6.2 STRUCTURAL STEEL**

a) If the boiler, heater, or vessel is supported by structural steel work, the steel supporting members shall be so located or insulated that the heat from the furnace will not affect their strength.

b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

**NB10-1201**

**Part 1, 1.6.3**

**1.6.3 EXIT**

Two means of exit shall be provided for equipment rooms exceeding 500 sq. ft. (46.5 sq. m) of floor area and containing one or more boilers having a combined fuel capacity of 1,000,000 Btu/hr (293 kW) or more (or equivalent electrical heat input). Each elevation shall be provided with at least two means of exit, each to be remotely located from each other. A platform at top of a single boiler, heater, vessel is not considered an elevation.

**Editorial**

**NB10-1201**

**Part 1, 1.6.4**

**1.6.4 LADDERS AND RUNWAYS**

a) All walkways, runways, and platforms shall be:

1) of metal construction or equivalent material;

2) provided between or over the top of boilers, heaters, or vessels that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;

3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);

4) of bolted, welded, or riveted construction; and

5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe board.

b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.

c) Ladders that serve as a means of access to walkways, runways, or platforms shall:

1) be of metal construction and not less than 18 in. (460 mm) wide;

2) have rungs that extend through the side members and are permanently secured;

3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;

4) have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and

5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.

d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.
### 1.6.5 FUEL
All fuel systems shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or industry standards, as applicable.

### 1.6.6 VENTILATION AND COMBUSTION AIR

- **a)** The equipment room shall have an adequate air to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room and sufficient to maintain ambient temperatures as recommended by the boiler, heater, or vessel manufacturer. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans. When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer’s recommendations. However, ventilation for the equipment room must still be considered.

- **b)** When combustion air is supplied to the boiler, heater, vessel by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer’s recommendations. However, ventilation for the equipment room must still be considered.

- **c)** Unobstructed air openings shall be sized on the basis of the manufacturer’s recommendations, or as specified by the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions, or 1 sq. in. (650 sq. mm) free area per 2000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room. The equipment room supply openings shall be kept clear at all times.

- **d)** Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1000 Btu/hr (293W) of maximum fuel input for the combined burners of all boilers and heaters located in the equipment room. Additional capacity may be required for other fuel burning equipment in the equipment room.

- **e)** When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that burners will not operate without an adequate number of ventilators/fans in operation.

- **f)** The size of openings specified in c) above may be reduced when special engineered air supply systems approved by the Jurisdiction are used.

- **g)** Care should be taken to ensure that steam, water and fluid lines are not routed across combustion air openings, where freezing may occur in cold climates.

### 1.6.7 LIGHTING
The equipment room should be well lighted and it should have an emergency light source for use in case of power failure.

### 1.6.8 CHIMNEY OR STACK
Chimneys or stacks shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or industry standards, as applicable.

### 1.6.9 FINAL ACCEPTANCE
Boilers, heaters, or pressure vessels may not be placed into service until its installation has been inspected and accepted by the appropriate jurisdictional authorities.
### 2.1 SCOPE

**NBIC Part 1, Section 2** This section provides requirements and guidelines for the installation of power boilers.

### 2.3.1 SUPPORTS, FOUNDATIONS, AND SETTINGS

Each boiler and its associated piping must be safely supported. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal movement), and loadings (including the weight of water during a hydrostatic test) in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

See **NBIC Part 1, Section 1.6.1, Supports, Foundations and Settings**

### 2.3.2 STRUCTURAL STEEL

a) 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 will not affect their strength.

b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

See **NBIC Part 1, Section 1.6.2, Structural Steel**

### 2.4.1 EXIT

Two means of exit shall be provided for equipment rooms exceeding 500 sq. ft. (46.5 sq. m) floor area and containing one or more boilers having a combined fuel capacity of 1,000,000 Btu/hr (293 kW) or more. Each elevation shall be provided with at least two means of exit, each to be remotely located from the other. A platform at the top of a single boiler is not considered an elevation.

See **NBIC Part 1, Section 1.6.3, Exit**

### 2.4.2 LADDERS AND RUNWAYS

a) All walkways, runways, and platforms shall be:

1) of metal construction;

2) provided between or over the top of boilers that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;

3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);

4) of bolted, welded, or riveted construction; and

5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe-board.

b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and shall be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.
c) Ladders that serve as a means of access to walkways, runways, or platforms shall:

1) be of metal construction and not less than 18 in. (460 mm) wide;

2) have rungs that extend through the side members and are permanently secured;

3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;

4) have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and

5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.

d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.

See NBIC Part 1, Section 1.6.4, Ladders and Runways

2.5.1.3 PUMPS

a) Boiler feedwater pumps shall have discharge pressure in excess of the maximum allowable working pressure (MAWP) highest set pressure relief valve in order to compensate for frictional losses, entrance losses, regulating valve losses, and normal static head, etc. Each source of feedwater shall be capable of supplying feedwater to the boiler at a minimum pressure of 3% higher than the highest setting of any safety pressure relief valve on the boiler proper plus the expected pressure drop across the boiler. Detailed engineering evaluation of the pump selection shall be performed and available. The following table is a guideline for estimating feedwater pump differential:

2.5.2 FUEL

Fuel systems, whether firing coal, oil, gas, or other substance, shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

See NBIC Part 1, Section 1.6.5, Fuel

2.5.3.2 REMOTE EMERGENCY SHUTDOWN SWITCHES

a) A manually operated remote shutdown switch(es) or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch(es) in order to safeguard against tampering. Where approved by the Jurisdiction, alternate locations of remote emergency switch(es) may be provided.

b) For equipment rooms exceeding 500 ft.² (46 m²) floor area or containing one or more boilers having a combined fuel capacity of 1,000,000 Btu/hr (293 kW) or more, additional manually operated remote emergency shutdown switches shall be located at suitably identified points of egress acceptable to the Jurisdiction.

c) Where a boiler is located indoors in a facility and not in a equipment room, a remote emergency shutdown switch shall be located within 50 ft. (15 m) of the boiler along the primary egress route from the boiler area.

d) Consideration should be given to the type and location of the remote emergency shutdown switch(es) in order to safeguard against tampering. Where approved by the Jurisdiction, alternate locations of remote emergency switch(es) may be provided.
For atmospheric-gas burners and for oil burners where a fan is on the common shaft with the oil pump, the emergency remote shutdown switch(es) or circuit breaker(s) must disconnect all power to the burner controls.

For power burners with detached auxiliaries, the emergency remote shutdown switch(es) or circuit breaker(s) need only shut off the fuel input to the burner.

### 2.5.4 VENTILATION AND COMBUSTION AIR

a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the boiler room. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans.2

b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2,000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room air supply openings shall be kept clear at all times.

c) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all boilers located in the equipment room. Additional capacity may be required for any other fuel-burning equipment in the boiler room.

d) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.

e) The size of openings specified in NBIC Part 1, 2.5.4 b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.

f) Care should be taken to ensure that steam and water lines are not routed across combustion air openings, where freezing may occur in cold climates.
See NBIC Part 1, Section 1.6.6, Ventilation and Combustion Air

2 Fans—When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer’s recommendations. However, ventilation for the equipment room must still be considered.

### 2.5.5 LIGHTING

The equipment room should be well lit and it should have an emergency light source for use in case of power failure.
See NBIC Part 1, Section 1.6.7, Lighting

### 2.6.1 CHIMNEY OR STACK

Chimneys or stacks shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or industry standards, as applicable.
See NBIC Part 1, Section 1.6.8, Chimney or Stack

p) Boiler blowoff systems shall be constructed in accordance with the Guide for Blowoff Vessels (NB-27), which can be found on the National Board website, www.nationalboard.org.2

### 2.8.2 PRESSURE GAGE

**a)** Each steam boiler shall have a pressure gage connected to the steam space or to the steam connection to the water column. When a pressure-reducing valve is installed in the steam supply piping, a pressure gage shall be installed on the low pressure side of the pressure-reducing valve.

**b)** The dial range shall not be less than 1.5 times and no greater than two times the pressure at which the lowest pressure relief valve is set.

### 2.8.4 PRESSURE CONTROL

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

**a)** Each individual steam boiler or each system of commonly connected steam boilers shall have a control that will cut off the fuel supply when the steam pressure reaches an operating limit, which shall be less than the maximum allowable working pressure.

**b)** Each individual automatically fired steam boiler shall have a safety limit control, with a manual reset, that will cut off the fuel supply to prevent steam pressure from exceeding the maximum allowable working pressure of the boiler. Each control shall be constructed to prevent a pressure setting above the maximum allowable working pressure of the boiler.

**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 connections to the boiler shall not be less than NPS 1/4 (DN 8), but where steel or wrought iron pipe or tubing is used, they shall not be less than NPS 1/2 (DN 15). The minimum size of an external siphon shall be NPS ¼ (DN 8) or 3/8 in. (10 mm) outside diameter nonferrous tubing. For manifold connections, the minimum size shall be as specified in the original code of construction.

### 2.8.5 AUTOMATIC LOW-WATER FUEL CUTOFF AND/OR WATER FEEDING DEVICE FOR STEAM OR VAPOR SYSTEM BOILERS

**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 when the surface of the water falls to 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 directly to a boiler, provided the connections are made to the boiler with nonferrous tees or Y’s not less than NPS 1/2 (DN 15) between the boiler and 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)** In addition to the requirements in **a)** and **b)** above, a secondary low-water fuel cutoff with manual reset shall be provided on each automatically fired steam or vapor system boiler.

**d)** Fuel cutoffs and water feeding devices embodying a separate chamber shall have a vertical drain pipe, extended to a safe point of discharge, and a blowoff valve not less than NPS 3/4 (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.
2.9.1 VALVE REQUIREMENTS – GENERAL

a) Safety valves are designed to relieve steam. Only direct spring loaded safety valves, direct spring loaded safety relief valves, or pilot operated pressure relief valves designed to relieve steam shall be used for steam service.

b) Safety relief valves are valves designed to relieve either steam or water, depending on the application.

c) Safety and safety pressure relief valves are to be manufactured in accordance with a national or international standard.

d) Deadweight or weighted-lever pressure relief valves shall not be used.

e) For high-temperature water boilers, safety relief valves shall have a closed bonnet, and safety relief valve bodies shall not be constructed of cast iron.

f) Safety and safety pressure relief valves with an inlet connection greater than NPS 3 (DN 80) used for pressure greater than 15 psig (103 kPa), shall have a flange inlet connection or a welding-end inlet connection. The dimensions of flanges subjected to boiler pressure shall conform to the applicable standards.

g) When a safety or safety pressure relief valve is exposed to outdoor elements that may affect operation of the valve, it is permissible to shield the valve with a cover. The cover shall be properly vented and arranged to permit servicing and normal operation of the valve.

2.9.1.1 NUMBER

At least one National Board capacity certified safety or safety pressure relief valve shall be installed on the boiler. If the boiler has more than 500 sq. ft. (46.5 sq. m.) of heating surface, or if an electric boiler has a power input of more than 3.76 million Btu/hr (1,100 kW), two or more National Board capacity certified safety or safety pressure relief valves shall be installed.

2.9.1.2 LOCATION

a) Safety or safety pressure relief valves shall be placed on, or as close as physically possible to, the boiler proper.

b) Safety or safety pressure relief valves shall not be placed on the feedline.

c) Safety or safety pressure relief valves shall be connected to the boiler independent of any other connection without any unnecessary intervening pipe or fittings. Such intervening pipe or fittings shall not be longer than the face-to-face dimension of the corresponding tee fitting of the same diameter and pressure rating as listed in the applicable standards.

2.9.1.3 CAPACITY

a) The pressure-relieving relief valve capacity for each boiler shall be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6% above the highest pressure at which any valve is set and in no case to more than 6% above the maximum allowable working pressure of the boiler.

b) The minimum relieving capacity for other than electric boilers and forced-flow steam generators with no fixed steam line and waterline shall be estimated for the boiler and waterwall heating surfaces as given in NBIC Part 1, Table 2.9.1.3, but in no case should the minimum relieving capacity be less than the maximum designed steaming capacity as determined by the manufacturer.

c) The required relieving capacity in pounds per hour of the safety or safety pressure relief valves on a high temperature water boiler shall be determined by dividing the maximum output in Btu at the boiler nozzle obtained by the firing of any fuel for which the unit is designed by one thousand.
d) The minimum safety or safety pressure relief valve relieving capacity for electric boilers is shall not be less than 3.5 lbs/hr/kW (1.6 kg/hr/kW) input.

e) If the safety or safety pressure relief valve capacity cannot be computed, or if it is desirable to prove the computations, it should be checked by any one of the following methods; and if found insufficient, additional relieving capacity shall be provided:

1) By performing an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. This method should not be used on a boiler with a superheater or reheater, or on a high-temperature water boiler;

2) By measuring the maximum amount of fuel that can be burned and computing the corresponding evaporative capacity upon the basis of the heating value of the fuel;

3) By determining the maximum evaporative capacity by measuring the feedwater. The sum of the safety pressure relief valve capacities marked on the valves shall be equal to or greater than the maximum evaporative capacity of the boiler. This method should not be used on high-temperature water boilers.

<table>
<thead>
<tr>
<th>NB11-0401 Part 1, 2.9.1.4</th>
<th>2.9.1.4 SET PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>One or more safety or safety pressure relief valves on the boiler proper shall be set at or below the maximum allowable working pressure. If additional valves are used, the highest pressure setting shall not exceed the maximum allowable working pressure by more than 3%. The complete range of pressure settings of all the safety pressure relief valves on a boiler shall not exceed 10% of the highest pressure to which any valve is set. Pressure setting of safety pressure relief valves on high temperature water boilers may exceed this 10% range.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 NB15-0306 Part 1, 2.9.2</th>
<th>2.9.2 FORCED-FLOW STEAM GENERATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>For a forced-flow steam generator with no fixed steamline and waterline, equipped with automatic controls and protective interlocks responsive to steam pressure, safety pressure relief valves may be provided in accordance with the above paragraphs identified in NBIC Part 1, 2.9.1 or the following protection against overpressure shall be provided:</td>
<td></td>
</tr>
</tbody>
</table>

a) One or more power-actuated pressure relieving valves shall be provided in direct communication with the boiler when the boiler is under pressure and shall receive a control impulse to open when the maximum allowable working pressure at the superheater outlet is exceeded. The total combined relieving capacity of the power-actuated pressure relieving valves shall be not less than 10% of the maximum design steaming capacity of the boiler under any operating condition as determined by the manufacturer. The valves shall be located in the pressure part system where they will relieve the overpressure. An isolating stop valve of the outside-screw-and-yoke type should be installed between the power-actuating pressure relieving valve and the boiler to permit repairs provided an alternate power-actuated pressure relieving valve of the same capacity is so installed as to be in direct communication with the boiler;

b) Spring-loaded safety pressure relieving valves shall be provided having a total combined relieving capacity, including that of the power-actuated pressure relieving valve, of not less than 100% of the maximum designed steaming capacity of the boiler, as determined by the manufacturer. In this total, credit in excess of 30% of the total relieving capacity shall not be allowed for the power-actuated pressure relieving valves actually installed. Any or all of the spring-loaded safety pressure relieving valves may be set above the maximum allowable working pressure of the parts to which they are connected, but the set pressures shall be such that when all these valves (together with the power-actuated pressure relieving valves) are in operation the pressure will not rise more than 20% above the maximum allowable working pressure of any part of the boiler, except for the steam piping between the boiler and the prime mover;

c) When stop valves are installed in the water-steam flow path between any two sections of a forced-flow steam generator with no fixed steamline and waterline:

1) The power-actuated pressure relieving valve shall also receive a control impulse to
open when the maximum allowable working pressure of the component, having the lowest pressure level upstream to the stop valve, is exceeded;

2) The spring-loaded safety pressure relief valve shall be located to provide overpressure protection for the component having the lowest working pressure; and

3) A reliable pressure-recording device shall always be in service and records kept to provide evidence of conformity to the above requirements.

**NB11-0401 Part 1, 2.9.3**

### 2.9.3 SUPERHEATERS

**a)** Every attached superheater shall have one or more safety pressure relief valves. The location shall be suitable for the service intended and shall provide the overpressure protection required. The pressure drop upstream of each safety pressure relief valve shall be considered in determining the set pressure and relieving capacity of that valve. If the superheater outlet header has a full, free steam passage from end to end and is so constructed that steam is supplied to it at practically equal intervals throughout its length so that there is a uniform flow of steam through the superheater tubes and the header, the safety pressure relief valve or valves may be located anywhere in the length of header.

**b)** The pressure-relieving capacity of the safety pressure relief valve or valves on an attached superheater shall be included in determining the number and size of the safety pressure relief valves for the boiler provided there are no intervening valves between the superheater safety pressure relief valve and the boiler and the discharge capacity of the safety pressure relief relief valve or valves, on the boiler, as distinct from the superheater, is at least 75% of the aggregate capacity required.

**c)** Every independently fired superheater that may be shut off from the boiler and permit the superheater to become a fired pressure vessel shall have one or more safety pressure relief valves having a discharge capacity equal to 6 pounds of steam per hr/sq. ft. (29 kg per hr per sq. m) of superheater surface measured on the side exposed to the hot gases.

**d)** Every safety pressure relief valve used on a superheater discharging superheated steam at a temperature over 450°F (230°C) shall have a casing, including the base, body, bonnet, and spindle constructed of steel, steel alloy, or equivalent heat-resistant material. The valve shall have a flanged inlet connection or a welded-end inlet connection. The seat and disk shall be constructed of suitable heat-erosive and corrosive-resistant material, and the spring fully exposed outside of the valve casing so that it is protected from contact with the escaping steam.

**NB11-0401 Part 1, 2.9.4**

### 2.9.4 ECONOMIZERS

An economizer that may not be isolated from a boiler does not require a safety pressure relief valve. Economizers that may be isolated from a boiler or other heat transfer device, allowing the economizer to become a fired pressure vessel, shall have a minimum of one safety pressure relief valve. Discharge capacity, rated in lbs/hr (kg/hr), of the safety pressure relief valve or valves shall be be calculated from the maximum expected heat absorption rate in Btu/hr (Joules/hr) of the economizer, and will be determined from manufacturer data, divided by 1,000 BTU/lb (2,326,645 W-hr/kg). The safety pressure relief valve shall be installed in a location recommended by the manufacturer, when no recommendation exists the location shall be as close as practical to the economizer outlet.

**NB11-0401 Part 1, 2.9.5**

### 2.9.5 PRESSURE-REDUCING VALVES

**a)** Where pressure-reducing valves are used, one or more safety or safety pressure relief valves shall be installed on the low pressure side of the reducing valve in those installations where the piping or equipment on the low pressure side does not meet the requirements for the steam supply piping.

**b)** The safety or safety pressure relief valves shall be located as close as possible to the pressure-reducing valve.

**c)** Capacity of the safety or safety pressure relief valves shall not be less than the total amount of steam that can pass from the high pressure side to the low pressure side and be such that the pressure rating of the lower pressure piping or equipment shall not be exceeded.
2.9.6 MOUNTING, INSTALLATION AND DISCHARGE REQUIREMENTS

Every boiler shall have outlet connections for the pressure relief valves, independent of any other outside steam connection, the area of opening shall be at least equal to the aggregate areas of inlet connections of all of the attached pressure relief valves. An internal collecting pipe, splash plate, or pan should be used, provided the total area for inlet of steam thereto is not less than twice the aggregate areas of the inlet connections of the attached pressure relief valves. The holes in such collecting pipes shall be at least 1/4 in. (6 mm) in diameter, and the least dimension in any other form of opening for inlet of steam shall be 1/4 in. (6 mm). If pressure relief valves are attached to a separate steam drum or dome, the opening between the boiler proper and the steam drum or dome shall be not less than 10 times the total area of the pressure relief valve inlet.

b) Every pressure relief valve shall be connected so as to stand in an upright position with spindle vertical.

c) The opening or connection between the boiler and the pressure relief valve shall have at least the area of the valve inlet and the inlet pipe to the pressure relief valve shall be as short and straight as possible, no longer than the face to face twice the center-to-end (face) dimension of the corresponding tee fitting of the same diameter, and pressure class, and connection type. When a discharge pipe is used, the cross-sectional area shall not be 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 arranged to avoid undue stresses on the valve or valves.

d) No valve of any description except a changeover valve as defined below, shall be placed between the pressure relief valves and the boiler, nor on the discharge pipe between the pressure relief valves and the atmosphere.

A changeover valve, which allows two redundant pressure relief valves to be installed for the purpose of changing from one pressure relief valve to the other while the boiler is operating, may be used provided the changeover valve is in accordance with the original code of construction. It is recommended that the jurisdiction be contacted to determine the acceptability of changeover valves on boiler applications.

The changeover valve shall be designed such that there is no intermediate position where both pressure relief valves are isolated from the boiler.

e) When two or more pressure relief valves are used on a boiler, they should be mounted either separately or as twin valves made by placing individual valves on Y-bases, or duplex valves having two valves in the same body casing. Twin valves made by placing individual valves on Y-bases or duplex valves having two valves in the same body shall be of equal size.

f) When two valves of different sizes are mounted singly, the relieving capacity of the smaller valve shall not be less than 50% of that of the larger valve.

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

h) All pressure relief valves shall be piped to a safe point of discharge so located or piped as to be carried clear from running boards or platforms. Provision for an ample gravity drain shall be made in the discharge pipe at or near each pressure relief valve, and where water or condensation may collect. Each valve shall have an open gravity drain through the casing below the level of the valve seat. For iron- and steel- bodied valves exceeding NPS 2 (DN 50), the drain hole shall be...
| **NB10-1201**  
Part 1, 2.10.5 | 2.10.5 FINAL ACCEPTANCE |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A boiler may not be placed into service until its installation has been inspected and accepted by the appropriate jurisdictional authorities.</td>
</tr>
<tr>
<td>See NBIC Part 1, Section 1.6.9, Final Acceptance</td>
</tr>
</tbody>
</table>

| **NB16-0809C**  
Part 1, 3.1 | 3.1 SCOPE |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The scope of NBIC Part 1, Section 3.1 provides requirements and guidelines for the installation of steam heating boilers, hot-water heating boilers, hot-water supply boilers, and potable water heaters.</td>
</tr>
</tbody>
</table>

| **NB10-1201**  
Part 1, 3.3.1 | 3.3.1 SUPPORTS |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Each heating boiler shall be supported by masonry and/or structural supports of sufficient strength and rigidity to safely support the heating boiler and its contents without vibration in the heating boiler or its connecting piping and to allow for expansion and contraction.</td>
</tr>
<tr>
<td>See NBIC Part 1, Section 1.6.1, Supports, Foundations and Settings</td>
</tr>
</tbody>
</table>

| **NB10-1201**  
Part 1, 3.3.2 | 3.3.2 SETTINGS |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam heating, hot-water heating, and hot-water supply boilers of wrought materials of the wet-bottom type having an external width of over 36 in. (914 mm) shall be supported so as to have a minimum clearance of 12 in. (305 mm) between the bottom of the boiler and the floor to facilitate inspection. When the width is 36 in. (914 mm) or less, the clearance between the bottom of the boiler and the floor line 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. (305 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.</td>
</tr>
<tr>
<td>See NBIC Part 1, Section 1.6.1, Supports, Foundations and Settings</td>
</tr>
</tbody>
</table>

| **NB10-1201**  
Part 1, 3.3.3 | 3.3.3 STRUCTURAL STEEL |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 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 will not affect their strength.</td>
</tr>
<tr>
<td>b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer's recommendations, and/or industry standards as appropriate.</td>
</tr>
<tr>
<td>See NBIC Part 1, Section 1.6.2, Structural Steel</td>
</tr>
</tbody>
</table>

| **NB15-2303**  
Part 1, 3.3.4 | 3.3.4 CLEARANCES |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Heating boilers shall have a minimum distance of at least 36 in. (914 mm) between the top of the heating boiler and any overhead structure and at least 36 in. (914 mm) between all sides of the heating boiler and adjacent walls, structures, or other equipment. Heating boilers having manholes shall have at least 84 in. (2,135 mm) of clearance between the manhole opening and any wall, ceiling, piping, or other equipment that may prevent a person from entering the heating boiler. Alternative clearances in accordance with the manufacturer's recommendations are subject to tapped not less than NPS 3/8 (DN 10).</td>
</tr>
</tbody>
</table>

i) Discharge piping from safety-pressure relief valves on high-temperature water boilers shall have adequate provisions for water drainage as well as steam venting. |

j) If a muffler is used on a safety or safety-pressure relief valve, it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid a possibility of restriction of the steam passages due to deposits. Mufflers shall not be used on high-temperature water boiler safety-pressure relief valves.
acceptance by the Jurisdiction.

b) Modular heating boilers that require individual units to be set side by side, front to back, or by stacking shall provide clearances in accordance with the manufacturer’s recommendations, subject to acceptance by the Jurisdiction.

c) Heating boilers shall be located so that adequate space is provided for proper operation, maintenance, and inspection of equipment and appurtenances, which shall include the removal of tubes if applicable.

Maintenance—This includes the removal of tubes.

### NB10-1201 Part 1, 3.4.1

#### EXIT

Two means of exit shall be provided for equipment rooms exceeding 500 sq. ft. (46.5 sq. m) of floor area and containing one or more boilers having a combined fuel capacity of 1,000,000 Btu/hr (293 kW) or more (or equivalent electrical heat input). Each elevation shall be provided with at least two means of exit, each to be remotely located from the other. A platform at the top of a single boiler is not considered an elevation.

See NBIC Part 1, Section 1.6.3, Exit.

### NB10-1201 Part 1, 3.4.2

#### LADDERS AND RUNWAYS

a) All walkways, runways, and platforms shall be:

1) of metal construction;

2) provided between or over the top of boilers that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;

3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);

4) of bolted, welded, or riveted construction; and

5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe board.

b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.

c) Ladders that serve as a means of access to walkways, runways, or platforms shall:

1) be of metal construction and not less than 18 in. (460 mm) wide;

2) have rungs that extend through the side members and are permanently secured;

3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;

4) have a clearance of not less than 6 1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and

5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.

d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.
### 3.5.2 FUEL

Fuel systems, whether firing coal, oil, gas, or other substance, shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or industry standards, as applicable.

See NBIC Part 1, Section 1.6.4, *Ladders and Runways*

### Editorial

#### Part 1, 3.5.3.1

**STEAM HEATING, HOT WATER HEATING, AND HOT WATER SUPPLY BOILERS**

a) All wiring for controls, heat generating apparatus, and other appurtenances necessary for the operation of the boiler or boilers shall be installed in accordance with the provisions of national or international standards and comply with the applicable local electrical codes.

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

c) A manually operated remote shutdown switch or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch to safeguard against tampering.

d) If the equipment room door is on the building exterior, the switch shall be located just inside the door. If there is more than one door to the equipment room, there shall be a switch located at each door of egress.
   1) 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.
   2) For power burners with detached auxiliaries, only the fuel input supply to the firebox need be shut off.

### Editorial

#### Part 1, 3.5.3.2 b)

b) A manually operated remote shutdown switch or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch to safeguard against tampering.

### 3.5.4 VENTILATION AND COMBUSTION AIR

a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room. The combustion and ventilation air may be supplied by either an unobstructed air opening or by power ventilation or fans.

b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (645 sq mm) free area per 2,000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room air supply openings shall be kept clear at all times.

c) Power ventilators or fans shall be sized on the basis of 0.2 ft$^3$ (0.006 m$^3$) for...
each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all boilers and/or water heaters located in the equipment room. Additional capacity may be required for any other fuel burning equipment in the equipment room.

d) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.

e) When combustion air is supplied to the heating boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer’s recommendations. However, ventilation for the equipment room must still be considered.

f) The size of openings specified in NBIC Part 1, 3.5.4 b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.

g) Care should be taken to ensure that steam and water lines are not routed across combustion air openings, where freezing may occur in cold climates.

See NBIC Part 1, Section 1.6.6, Ventilation and Combustion Air

Fans – When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.

3.5.5 LIGHTING

The boiler room should be well lit, and it should have an emergency light source for use in case of power failure.

See NBIC Part 1, Section 1.6.7, Lighting

3.6.1 CHIMNEY OR STACK

Chimneys or stacks shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or industry standards, as applicable.

See NBIC Part 1, Section 1.6.8, Chimney or Stack
FIGURE 3.7.5.1-a
STEAM BOILERS IN BATTERY — PUMPED RETURN — ACCEPTABLE PIPING INSTALLATION
FIGURE 3.7.5.2-a
STORAGE POTABLE WATER HEATERS IN BATTERY – ACCEPTABLE PIPING INSTALLATION

Note:
(1) Recirculation system may be gravity or pump activated.

FIGURE 3.7.5.2-b
FLOW THROUGH PORTABLE WATER HEATER WITHOUT PROVISION FOR PIPING EXPANSION—ACCEPTABLE PIPING INSTALLATION.
TABLE 3.7.7.1
SIZE OF BOTTOM BLOWOFF PIPING, VALVE, AND COCKS

<table>
<thead>
<tr>
<th>Minimum Required Safety Valve Capacity, lbs. of steam/hr (kg steam/hr)</th>
<th>Blowoff Piping, Valve, and Cock Sizes, in. (mm) NPS (DN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 500 (227)</td>
<td>¾ (19)</td>
</tr>
<tr>
<td>501 to 1,250 (over 227 to 567)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>1,251 to 2,500 (227 to 1,134)</td>
<td>1-1/4 (32)</td>
</tr>
<tr>
<td>2,501 to 6,000 (1,134 to 2,722)</td>
<td>1-1/2 (38)</td>
</tr>
<tr>
<td>6,001 and larger (2,722)</td>
<td>2 (50)</td>
</tr>
</tbody>
</table>

Note:
To determine the discharge capacity of the safety relief valves in terms of total energy absorbed, use 1 lb steam per hour per 1,000 Btu (1 kg steam per hour per 2,326 kJ).

3.8.1.5 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. The low-water fuel cutoffs must be so located as to automatically cut off the fuel supply when the surface of the water falls to a level not lower than 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.

3.8.2.3 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 hot-water heating or hot-water supply boiler or each system of commonly connected boilers shall have a control that will cut off the fuel supply when the water temperature reaches an operating limit, which shall be less than the maximum allowable temperature.

b) In addition to a) above, each individual automatically fired hot-water heating or hot-water supply boiler shall have a safety limit control with manual reset that will cut off the fuel supply at or below the water temperature at the boiler outlet to prevent the water temperature from exceeding the maximum allowable temperature at the boiler outlet.

3.9 PRESSURE-RELIEVING VALVES

See NBIC Part 1, 3.2 for the scope of pressure retaining items covered by these requirements.

3.9.1 SAFETY PRESSURE RELIEF VALVE REQUIREMENTS – GENERAL

The following general requirements pertain to installing, mounting, and connecting safety pressure relief valves on heating boilers.
### 3.9.1.1 MOUNTING INSTALLATION OF SAFETY AND SAFETYPRESSURE RELIEF VALVES FOR STEAM HEATING, HOT-WATER HEATING, AND HOT-WATER SUPPLY BOILERS

#### 3.9.1.1.1 PERMISSIBLE MOUNTING INSTALLATION

Safety valves and safety relief valves shall be located at the top side of the boiler. The top side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the safety valves be located below the normal operating level and in no case shall the pressure relief valve be located below the lowest permissible water level. 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.

---

#### 3.9.1.1.2 REQUIREMENTS FOR COMMON CONNECTIONS FOR TWO OR MORE VALVES

a) When a boiler is fitted with two or more safety relief 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 relief 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 NPS 4 (DN 100), 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.

---

#### 3.9.1.3 PROHIBITED MOUNTINGS INSTALLATIONS

Safety and safety relief valves shall not be connected to an internal pipe in the boiler.

---

#### 3.9.1.4 USE OF SHUTOFF VALVES PROHIBITED

No shutoff valve 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.

---

#### 3.9.1.5 SAFETY AND SAFETYPRESSURE 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 to minimize reaction moment stress.

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 a safe point of discharge, and there shall be provisions made for properly draining the piping. The size and arrangement of discharge piping 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.
### 3.9.1.6 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 National Board capacity certified temperature and pressure safety relief valve(s) installed. The requirements of NBIC Part 1, 3.9.1.1 through 3.9.1.5 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 should be installed in the horizontal position with the outlet pointed down.

### 3.9.2 PRESSURE RELIEF VALVE REQUIREMENTS FOR STEAM HEATING BOILERS

- Safety pressure relief valves are to be manufactured in accordance with a national or international standard.
- Each steam boiler shall have one or more National Board capacity certified safety pressure relief valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 psig (100 kPa).
- No safety pressure relief valve for a steam boiler shall be smaller than NPS 1/2 (DN 15). No safety pressure relief valve shall be larger than NPS 4 (DN 100). The inlet opening shall have an inside diameter equal to or greater than the seat diameter.
- The minimum valve capacity in pounds (kilograms) per hour (lbs/hr (kg/hr)) shall be the greater of that determined by dividing the maximum BTU/hr (Watts) output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000 BTU/hr/lb (646 W/kg), or shall be determined on the basis of the pounds (kilograms) of steam generated per hour per square foot (square meter) lbs steam/hr/ft² (kg steam/hr/m²) of boiler heating surface as given in NBIC Part 1, Table 3.9.2.9.1.3. For cast-iron boilers, 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 NBIC Part 1, 3.9.2 e) shall be met.
- The safety pressure relief 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 psig (34 kPa) above the maximum allowable working pressure.
- 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 NBIC Part 1, 3.9.2 e). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.
3.9.3 SAFETY PRESSURE RELIEF VALVE REQUIREMENTS FOR HOT-WATER HEATING OR HOT-WATER SUPPLY BOILERS

a) Safety-Pressure relief valves are to shall be manufactured in accordance with a national or international standard.

b) Each hot-water heating or hot-water supply boiler shall have at least one National Board capacity certified safety-pressure relief valve, of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.

c) Hot-water heating or hot-water supply boilers limited to a water temperature not in excess of 210°F

Notes:

- When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/cu.ft. (7.5 MJ/ cu. m), the minimum relieving capacity should be based on the values given for hand-fired boilers above.

- The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tubesheets, and the projected area of headers need to be considered, except that for vertical firetube steam boilers, only that portion of the tube surface up to the middle gage cock is to be computed.

- For firetube boiler units exceeding 8,000 Btu/ft.² (9,085 J/cm.²) (total fuel Btu (J) Input divided by total heating surface), the factor from the table will be increased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) above 8,000 Btu/ft.² (9,085 J/cm.²). For units less than 7,000 Btu/ft.² (7,950 J/cm.²), the factor from the table will be decreased by 1 (4.88).

- For watertube boiler units exceeding 16,000 Btu/ft.² (18,170 J/cm.²) (total fuel Btu input divided by the total heating surface) the factor from the table will be increased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) above 16,000 Btu/ft.² (18,170 J/cm.²). For units with less than 15,000 Btu/ft.² (17,034 J/cm.²), the factor in the table will be decreased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) below 16,000 Btu/ft.² (17,034 J/cm.²).
(99°C) may have, in lieu of the valve(s) specified in b) above, one or more National Board capacity certified temperature and pressure safety relief valves of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.

d) When more than one safety-pressure relief valve is used on either hot-water heating or hot-water supply boilers, the additional valves shall be National Board capacity certified and may have a set pressure within a range not to exceed 6 psig (40 kPa) above the maximum allowable working pressure of the boiler up to and including 60 psig (414 kPa), and 5% for those having a maximum allowable working pressure exceeding 60 psig (4134 kPa).

e) No safety-pressure relief valve shall be smaller than NPS 3/4 (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) should be equipped with a rated safety-pressure relief valve of NPS 1/2 (DN 15).

f) The required relieving capacity, in pounds per hour (lbs/hr) (kg/hr), of the pressure relieving device or devices on a boiler shall be the greater of that determined by dividing the maximum output in BTU/hr (Watts) at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000 BTU/lb (645 W/kg), or shall be determined on the basis of pounds (kilograms) of steam generated per hour per square foot (square meter) of boiler heating surface, as given in NBIC Part 1, Table 3.9.2.2.9.1.3. For cast-iron boilers, 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 NBIC Part 1, 3.9.3 h) shall be met.

g) 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 NBIC Part 1, 3.9.3 h). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

h) Safety-Presure relief valve capacity for each boiler with a single safety-pressure 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-pressure relief valve is used, the over pressure shall be limited to 10% above the set pressure of the highest set valve allowed by NBIC Part 1, 3.9.3 gb).

3.9.4 SAFETY PRESSURE RELIEF VALVE REQUIREMENTS FOR POTABLE WATER HEATERS

a) Each water heater shall have at least one National Board capacity certified temperature and pressure safety relief valve. No safety-temperature and pressure relief valve shall be smaller than NPS 3/4 (DN 20).

b) The pressure setting shall be less than or equal to the maximum allowable working pressure of the water heater. However, if any of the other components in the hot-water supply system (such as valves, pumps, expansion or storage tanks, or piping) have a lesser working pressure rating than the water heater, the pressure setting for the safety-temperature and pressure relief valve(s) shall be based upon the component with the lowest maximum allowable working pressure rating. If more than one safety-temperature and pressure relief valve is used, the additional valve(s) may be set within a range not to exceed 10% over the set pressure of the first valve.

c) The required relieving capacity in Btu/hr (W) of the safety-temperature and pressure relief valve shall not be less than the maximum allowable input unless the water heater is marked with the rated burner input capacity of the water heater on the casing in a readily visible location, in which case the rated burner input capacity may be used as a basis for sizing the safety-temperature pressure relief valves. The relieving capacity for electric water heaters shall be 3,500 Btu/hr (1.0 kW) per kW of input. In every case, the following requirements shall be met. Safety Temperature and pressure relief valve capacity for each water heater 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. Many temperature and pressure relief valves have a National Board capacity certified rating which was determined according to ASME Code requirements, and a lower Canadian Standards Association (CSA) rating value. Where the ASME Code is the only referenced Code of Construction the National Board capacity certified rating may be used. If the water heater is not an ASME vessel, or the CSA rating is required by another standard (such as a plumbing or building code) then that rating shall be used.

d) If operating conditions are changed or additional heating surface is installed, the safety temperature and pressure relief valve capacity shall be increased, if necessary, to meet the new conditions and shall be in accordance with the above provisions. In no case shall the increased input capacity exceed the maximum allowable input capacity. The additional valves required, on account of changed conditions, may be installed on the outlet piping providing there is no intervening valve.

<table>
<thead>
<tr>
<th>NB11-0401 Part 1, 3.9.4.1</th>
<th>3.9.4.1 INSTALLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Temperature and pressure relief valves shall be installed by either the installer or the manufacturer before a water heater is placed in operation.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 1, 3.9.4.2</th>
<th>3.9.4.2 PERMISSIBLE MOUNTINGS, INSTALLATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Temperature and pressure relief valves shall be connected directly to a tapped or flanged opening in the top of the water heater, to a fitting connected to the water heater by a short nipple, to a Y-base, or to a valveless header connecting water outlets on the same heater. Safety Temperature and pressure relief valves shall be installed with their spindles upright and vertical with no horizontal connecting pipe, except that, when the safety temperature and pressure relief valve is mounted directly on the water heater vessel 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. The center line of the safety temperature and pressure relief valve connection shall be no lower than 4 in. (100 mm) from the top of the shell. No piping or fitting used to mount the safety temperature and pressure relief valve shall be of nominal pipe size less than that of the valve inlet.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 1, 3.9.4.3</th>
<th>3.9.4.3 REQUIREMENTS FOR COMMON CONNECTION FOR TWO OR MORE VALVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) When a potable water heater is fitted with two or more safety temperature and pressure relief 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 temperature and pressure release valves with which it connects.</td>
<td></td>
</tr>
<tr>
<td>b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas.</td>
<td></td>
</tr>
<tr>
<td>c) When the size of the water heater requires a safety temperature and pressure relief valve larger than NPS 4 (DN 100) two or more valves having the required combined capacity shall be used. When two or more valves are used on a water heater, they may be single, directly attached, or mounted on a Y-base.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 1, 3.9.4.4</th>
<th>3.9.4.4 THREADED CONNECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A threaded connection may be used for attaching a temperature and pressure relief valve.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 1, 3.9.4.5</th>
<th>3.9.4.5 PROHIBITED MOUNTINGS, INSTALLATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Temperature and pressure relief valves shall not be connected to an internal pipe in the water heater or a cold water feed line connected to the water heater.</td>
<td></td>
</tr>
</tbody>
</table>
### 3.9.4.6 USE OF SHUTOFF VALVES PROHIBITED

No shutoff valve of any description shall be placed between the safety temperature and pressure relief valve and the water heater or on discharge pipes between such valves and the atmosphere.

### 3.9.4.7 SAFETY TEMPERATURE AND PRESSURE RELIEF VALVE DISCHARGE PIPING

a) The discharge from safety temperature and pressure relief valves shall be so arranged that there will be no danger of scalding attendants. When the safety temperature and pressure relief valve discharge is piped away from the water heater to the point of discharge, there shall be provisions for properly draining the piping and valve body. The size and arrangement of discharge piping 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 water heater.

b) When a discharge pipe is used, its internal cross-sectional area shall be not less than the full areanominal size 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. When an elbow is placed on a safety temperature and pressure relief discharge pipe, it shall be located close to the valve outlet.

c) Where multiple valves relieve into a common discharge pipe, the cross-sectional flow area of the common discharge pipe shall be equal to or greater than the sum of the individual temperature and pressure relief valve discharge pipe areas.

### 3.9.5 SAFETY PRESSURE AND SAFETY RELIEF VALVES FOR TANKS AND HEAT EXCHANGERS

#### 3.9.5.1 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 NBIC Part 1, 3.2, Definitions, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a safety pressure 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.

#### 3.9.5.2 HIGH-TEMPERATURE WATER TO WATER HEAT EXCHANGER

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 NBIC Part 1, 3.2, Definitions, the heat exchanger shall be equipped with one or more National Board capacity certified safety pressure relief valves 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.

#### 3.9.5.3 HIGH-TEMPERATURE WATER TO STEAM HEAT EXCHANGER

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 NBIC Part 1, 3.2, Definitions, the heat exchanger shall be equipped with one or more National Board capacity certified safety pressure relief valves set to relieve at a pressure not to exceed 15 psig (100 kPa), and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than 5 psig (34 kPa) above the maximum allowable working pressure of the vessel. For heat exchangers requiring steam pressures greater than 15 psig (100 kPa), refer to NBIC
<table>
<thead>
<tr>
<th>Part 1, Section 2 or Section 4.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.10.2 FINAL ACCEPTANCE</strong></td>
</tr>
<tr>
<td>a) In addition to determining that all equipment called for is furnished and installed in accordance with the plans and specifications, all controls shall be tested by a person familiar with the control system.</td>
</tr>
<tr>
<td>b) Before any new heating plant (or boiler) is accepted for operation, a final (or acceptance) inspection by a person familiar with the system shall be completed and all items of exception corrected.</td>
</tr>
<tr>
<td>See NBIC Part 1, Section 1.6.9, Final Acceptance</td>
</tr>
</tbody>
</table>

| **4.1 SCOPE** |
| NBIC Part 1, Section 4 This section provides requirements and guidelines for the installation of pressure vessels. |

| **4.3.1 SUPPORTS** |
| Each pressure vessel shall be safely supported. The potential for future hydrostatic pressure tests of the vessel after installation shall be considered when designing vessel supports. Design of supports, foundations, and settings shall consider vibration (including seismic and wind loads where necessary), movement (including thermal movement), and loadings (including the weight of water during a hydrostatic test) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable. |
| See NBIC Part 1, Section 1.6.1, Supports, Foundations and Settings |

| **4.5 PRESSURE RELIEF DEVICES** |
| All pressure vessels shall be protected by pressure relief devices in accordance with the following requirements. See NBIC Part 1, 4.1 for the scope of pressure vessels covered by these requirements. Pressure vessels protected by pressure relief devices shall meet the following requirements: |

| **4.5.1 DEVICE REQUIREMENTS** |
| a) Pressure relief devices are to be manufactured in accordance with a national or international standard and be certified for capacity (or resistance to flow for rupture disk devices) by the National Board. |
| b) Dead weight or weighted lever pressure relief valves shall not be used. |
| c) An unfired steam boiler shall be equipped with pressure relief valves as required in NBIC Part 1, 2.9. |
| d) Pressure relief devices shall be selected (e.g., material, pressure, etc.) and installed such that their proper functioning will not be hindered by the nature of the vessel’s contents. |

| **4.5.3 LOCATION** |
| a) The pressure relief device shall be installed directly on the pressure vessel, unless the source of pressure is external to the vessel and is under such positive control that the pressure cannot exceed the maximum overpressure permitted by the original code of construction and the pressure |
relief device cannot be isolated from the vessel, except as permitted by NBIC Part 1, 4.5.6 e) 2).

b) Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or in the piping system connected to the vapor space.

c) Pressure relief devices intended for use in liquid service shall be connected below the normal liquid line. The liquid level during upset conditions shall be considered.

### 4.5.4 CAPACITY

a) The pressure relief device(s) shall have sufficient capacity to ensure that the pressure vessel is not exposed to pressure greater than that specified in the original code of construction.

b) If an additional hazard can be created by exposure of a pressure vessel to fire or other unexpected source of external heat, supplemental pressure relief devices shall be installed to provide any additional capacity that should be required. Pressure vessels that can be exposed to fire or other sources of unexpected external heat may require supplemental pressure relief devices to provide additional relieving capacity.

1) The combined relieving capacity of all installed pressure relief devices shall be adequate to prevent the pressure from rising more than 21% above maximum allowable working pressure.

2) The set point of any supplemental pressure relief devices(s) shall not exceed 110% of the maximum allowable working pressure. If a single pressure relief device is utilized to protect the vessel during both operational and fire or other unexpected external heating conditions, the set point shall not exceed maximum allowable working pressure.

c) Vessels connected together by a system of piping not containing valves that can isolate any pressure vessel should may be considered as one unit when determining capacity requirements.

d) Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid overpressure in case of internal failure.

e) When a non-reclosing device is installed between a pressure relief valve and the pressure vessel, the reduction in capacity due to installation of the nonreclosing device shall be determined in accordance with the code of construction by use of a National Board certified Combination Capacity Factor (CCF). For rupture disks, if a certified combination capacity factor is not available, the capacity of the pressure relief valve shall be multiplied by 0.9 and this value used as the capacity of the combination installation.

a) The owner shall make information regarding the basis of pressure relief device selection, including required capacity, available to the Jurisdiction.

### 4.5.6 INSTALLATION AND DISCHARGE PIPING REQUIREMENTS

a) The opening through all pipe and fittings between a pressure vessel and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. When a discharge pipe is used, the size shall be such that any pressure that may exist or develop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

b) A non-reclosing device installed between a pressure vessel and a pressure relief valve shall meet the requirements of 4.5.6 a).

c) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between...
the vessel and its pressure relief device.

d) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of NBIC Part 1, 4.5.6 a).

e) There shall be no intervening stop valves between the vessel and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge, except under the following conditions:

1) When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity; or,

2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a pressure vessel and its pressure relief device should may be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station.

3) A full area stop valve should may also be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked and sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed.

4) A pressure vessel in a system where the pressure originates from an outside source should may have a stop valve between the vessel and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of the pressure.

5) Pressure vessels designed for human occupancy (such as decompression or hyperbaric chambers) shall be provided with a quick opening stop valve between the pressure vessel and its pressure relief valve. The stop valve shall be normally sealed open with a frangible seal and be readily accessible to the pressure relief attendant.

f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

h) Pressure relief devices shall be installed so they are readily accessible for inspection, repair, or
replacement.]

h) Pressure vessel pressure relief devices and discharge piping shall be safely supported. The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping. Design of supports, foundations, and settings shall consider vibration (including seismic when necessary), movement (including thermal movement), and loadings (including reaction forces during device operation) in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>Part 1, 4.7.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SAFETY PRESSURE RELIEF DEVICES</strong></td>
<td></td>
</tr>
<tr>
<td>a) Each hot water storage tank shall be equipped with an ASME/NB certified temperature and pressure relieving device set at a pressure not to exceed the maximum allowable working pressure and 210°F (99°C).</td>
<td></td>
</tr>
<tr>
<td>b) The temperature and pressure relieving device shall meet the requirements of NBIC Part 1, 4.5.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB16-0809C</th>
<th>Part 1, 5.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 SCOPE</td>
<td></td>
</tr>
<tr>
<td>NBIC Part 1, Section 5 This section provides requirements and guidelines for the installation of piping.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-0303</th>
<th>NB15-0317</th>
<th>Part 1, 5.3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEVICE REQUIREMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Pressure relief devices are to be manufactured in accordance with a national or international standard and be certified for capacity (or resistance to flow for rupture disc devices) by the National Board. shall be manufactured in accordance with a national or international standard and be certified for capacity or flow resistance by the National Board.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) In certain cases piping standards codes of construction permit the use of regulators, which may include integral pressure relief valves to limit the pressure in a piping system. In this case, capacity certification of the pressure relief valve is not required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Some piping codes of construction permit the use of pressure relief devices without capacity certification. In this case, capacity certification of the pressure relief device by the National Board is not required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Dead weight or weighted lever pressure relief devices shall not be used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Pressure relief devices shall be selected (i.e., material, pressure, etc.) and installed such that their proper functioning will not be hindered by the nature of the piping system’s contents.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-0309</th>
<th>Part 1, 5.3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NUMBER OF DEVICES</strong></td>
<td></td>
</tr>
<tr>
<td>At least one pressure relief device shall be provided for protection of a piping system. A pressure relief device installed on a pressure vessel or other component connected to the piping system should be used to meet this requirement. Portions of piping systems with different maximum allowable working pressures shall have a pressure relief device to protect each portion separately.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-0318</th>
<th>Part 1, 5.3.5 b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SET PRESSURE</strong></td>
<td></td>
</tr>
<tr>
<td>a) When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure, except when allowed by the original code of construction.</td>
<td></td>
</tr>
<tr>
<td>b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure needs to be at or below the maximum allowable working pressure.</td>
<td></td>
</tr>
</tbody>
</table>
The set pressures of the additional pressure relief devices shall be such that the pressure cannot exceed the overpressure permitted by the code of construction.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th><strong>NB15-0309</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Part 1, 5.3.6</em></td>
<td><strong>5.3.6</strong> INLET AND DISCHARGE PIPING REQUIREMENTS</td>
</tr>
<tr>
<td>a)</td>
<td>The opening through all pipes and fittings between a piping system and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the operation of the pressure relief device.</td>
</tr>
<tr>
<td>b)</td>
<td>A non-reclosing device installed between a piping system and a pressure relief valve shall meet the requirements of NBIC Part 1, 5.3.6 a).</td>
</tr>
<tr>
<td>c)</td>
<td>The opening in the pipe shall be designed to provide unobstructed flow between the pipe and its pressure relief device.</td>
</tr>
<tr>
<td>d)</td>
<td>When two or more required pressure relief devices are placed on the connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of NBIC Part 1, 5.3.6 a).</td>
</tr>
<tr>
<td>e)</td>
<td>There shall be no intervening stop valves between the piping system and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge except under the following conditions:</td>
</tr>
<tr>
<td>1)</td>
<td>When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity;</td>
</tr>
<tr>
<td>2)</td>
<td>Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a piping system and its pressure relief device should be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station;</td>
</tr>
<tr>
<td>3)</td>
<td>A full area stop valve may be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed; or</td>
</tr>
<tr>
<td>4)</td>
<td>A piping system where the pressure originates from an outside source should have a stop valve between the system and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of pressure.</td>
</tr>
</tbody>
</table>
| f) | Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or
other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

h) The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping.

i) Pressure relief devices shall be installed so they are accessible for inspection, repair, or replacement.

<table>
<thead>
<tr>
<th>NB16-0809C</th>
<th>S1.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1, S1.1</td>
<td>a) This supplement describes provides guidelines for the installation of a Yankee dryer. A Yankee dryer is a pressure vessel with the following characteristics:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-2303</th>
<th>b) 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1, S1.2</td>
<td>4) Pressure roll load (line or nip load)(^7) due to pressing the wet web onto the dryer. Overload protection is usually provided by a control valve that limits the pneumatic or hydraulic forces on the roll loading arms such that the resultant nip load does not exceed the allowable operating nip load.</td>
</tr>
</tbody>
</table>

---

**SUPPLEMENT 2**

**SAFETY PRESSURE RELIEF VALVES ON THE LOW-PRESSURE SIDE OF STEAM PRESSURE-REDUCING VALVES**

<table>
<thead>
<tr>
<th>S2.1 SCOPE</th>
</tr>
</thead>
</table>

This supplement provides requirements and guidelines for the installation of safety valves on the low-pressure side of steam pressure-reducing valves.

a) The subject of protection of vessels in steam service connected to the low-pressure side of a steam-pressure-reducing valve is of considerable importance to proper operation of auxiliary equipment such as pressure cookers, hot-water heating systems, etc., operating at pressures below that which the primary boiler generating unit is operating.

b) To automatically reduce the primary boiler pressure for such processing equipment, pressure-reducing valves are used. The manufacturers of such equipment have data available listing the volume of flow through reducing valves manufactured by them, but such data are not compiled in a form that the results can be deduced readily. To protect the equipment operating on the low-pressure side of a pressure-reducing valve, safety-pressure relief valves of a relieving capacity sufficient to prevent an unsafe pressure rise in case of failure of the pressure-reducing valve, should be installed.

c) The pressure-reducing valve is a throttling device, the design of which is based on certain diaphragm pressures opposed by spring pressure which, in turn, controls the opening through the valve. If the spring, the diaphragm, or any part of the pressure-reducing valve fails, steam will flow...
directly through the valve and the low pressure equipment will be subjected to the boiler pressure. To protect the equipment operating on the low pressure side of the pressure-reducing valve, safety pressure relief valve(s) should be installed on the low pressure side of the pressure-reducing valve, which will provide a relieving capacity sufficient to prevent the pressure from rising above the system design pressure.

d) In most cases pressure-reducing valves used for the reduction of steam pressures have the same pipe size on the inlet and outlet. In case of failure of a pressure-reducing valve, the safety pressure relief valve on the low-pressure side must have a capacity to take care of the volume of steam determined by the high pressure side and the area of the pipe.

**S2.2 SAFETY PRESSURE RELIEF VALVE CAPACITY**

a) The capacity of the safety pressure relief valve(s) on the low-pressure side of the pressure-reducing valve should be based on the capacity of the pressure-reducing valve when wide open or under maximum flow conditions or the flow capacity through the bypass valve.

b) By using the formula in NBIC Part 1, S2.3, Inspectors may calculate the required relieving capacities of the safety pressure relief valve(s) installed on the low-pressure side of the pressure-reducing valve.

c) Usually a pressure-reducing valve has a bypass arrangement so that in case of failure of the pressure-reducing valve the boiler pressure may be short circuited into the low-pressure line without passing through the pressure-reducing valve. When determining the required relieving capacity of safety pressure relief valves for the low-pressure side of the pressure-reducing valve, the steam flow through the bypass must be taken into consideration.

**S2.3 CALCULATION OF SAFETY PRESSURE RELIEF VALVE RELIEVING CAPACITY**

a) When a pressure-reducing valve is installed, there are two possibilities of introducing boiler pressure into the low-pressure system:

1) the failure of the pressure-reducing valve so that it remains wide open; and
2) the possibility of the bypass valve being open.

b) It is necessary therefore, to determine the flow under both circumstances in paragraph a) above and check that the size of the safety pressure relief valve under either condition will be adequate. The following formulas should be used:

1) \[ W = AKC \]

where,

\[ A = \text{internal area in sq. in. (sq. mm) of the inlet pipe size of the pressure-reducing valve (see NBIC Part 1, Table S2.5)} \]

\[ K = \text{flow coefficient for the pressure-reducing valve (see NBIC Part 1, S2.4)} \]

\[ C = \text{flow capacity of saturated steam through a 1 sq. in. (1 sq. mm) pipe in lbs/hr/in}^2 \text{ (kg/hr/mm}^2\text{) at various pressure differentials from NBIC Part 1, Tables S2.3-a, S2.3-b, or S2.3-c (for U.S. Customary units) or NBIC Part 1, Tables S2.3M-a, S2.3M-b, or S2.3M-c (for metric units).} \]

2) \[ W = A_1 K_1 C_1 \]

where,
A₁ = internal area in sq. in. (sq. mm) of the pipe size of the bypass around the pressure-reducing valve

K₁ = flow coefficient for the bypass valves (see NBIC Part 1, S2.4)

C₁ = flow capacity of saturated steam through a 1 sq. in. (1 sq. mm) pipe in lbs/hr/in² (kg/hr/mm²) at various pressure differentials from Tables S2.3-a, S2.3-b, or S2.3-c (for U.S. Customary units) or Tables NBIC Part 1, S2.3M-a, S2.3M-b, or S2.3M-c (for metric units).

<table>
<thead>
<tr>
<th>Editorial Part 1, Tables S2.3-a, M-a, -b, M-b, -c, and M-c</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TABLE S2.3-a</strong> CAPACITY OF SATURATED STEAM, IN LB./HR., PER SQ. IN. OF PIPE AREA</td>
</tr>
<tr>
<td><strong>TABLE S2.3M-a</strong> CAPACITY OF SATURATED STEAM, IN KG/HR., PER MM² SQ. MM. OF PIPE AREA</td>
</tr>
<tr>
<td><strong>TABLE S2.3-b</strong> CAPACITY OF SATURATED STEAM, IN LB./HR., PER IN² SQ. IN. OF PIPE AREA</td>
</tr>
<tr>
<td><strong>TABLE S2.3M-b</strong> CAPACITY OF SATURATED STEAM, IN KG/HR.ₚₚ, PER MM² OF PIPE AREA</td>
</tr>
<tr>
<td><strong>TABLE S2.3-c</strong> CAPACITY OF SATURATED STEAM, IN LB./HR.ₚₚ, PER IN² OF THE PIPE AREA</td>
</tr>
<tr>
<td><strong>TABLE S2.3M-c</strong> CAPACITY OF SATURATED STEAM, IN KG/HR.ₚₚ, PER MM² OF PIPE AREA</td>
</tr>
</tbody>
</table>

**S2.5 TWO-STAGE PRESSURE-REDUCING VALVE STATIONS**

The safety pressure-relief valve for two-stage pressure-reducing valve stations shall be sized on the basis of the high-side pressure and the inlet size of the first pressure-reducing valve in the line. If an intermediate pressure line is taken off between the pressure-reducing valves, then this line and the final low side shall be protected by safety pressure relief valves sized on the basis of the high-side pressure and the inlet size of the first pressure-reducing valve. See NBIC Part 1, Table S2.5.

**S3.4 GAS DETECTION SYSTEMS**

Rooms or areas where carbon dioxide storage vessel(s) are located indoors or in enclosed or below grade outdoor locations shall be provided with a gas detection and alarm system for general area monitoring that is capable of detecting and notifying building occupants of a CO₂ gas release. Alarms will be designed to activate a low level pre-alarm at 5,000 ppm concentration of CO₂ and a full high alarm at 30,000 ppm concentration of CO₂ which is the NIOSH & ACGIH 15 minute Short Term Exposure Limit for CO₂. These systems are not designed for employee personal exposure monitoring. Gas detection systems shall be installed and tested in accordance with manufacturer’s installation instructions and the following requirements:
a) Activation of the gas detection system shall activate an audible alarm within the room or area in which the carbon dioxide storage vessel is located.

Audible alarms shall also be placed at the entrance(s) to the room or area where the carbon dioxide storage vessel and/or fill box is located to notify anyone who might try to enter the area of a potential problem.

A continuous gas detection system shall be provided in the room or area where container systems are filled and used, in areas where the heavier than air gas can congregate and in below grade outdoor locations. Carbon dioxide (CO₂) sensors shall be provided within 12 inches (305mm) of the floor in the area where the gas is most likely to accumulate or leaks are most likely to occur. The system shall be designed to detect and notify at a low level alarm and high level alarm.

a) The threshold for activation of the low level alarm shall not exceed a carbon dioxide concentration of 5,000 ppm (9,000 mg/m³) Time Weighted Average (TWA) over 8 hours. When carbon dioxide is detected at the low level alarm, the system shall activate a signal at a normally attended location within the building.

a) The threshold for activation of the high level alarm shall not exceed a carbon dioxide concentration of 30,000 ppm (54,000 mg/m³). When carbon dioxide is detected at the high level alarm, the system shall activate an audible and visual alarm at a location approved by the jurisdiction having authority.

### NB15-2104

**Part 1, S3.5**

**SIGNAGE**

**FIGURE S3.5**

**CO2 WARNING SIGN**

**WARNING**

**CAUTION** - CARBON DIOXIDE GAS

Ventilate the area before entering.

A high carbon dioxide (CO₂) gas concentration in this area can cause suffocation.

**WARNING** Hazard identification signs shall be posted at the entrance to the building, room, enclosure, or the confined enclosed area where the LCDSV container is located. The warning sign shall be at least 8 in. (200 mm) wide and 6 in. (150 mm) high and indicate:
The wording shall be concise and easy to read and the upper portion of the sign must be orange as shown in figure NBIC Part 1, S3.5. The size of the lettering must be as large as possible for the intended viewing distance and in accordance with jurisdictional requirements. When no jurisdictional requirements exist, the minimum letter height shall be in accordance with NEMA American National Standard for Environmental and Facility Safety Signs (ANSI Z535.2). The warning sign shall be as shown in Figure S3.5.

Additional instructional signage shall be posted outside of the area where the container is located and such signage shall contain at minimum the following information:

a) Carbon Dioxide Monitors for general area monitoring (not employee personal exposure monitoring) are provided in this area. These monitors are set to alarm at 5,000 ppm for the low level alarm and at 30,000 ppm for high level alarm.

b) Low Level Alarm (5,000 ppm) — Provide appropriate cross ventilation to the area. Personnel may enter area for short periods of time (not to exceed 15 minutes at a time) in order to identify and repair potential leaks.

c) High Level Alarm (30,000 ppm) — Personnel should evacuate the area and nobody should enter the affected area without proper self-contained breathing apparatus until the area is adequately ventilated and the concentration of CO2 is reduced below the high alarm limit.
**S4.1 SCOPE**

This supplement provides requirements and guidelines for the installation of biomass (wood/solid fuel) fired boilers as defined in NBIC Part 1, Section 9.

**S5.1 SCOPE**

This supplement provides requirements and describes guidelines for the installation of a thermal fluid heater. A thermal fluid heater system consists of the heater, expansion tank, circulating pump, safe catchment with the proper piping and controls to heat jacketed kettles, presses, reactors, ovens, exchangers, etc. The scope does not include thermal fluid vaporizers.

**S5.3.1 SUPPORTS, FOUNDATIONS, AND SETTINGS**

Each thermal fluid heater and its associated piping must be safely supported. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal movement), and loadings (including the weight of the fluid in the system) in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

See NBIC Part 1, Section 1.6.1 Supports, Foundations, and Settings

**S5.3.2 STRUCTURAL STEEL**

a) If the thermal fluid heater is supported by structural steel work, the steel supporting members shall be so located or insulated that the heat from the furnace will not affect its strength.

b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

See NBIC Part 1, Section 1.6.2 Structural Steel

**S5.4.1 EXIT**

Two means of exit shall be provided for thermal fluid heater rooms exceeding 500 sq. ft. (46.5 sq. m) floor area and containing one or more thermal fluid heaters having a combined fuel capacity of 1,000,000 Btu/hr (293 kW) or more. Each elevation shall be provided with at least two means of exit, each to be remotely located from the other. A platform at the top of a single thermal fluid heater is not considered an elevation.

See NBIC Part 1, Section 1.6.3 Exit

**S5.4.2 LADDERS AND RUNWAYS**

a) All walkways, runways and platforms shall be:

1) Of metal construction;

2) Provided between or over the top of heaters that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;

3) Constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);

4) Of bolted, welded, or riveted construction; and

5) Equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe board.

b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped...
with handrails 42 in. (1,070 mm) high with an intermediate rail.

c) Ladders that serve as a means of access to walkways, runways, or platforms shall:

1) Be of metal construction and not less than 18 in. (460 mm) wide;

2) Have rungs that extend through the side members and are permanently secured;

3) Have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;

4) Have a clearance of not less than 6½ in. (165 mm) from the back of rungs to the nearest permanent object; and

5) Have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.

d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.

See NBIC Part 1, Section 1.6.4 Ladders and Runways

<table>
<thead>
<tr>
<th>NB10-1201</th>
<th>Part 1, S5.5.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUEL</td>
<td>S5.5.6</td>
</tr>
<tr>
<td>Fuel systems, whether firing on oil, gas, or other substances, shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.</td>
<td></td>
</tr>
</tbody>
</table>

See NBIC Part 1, Section 1.6.5 Fuel

<table>
<thead>
<tr>
<th>NB10-1201</th>
<th>Part 1, S5.5.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>VENTILATION AND COMBUSTION AIR</td>
<td>S5.5.8</td>
</tr>
<tr>
<td>a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room and sufficient to maintain ambient temperatures as recommended by the heater manufacturer. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans.</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** When combustion air is supplied to the thermal fluid heater by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer’s recommendations. However, ventilation for the equipment room must still be considered.

b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2,000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The heater equipment room air supply openings shall be kept clear at all times.

c) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all thermal fluid heaters located in the equipment room. Additional capacity may be required for any other fuel burning.
equipment in the equipment room. Pressure in the room should be consistently neutral.

d) When power ventilators or fans are used to supply combustion air they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.

e) The size of openings specified in b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.

f) Care should be taken to ensure that thermal fluid lines are not routed across combustion air openings, where freezing may occur in cold climates.

See NBIC Part 1, Section 1.6.6 Ventilation and Combustion Air

<table>
<thead>
<tr>
<th>NB10-1201</th>
<th>Part 1, S5.5.9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S5.5.9</strong></td>
<td><strong>LIGHTING</strong></td>
</tr>
<tr>
<td>The equipment room should be well lit and it should have an emergency light source for use in case of power failure.</td>
<td></td>
</tr>
</tbody>
</table>

See NBIC Part 1, Section 1.6.7 Lighting

<table>
<thead>
<tr>
<th>NB10-1201</th>
<th>Part 1, S5.6.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S5.6.1</strong></td>
<td><strong>CHIMNEY OR STACK</strong></td>
</tr>
<tr>
<td>Chimneys or stacks shall be installed in accordance with jurisdictional and environmental requirements, manufacturer’s recommendations, and/or industry standards, as applicable.</td>
<td></td>
</tr>
</tbody>
</table>

See NBIC Part 1, Section 1.6.8 Chimney or Stack

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>Part 1, S5.7.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S5.7.2</strong></td>
<td><strong>PRESSURE RELIEF DEVICES</strong></td>
</tr>
<tr>
<td>Thermal fluid heaters shall be equipped with one or more pressure relief devices unless the option for overpressure protection by system design is utilized (when permitted by the original code of construction). When pressure relief devices are used, the following shall apply:</td>
<td></td>
</tr>
<tr>
<td>a) Pressure relief valve(s) shall be of a totally enclosed type and shall not have a lifting lever. <strong>A body drain is not required.</strong></td>
<td></td>
</tr>
<tr>
<td>b) Rupture disks may be installed upstream or downstream of the pressure relief valve(s) in accordance with the original code of construction.</td>
<td></td>
</tr>
<tr>
<td>c) Pressure relief valves and rupture disks shall be in accordance with the code of construction and designed for liquid, vapor, or combination service as required for the specific installation, service fluids, and overpressure conditions.</td>
<td></td>
</tr>
<tr>
<td>d) The inlet connection to the valve shall be not less than NPS ½ (DN 15).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB10-1201</th>
<th>Part 1, S5.8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S5.8.5</strong></td>
<td><strong>FINAL ACCEPTANCE</strong></td>
</tr>
<tr>
<td>A thermal fluid heater may not be placed into service until its installation has been inspected and accepted by the appropriate jurisdictional authorities.</td>
<td></td>
</tr>
</tbody>
</table>

See NBIC Part 1, Section 1.6.9, Final Acceptance

<table>
<thead>
<tr>
<th>NB13-1101</th>
<th>Part 1, Supplement 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S6.1</strong></td>
<td><strong>SCOPE</strong></td>
</tr>
<tr>
<td>a) NBIC Part 1 Section 6 Supplement 6 provides requirements for various aspects of the installation of Condensing Boilers which are unique from other products covered by this section.</td>
<td></td>
</tr>
<tr>
<td>b) This supplement is based on Local, State or National Building Codes requiring the installation of a Carbon Monoxide (CO) detector/alarm in the boiler room.</td>
<td></td>
</tr>
</tbody>
</table>

**S6.2** | **DETERMINATION OF ALLOWABLE OPERATING PARAMETERS** |
The allowable operating parameters of the combustion air intake and the exhaust gas venting shall be in accordance with jurisdictional, environmental and manufacturers recommendations, as applicable.

**S6.3 GENERAL REQUIREMENTS**

Condensing boilers shall meet all the requirements of NBIC Part 1, Section 3 and this Supplement.

**S6.4 FLUE GAS VENTING SYSTEM PIPING REQUIREMENTS**

a) The vent piping shall be corrosion resistant and fabricated from either stainless alloy or plastic material as defined by the boiler manufacturer and certified for the application.

b) The diameter of the vent piping shall be as defined by the boiler manufacturer and shall not be reduced, except as allowed by the boiler manufacturer.

c) The “Total Equivalent Length” of the vent piping, and the pressure drop through the vent piping, shall not exceed that stated in the Boiler Manufacturer’s Installation Manual. (Note: Equivalent Length includes the pressure loss effect of various pipe fittings, such as elbows, etc.) Horizontal pipe runs shall slope toward the boiler and the condensate collection point.

d) The termination point of the vent piping shall be positioned such that there is no possibility of vented flue gas being entrained in the combustion air intake, as defined by the manufacturer and National Fuel Gas Code (ANSI Z223.1). Additionally the vent termination shall be located above the highest known snowline for the location involved, and be designed in such a manner, so as to prevent freezing.

e) This supplement requires the owner/user/installer contact the authority having Jurisdiction regarding the installation of carbon monoxide (CO) detector/alarm in boiler rooms in which condensing boilers are to be installed.

**S6.5 SEALED COMBUSTION SYSTEM REQUIREMENTS**

a) The location of the outside air intake, relative to the flue gas vent, shall be such that there shall be no cross contamination with products of combustion or other airborne corrosive or hazardous contaminants, as defined by the manufacturer. Additionally the location of the combustion air intake shall be above the highest known snowline for the location involved.

b) The diameter, length and routing of the combustion air intake piping shall be such that the pressure drop though the system, including any filters, shall not exceed the maximum pressure drop stated by the boiler/burner manufacturer.

**S6.6 CONDENSATE DRAIN SYSTEM REQUIREMENTS**

The flue gas condensate from an individual boiler shall be collected at a single point, and the routing of the drain piping shall include the following features:

a) A water trap, the height of which cannot be varied by field manipulation, and is in accordance with boiler manufacturers requirements.

b) A visible means of ensuring that the condensate water trap contains the correct water level.

c) A discharge point away from occupied areas.

d) A method of controlling the pH of the condensate prior to its discharge into a sewer system, if required by local building Codes.

---

**NB16-0809D**

<table>
<thead>
<tr>
<th>Part 2, 1.1</th>
</tr>
</thead>
</table>

**1.1 SCOPE**

This section provides general guidelines and requirements for conducting inservice inspection of pressure-retaining items.
This section provides general requirements and guidelines for inservice inspection. This section includes precautions for the safety of inspection personnel. The safety of the public and the Inspector is the most important aspect of any inspection activity.

**1.2 ADMINISTRATION**

Jurisdictional requirements describe the frequency, scope, type of inspection, whether internal, external, or both, and type of documentation required for the inspection. The Inspector shall have a thorough knowledge of jurisdictional regulations where the item is installed, as jurisdictional or regulatory inspection requirements do vary.

Unless otherwise specifically required by the jurisdiction, the duties of the Inspector do not include inspection to other standards and requirements (e.g., environmental, construction, electrical, operational, undefined industry standards, etc) for which other regulatory agencies have authority and responsibility to oversee.

**2.1 SCOPE**

a) This section describes provides general and detailed inspection requirements and guidelines for pressure-retaining items to determine corrosion deterioration and possible prevention of failures for boilers, pressure vessels, piping, and pressure relief devices.

b) Materials to be inspected shall be suitably prepared so that surface irregularities will not be confused with or mask any defects. Material conditioning such as cleaning, buffing, wire brushing, or grinding may be required by procedure or, if requested, by the Inspector. The Inspector may require insulation or component parts to be removed.

**2.3.6.6 INSPECTION OF WIRE WOUND PRESSURE VESSELS**

a) This section provides guidelines for inspection of wire wound pressure vessels typically designed for 10,000 psi or greater service. The scope of inspection of these vessels should include components affected by repeated opening and closing, such as the frame, yolk and cylinder inner diameter surface, or alignment of the yolk with the cylinder, lack of maintenance and a check for inoperable or bypassed safety and warning devices. Early detection of any damage to the cylinder, closures or frame is essential to avoid catastrophic failure.

b) These vessels consist of four parts, a wire wound cylinder, two end closures and a frame to retain the closures in the cylinder. The wire is one continuous piece and is wound in tension. On the cylinder, the wire can only carry circumferential or radial loading. The cylinder is typically not of sufficient thickness to carry axial load which requires the end closures have no threads or retaining grooves and requires a frame to retain the pressure vessel axial load imposed on the closures. The purpose for this design is to minimize weight of the containment cylinder using thinner wall materials and using external wound wire to induce a compressive preload. This design also provides increased resistance to damage from fatigue loading.

Note that some vessels may be monoblock cylinders (no winding) with wire wound frame and some vessels may be wire wound cylinder with a forged or welded plate frame (not wire wound). Use of a frame to retain the end closures removes the sharp transitions in shape (threads or grooves) associated with monoblock cylinder failures. The design of high pressure vessels is typically based on fatigue life criteria. The majority of operating wire wound vessels in North America were manufactured to ASME BPVC Section VIII Division 3, Alternative Rules for Construction of High Pressure Vessels. Some in-service vessels may have been manufactured to ASME BPVC Section VIII Division 1 or Division 2, and others have been installed as "State Specials" that require fatigue life analysis to determine a safe operating life. The primary failure mode is fatigue cracking. Early detection of any damage to the cylinder, closures or frame is essential to avoid catastrophic failure.

c) Record keeping

1) Since these vessels have a finite fatigue life, it is essential a record be maintained of each operating cycle, recording both temperature and pressure. Deviation beyond design limits is cause for suspending operation and reevaluation of remaining fatigue life. Vessels having no operating...
record should shall be inspected and a fracture mechanics evaluation with a fatigue analysis test be performed to establish remaining life before resuming operation. Vessels having no operating record shall not be used for service until such time previous operating history can be determined.

2) Operating data should be recorded and include the following whenever the vessel is operating:

   a. Number of cycles
   b. Maximum pressure
   c. Maximum temperature
   d. Any unusual conditions

d) Any damage to the cylinder or closures can lead to premature failure. Frequent visual inspection should be made of internal and external surfaces of the cylinder, frame and closures. A thorough examination should be completed if any visually apparent damage is identified or if any excursion beyond design temperature or pressure occurs.

In addition, surfaces of the cylinder and closures should be examined by dye penetrant or magnetic particle method at intervals based on vessel remaining life. Closures may require ultrasonic examination of passageways.

As part of this inspection guideline for wire wound pressure vessels frequent inspection, the following items should be reviewed:

1) Verify no change in the process, such as the processing fluid, that might adversely impact vessel integrity.

2) Review the vessel manufacturer’s inspection recommendations for vessels, closures and frame. If manufacturer’s recommendations are not available, obtain recommendations from a recognized wire wound vessel service provider.

3) Verify any repair to pressure retaining items has been completed by National Board authorized service provider having wire wound vessel expertise.

4) Verify overpressure protection with appropriate set pressure and capacity is provided. Rupture discs are commonly used for pressures exceeding 14,500 psi (100 MPa) to avoid valve seat leakage. Overpressure protection devices are frequently replaced to avoid premature operation.

5) If there are no manufacturer’s recommendations available for the vessel, the following are additional recommended inspections that should be conducted to ensure vessel integrity and safety

   a. Conduct annual visual and dimensional vessel inspections with liquid penetrant examination of maximum stressed areas to ensure that the surfaces are free of defects. Conduct ultrasonic examination of the vessel after every 25% of the design cycle life or every five years, whichever comes first, to detect subsurface cracks. Special attention should be given to the roots of threads and closures using threaded head retention construction. Other geometric discontinuities that are inherent in the design or irregularities resulting from localized corrosion, erosion, or mechanical damage should be carefully examined. This is particularly important for units of monoblock construction.

   b. The closure mechanism of the vessel end-closure is opened and closed frequently during operation. It should be closely inspected for freedom of movement and proper contact with its locking elements. Wire wound vessels must have yoke-type closures so the yoke frame will need to be closely inspected on a regular basis.

6) Gages, Safety Devices, and Controls

   a. Verify that the vessel is provided with control and monitoring of pressure, temperature, the electrical system, fluid flow, liquid levels and all variables that are essential for the safe
operation of the system. If the vessel is automatically controlled, manual override should be available. Also, safety interlocks should be provided on the vessel closure to prevent vessel pressurization if the vessel closure is not complete and locked.

b. Verify that all safety device isolation valves are locked open if used.

c. Verify appropriate pressure relief device is installed with the setpoint at the lowest pressure possible, consistent with the normal operating pressure but in no case higher than the design operating pressure of the vessel. Rupture discs are normally considered more suitable for these types of applications since pressure relief devices operating at pressures above 14500 psi may tend to leak by their seat.

d. Verify that pressure and temperature of the vessel coolant and vessel wall is controlled and monitored. Interlock devices should be installed that will de-energize or depressurize the vessel at established setpoints.

e. Verify audible and visual alarms are installed to indicate unsafe conditions.

<table>
<thead>
<tr>
<th>Operation of Pressure Vessels for Human Occupancy (PVHO’s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSPECTION OF PRESSURE VESSELS FOR HUMAN OCCUPANCY (PVHO’s)</td>
</tr>
<tr>
<td>A pressure vessel for human occupancy (PVHO), as defined by ASME PVHO-1 is a pressure vessel that encloses a human being or animal within its pressure boundary while it is subject to internal or external pressure that exceeds a 2 psi (14 kPa) differential pressure. PVHOs include, but are not limited to submersibles, diving bells, personal transfer capsules, decompression chambers, recompression chambers, hyperbaric chambers, high altitude chambers and medical hyperbaric oxygenation facilities. This section provides guidelines for inspection of PVHOs. Due to the many different designs and applications of PVHOs, potential failures of components or safety concerns that are not specifically covered, such as rapid decompression or fire/sparking issues should be considered.</td>
</tr>
<tr>
<td>a) General/operational</td>
</tr>
<tr>
<td>1) PVHOs must be constructed in accordance with ASME PVHO-1 and PVHO-2. These codes adopt Section VIII and therefore the vessels should bear a “U” or “U2” ASME designator. Inspections may be conducted using ASME PVHO-2 for reference.</td>
</tr>
<tr>
<td>2) Cast and ductile iron fittings are not allowed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inspection of Static Vacuum Insulated Cryogenic Vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>A static vacuum insulated cryogenic vessel is a vessel that is thermally insulated for use with one or more cryogenic liquid, consisting of: 1) an inner vessel holding the cryogenic liquid, 2) an outer jacket that serves as an air tight enclosure which supports the inner vessel, holds the insulation and enables the vacuum to be established, and 3) the associated piping system.</td>
</tr>
<tr>
<td>a) This section covers the periodic inspection and testing of static vacuum insulated cryogenic pressure vessels used in the storage of cryogenic liquefied gases. Owner-users should inspect static cryogenic vacuum-insulated storage tanks to ensure that the equipment is in safe operable condition.</td>
</tr>
<tr>
<td>b) Check that the following conditions or safeguards are adequate prior to doing a periodic external inspection of the vessel:</td>
</tr>
<tr>
<td>1) Surface water drainage is directed away from the location of installation. Proximity of storage tank to sewer inlets shall comply with local fire jurisdictional requirements.</td>
</tr>
<tr>
<td>2) Protective measures are in place for the vessels and components from mechanical impact damage (such as barricades, safe set-back distances, poles and bars.</td>
</tr>
</tbody>
</table>
3) Any fire proofing for external supports is in acceptable condition. Any gas from pressure relief devices or vents is discharged to a safe point of discharge. Relief valve discharges are not aimed directly at external supports or the outer jacket wall.

4) There is sufficient ventilation to avoid the formation of explosive gas-air mixtures or an oxygen deficient/enriched atmosphere.

d) A periodic external visual inspection of the vessel and equipment should be made to ensure that the vacuum between the inner vessel and outer jacket has not been compromised. If the vessel has lost vacuum, the owner-user of the cryogenic storage vessel shall immediately investigate the cause. Any loss of vacuum should be investigated as this could affect the integrity of the vessel and support system. If the cause is due to an internal pipe failure as evidenced by vapor escaping from the vacuum relief device, the pressure should be immediately reduced to atmospheric pressure followed by emptying of all of the cryogenic liquid in a safe manner.

e) External visual inspections are possible at all accessible parts of the vessel and piping. The following inspections should be included as part of the periodic external visual inspection.

1) A functional check of essential and critical valves and their operability.

2) Leak tests under operating conditions of the vessel and piping.

3) Assessing if there have been any significant changes in the operational conditions of the installation and its surroundings.

4) Check that there is no excessive out-of-roundness or deformation of the outer jacket

5) Check all nozzles for corrosion or damage.

6) Check the vessel supports for structural damage.

7) Check that any attachments to the outer jacket are not damaged or affecting the vessel condition.

8) Verification of periodic testing and repair (or replacement) of the pressure relief device(s)

9) Check that the pressure relief device(s) are not continually venting. PRD’s may vent periodically under normal circumstances but should be reported for maintenance testing and repair if venting continually.

10) Checking the condition of the outer jacket, piping and accessories

11) Check for abnormal frosting on outer jacket surface. Under normal usage, frost and ice will develop around pipes, valves, controls and vaporizers

12) Inspect the outer skin of the outer jacket for any new or abnormal signs of excessive frosting.

13) Confirm that the duplicate ASME nameplate is attached to the outer jacket, tank leg or other permanent location affixed to the vessel.

2.4.9 COVERED PIPING SYSTEMS

Covered Piping Systems (CPS) designed to ASME B31.1 or other construction piping codes as deemed necessary by the owner may be subjected to the same damage mechanisms as “covered piping”, such as boiler and boiler external piping, based on temperature, pressure and environmental conditions. Examples of CPS are main steam, hot and cold reheat, feedwater, drains and other piping systems where failure may occur as a result of creep, fatigue, erosion–corrosion, corrosion–fatigue, wall thinning, graphitization and other failure mechanisms. Based on these considerations a program should be established where CPS is periodically evaluated by an owner’s assessment program using suitable NDE, metallurgical analysis or other methods to determine whether continued operation of this piping is justified. ASME B31.1, Chapter
VII - Operation and Maintenance provides guidance on how these systems should be evaluated, maintained and documented. It is recognized that all of the documentation, data and records for CPS, identified in ASME B31.1, Chapter VII may not be available for a specific plant, particularly for older plants and for piping systems identified as nonboiler external or similar piping. The rigor and detail of the owner’s CPS assessment programs are the responsibility of the owner and should ensure the continued safe operation of this piping. The owner should ensure to the extent possible that CPS do not represent safety risks. The assessment program should be made available for review.

### NB11-0401 Part 2, 2.5.1

#### 2.5.1 SCOPE

a) The most important appurtenances on any pressurized system are the pressure relief devices (PRDs) provided for overpressure protection of that system. These are devices such as safety valves, safety relief valves, pilot valves, pressure relief valves and rupture disks or other non-reclosing devices that are called upon to operate and reduce an overpressure condition.

b) These devices are not designed or intended to control the pressure in the system during normal operation. Instead, they are intended to function when normal operating controls fail or abnormal system conditions are encountered.

c) Periodic inspection and maintenance of these important safety devices is critical to ensure their continued functioning and availability when called upon to operate. See NBIC Part 2, 2.5.8 for recommended testing frequency for PRDs.

d) Inspection areas of concern include:
   1) correct set pressure (matching of set pressure to MAWP);
   2) safety considerations;
   3) device data;
   4) condition of the device;
   5) condition of the installation; and
   6) testing and operational inspection.

### NB15-0318 Part 2, 2.5.2

#### 2.5.2 PRESSURE RELIEF DEVICE DATA

a) Nameplate marking or stamping of the device should be compared to stamping on the protected pressure-retaining item. For a single device, the set pressure shall be no higher than the maximum allowable working pressure (MAWP) marked on the protected pressure-retaining item or system.

b) If multiple devices are provided, the difference between set pressures shall not exceed that permitted by the original code of construction. When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure need be at or below the maximum allowable working pressure. The set pressure of additional devices may exceed the MAWP, as permitted by the original code of construction.

c) Verify nameplate capacity and, if possible, compare to system capacity requirements.

d) Check identification on seals and ensure they match nameplates or other identification (repair or reset nameplate) on the valve or device.

### NB11-0401 Part 2, 2.5.3

#### 2.5.3 INSERVICE INSPECTION REQUIREMENTS FOR PRESSURE RELIEF DEVICE CONDITIONS

a) Check for evidence that the valve or device is leaking. The valve or device shall be checked for evidence that it is leaking or not sealing properly. Evidence of leakage through pressure-relief valves may indicate that the system is being operated at a pressure that is too close to the valve’s set pressure. (See NBIC Part 2, Supplement 8 for guidance on the pressure differential between the pressure relief valve set pressure and system operating pressure).
b) Seals for adjustments should be intact and show no evidence of tampering.

c) Connecting bolting should be tight and all bolts intact.

d) The valve or device should be examined for deposits or material buildup.

e) Evidence of rust or corrosion should be checked. The valve or device shall be checked for evidence of rust or corrosion.

f) Check for damaged or misapplied parts. The valve or device shall be checked for damaged or misapplied parts.

g) If a drain hole is visible, the valve or device should be checked to ensure it is not clogged with debris or deposits.

h) The valve or device shall be checked for test gages left in place after pressure testing of the unit.

i) Bellows valves shall be checked to ensure the bonnet vent is open or piped to a safe location. The vent shall not be plugged since this will cause the valve set pressure to be high if the bellows develops a leak. Leakage noted from the vent indicates the bellows is damaged and will no longer protect the valve from the effects of back pressure.

---

<table>
<thead>
<tr>
<th>NB11-0401 Part 2, 2.5.4</th>
<th>2.5.4 INSERVICE INSPECTION REQUIREMENTS FOR PRESSURE RELIEF DEVICE INSTALLATION CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Inspect inlet piping shall be inspected to ensure it meets the requirements of the original Code of Construction. For pressure relief valves, check that the inlet pipe shall be checked to ensure the inlet pipe size is not smaller than the device inlet size.</td>
<td></td>
</tr>
<tr>
<td>b) Inspect discharge piping and ensure it meets the original Code of Construction. For pressure relief valves, the discharge pipe shall be checked to ensure the discharge pipe size is not smaller than the device outlet size.</td>
<td></td>
</tr>
<tr>
<td>c) Check that the valve drain piping is open. The valve drain piping shall be checked to ensure the piping is open.</td>
<td></td>
</tr>
<tr>
<td>d) Check drainage of discharge piping. The discharge piping shall be checked to ensure it drains properly.</td>
<td></td>
</tr>
<tr>
<td>e) Check that the inlet and discharge piping shall be checked to ensure they are not binding or placing excessive stress on the valve body, which can lead to distortion of the valve body and leakage or malfunction.</td>
<td></td>
</tr>
<tr>
<td>f) Check the condition and adequacy of piping supports. The condition and adequacy of the pipe supports shall be inspected. Discharge piping should be supported independent of the device itself.</td>
<td></td>
</tr>
<tr>
<td>g) Check for possible hazards to personnel from the valve discharge or discharge pipe. The valve discharge and discharge pipe shall be checked for possible hazards to personnel.</td>
<td></td>
</tr>
<tr>
<td>h) The installation shall be checked to ensure that there are no intervening isolation valves between the pressure source and the valve inlet or between the valve outlet and its point of discharge. Isolation valves may be permitted in some pressure vessel service (See NBIC Part 14, 5.3.6.2.6 e) and jurisdictional requirements). Isolation valves are not permitted shall not be used for power boilers, heating boilers, or water heaters.</td>
<td></td>
</tr>
<tr>
<td>i) A change-over valve, which is used to install two pressure relief devices on a single vessel location for the purpose of switching from one device to a spare device, is not considered a block valve if it is arranged such that there is no intermediate position that will isolate both pressure relief devices.</td>
<td></td>
</tr>
</tbody>
</table>
from the protected system. Change-over valves should be carefully evaluated to ensure they do not have excessive pressure drop that could affect the pressure relief device operation or capacity. These devices are commonly used in pressure vessel service. They may also be used in some boiler applications. It is recommended that the Jurisdiction be contacted to determine their acceptability on boiler applications.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>2.5.5</th>
<th>ADDITIONAL INSPECTION REQUIREMENTS</th>
</tr>
</thead>
</table>
| **2.5.5.1** BOILERS | a) If boilers are piped together with maximum allowable working pressures differing by more than 6%, additional protective devices may be required on the lower-pressure units to protect them from overpressure from the higher pressure unit.  
b) Hot-water heating boilers and water heaters.  
1) These units generally do not use any water treatment and therefore may be more prone to problems with deposits forming that may impair a safety device's operation. Particular attention should be paid to signs of leakage through valves or buildups of deposits.  
2) Hot-water boilers tend to have buildups of corrosion products since the system is closed with little makeup. These products can foul or block the valve inlet.  
3) Water heaters will have cleaner water due to continuous makeup. However, these valves usually have a thermal element that will cause the valve to open slightly when the water is heated and the heat is not removed from the system. When this hot water evaporates in the discharge piping, calcium deposits may tend to form in the valve inlet and outlet. |

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>2.5.5.2</th>
<th>PRESSURE VESSELS AND PIPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard practice for overpressure protection devices is to not permit any type of isolation valve either before or after the device. However, some pressure vessel standards permit isolation valves under certain controlled conditions when shutting down the vessel to repair a damaged or leaking valve. If isolation block valves are employed, their use should be carefully controlled by written procedures. Block valves should have provisions to be either carcap-sealed or locked in an open position when not being used. For ASME Section VIII, Div. 1 pressure vessels, see UG-135, Appendix M, and jurisdictional rules for more information.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>2.5.5.3</th>
<th>g) 4), 5)</th>
</tr>
</thead>
</table>
| 4) The rupture disk shall be checked that the space between the rupture disk and a safety-pressure relief valve is supplied with a pressure gage, try cock, or telltale indicator to indicate signs of leakage through the rupture disk. The pressure relief valve shall be inspected and the leaking disk shall be replaced if leakage through the disk is observed.  
5) If a rupture disk is used on a valve outlet, the valve design must be of a type not influenced by back pressure due to leakage through the valve. Otherwise, for nontoxic and non-hazardous fluids, the space between the valve and the rupture disk shall be vented or drained to prevent the accumulation of pressure. |

<table>
<thead>
<tr>
<th>NB15-0320</th>
<th>2.5.5.3</th>
<th>g) 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9) Since rupture disks are single activation devices, a visual inspection is the only inspection that can be performed. A rupture disk that is removed from its holder it should not be reinstalled. A rupture disk contained in an assembly that can be removed from a system without releasing the force maintaining the intimate contact between the disk and the holder, such as pre-torqued, welded, soldered, and some threaded assemblies, may be suitable for reinstallation after visual inspection. The manufacturer should be consulted for specific recommendations. Since these devices are for one-time use, a visual inspection is the only inspection that can be performed. Rupture disks that are installed using a specified bolting torque</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2.5.7 TESTING AND OPERATIONAL INSPECTION OF PRESSURE RELIEF DEVICES

a) Pressure relief valves **must** be tested periodically to ensure that they are free to operate and will operate in accordance with the requirements of the original code of construction. Testing should include device set or opening pressure, reclosing pressure, where applicable, and seat leakage evaluation. Tolerances specified for these operating requirements in the original code of construction shall be used to determine the acceptability of test results.

b) Testing may be accomplished by the owner on the unit where the valve is installed or at a qualified test facility. In many cases, testing on the unit may be impractical, especially if the service fluid is hazardous or toxic. Testing on the unit may involve the bypassing of operating controls and should only be performed by qualified individuals under carefully controlled conditions. It is recommended that a written procedure be available to conduct this testing.

1) The Inspector should ensure that calibrated equipment has been used to perform this test and the results should be documented by the owner.

2) If the testing was performed at a test facility, the record of this test should be reviewed to ensure the valve meets the requirements of the original code of construction. Valves which have been in toxic, flammable, or other hazardous services shall be carefully decontaminated before being tested. In particular, the closed bonnet of valves in these services may contain fluids that are not easily removed or neutralized. If a test cannot be performed safely, the valve shall be disassembled, cleaned, and decontaminated, repaired, and reset.

3) If a valve has been removed for testing, the inlet and outlet connections should be checked for blockage by product buildup or corrosion.

c) Valves may be tested using lift assist devices when testing at full pressure may cause damage to the valve being tested, or it is impractical to test at full pressure due to system design considerations. Lift assist devices apply an auxiliary load to the valve spindle or stem, and using the measured inlet pressure, applied load and other valve data allow the set pressure to be calculated. If a lift assist device is used to determine valve set pressure, the conditions of NBIC Part 3, 4.5.3 shall be met. It should be noted that false set pressure readings may be obtained for valves which are leaking excessively or otherwise damaged.

d) If valves are not tested on the system using the system fluid, the following test mediums shall be used:

1) High-pressure boiler **safety pressure relief** valves, high-temperature hot-water boiler **safety pressure** relief valves, low-pressure steam heating boilers: steam;

2) Hot-water heating boiler **safety pressure** relief valves: steam, air, or water;

3) Hot-water heater temperature and pressure relief valves: air or water;

4) Air and gas service process **safety pressure** relief valves: air, nitrogen, or other suitable gas;

5) Liquid service process pressure relief valves: water or other suitable fluid;

6) Process steam service **safety pressure** relief valves: steam or air with manufacturer’s steam to air correction factor.

**Note:** Valves being tested after a repair must be tested on steam except as permitted by NBIC Part 3, 4.5.24, 4.6.2.
e) As an alternative to a pressure test, the valve may be checked by the owner for freedom of operation by activating the test or "try" lever (manual check). For high pressure boiler and process valves, this test should be performed only at a pressure greater than 75% of the stamped set pressure of the valve or the lifting device may be damaged. This test will only indicate that the valve is free to operate and does not provide any information on the actual set pressure. All manual checks should be performed with some pressure under the valve in order to flush out debris from the seat that could cause leakage.

Note: The manual check at 75% or higher is based on lift lever design requirements for ASME Sections I and VIII valves. Code design requirements for lifting levers for ASME Section IV valves require that the valve be capable of being lifted without pressure.

f) If a valve is found to be stuck closed, the system should immediately be taken out of service until the condition can be corrected, unless special provisions have been made to operate on a temporary basis (such as additional relief capacity provided by another valve).

g) If a pressure test indicates the valve does not open within the requirements of the original code of construction, but otherwise is in acceptable condition, minor adjustments (defined as no more than twice the permitted set pressure tolerance) shall be made by an organization accredited by the National Board to reset the valve to the correct opening pressure. All adjustments shall be resealed with a seal identifying the responsible organization and a tag shall be installed identifying the organization and the date of the adjustment.

h) If a major adjustment is needed, this may indicate the valve is in need of repair or has damaged or misapplied parts. Its condition should be investigated accordingly.

i) Systems with multiple valves will require the lower set valves to be held closed to permit the higher set valves to be tested. A test clamp or "gag" should be used for this purpose. The spring compression screw shall not be tightened. It is recommended that the test clamps be applied in accordance with the valve manufacturer's instructions when the valve is at or near the test temperature, and be applied hand tight only to avoid damage to the valve stem or spindle.

j) Upon completion of set pressure testing, all pressure relief valve gags shall be removed.

---

**NB11-0401**

**Part 2, 2.5.7.1**

**3.2.5.1 CORRECTIVE ACTION**

If a valve is found to be stuck closed, the system should immediately be taken out of service until the condition can be corrected, unless special provisions have been made to operate on a temporary basis (such as additional relief capacity provided by another valve.) The owner shall be notified and corrective action such as repairing or replacing the inoperative valve shall be taken.

**NB11-0401**

**Part 2, 2.5.7.2**

**3.2.5.2 VALVE ADJUSTMENTS**

a) If a set pressure test indicates the valve does not open within the requirements of the original code of construction, but otherwise is in acceptable condition, minor adjustments (defined as no more than twice the permitted set pressure tolerance) shall be made by a qualified organization accredited by the National Board to reset the valve to the correct opening pressure. All adjustments shall be resealed with a seal identifying the responsible organization and a tag shall be installed identifying the organization and the date of the adjustment. Qualified organizations are considered to be National Board "VR" Certificate Holders, or organizations authorized by the Jurisdiction to make adjustments. See Supplement 3 for more information.

b) If a major adjustment is needed, this may indicate the valve is in need of repair or has damaged or misapplied parts. Its condition should be investigated accordingly.

---

**NB11-0401**

**NB15-0312**

**NB15-0319**

**NB16-0902**

**Part 2, 2.5.8**

**RECOMMENDED INSPECTION AND TEST FREQUENCIES FOR PRESSURE RELIEF DEVICES**

a) Power Boilers
1) Pressure less than 400 psig (2.76 MPa): Manual check every 6 months; pressure test annually to verify nameplate set pressure or as determined by operating experience as verified by testing history.

2) Pressure greater than or equal to 400 psig (2.76 MPa) or greater: Pressure Set pressure test to verify nameplate set pressure every three years or as determined by operating experience as verified by testing history.

3) Pressure Set pressure tests should be performed prior to bringing the boiler down for planned internal inspection so needed repairs or adjustments can be made while the boiler is down.

b) High-temperature hot-water boilers

Pressure Set pressure test annually to verify nameplate set pressure or as determined by operating experience as verified by testing history. For safety reasons, removal and testing on a steam test bench is recommended. Such testing will avoid damaging the pressure relief valve by discharge of a steam-water mixture, which could occur if the valve is tested in place.

c) Organic Fluid Vaporizers

Pressure relief valves shall be disconnected from the vaporizer at least once yearly, when they shall be inspected, tested, repaired if necessary, and then replaced on the vaporizer.

d) Low-pressure steam heating boilers

Manual check quarterly; pressure test annually prior to steam heating season to verify nameplate set pressure.

d) Hot-water heating boilers

Manual check quarterly; pressure test annually prior to heating season to verify nameplate set pressure.

Note: The frequencies specified for the testing of pressure relief valves on boilers is primarily based on differences between high pressure boilers that are continuously manned, and lower pressure automatically controlled boilers that are not monitored by a boiler operator at all times. When any boiler experiences an overpressure condition such that the safety or safety pressure relief valves actuate, the valves should be inspected for seat leakage and other damage as soon as possible and any deficiencies corrected.

e) Water heaters

Manual check every two months, or as determined based upon inspection history and manufacturer recommendations. Every 3 years, remove safety valve to inspect temperature probe for damage, buildup, or corrosion. The temperature probe shall be checked for the condition of the coating material and freedom of movement without detaching. If the probe pulls out or falls off during inspection, the valve shall be repaired or replaced. Due to the relatively low cost of pressure relief valves for this service, it is recommended that a defective valve be replaced with a new valve if a repair or resetting is indicated.

f) Pressure vessels and piping
Frequency of test and inspection of pressure relief devices for pressure vessel and piping service is greatly dependent on the nature of the contents, external environment, and operation of the system; therefore only general recommendations can be given. Inspection frequency should be based on previous inspection history. If, during inspection, valves are found to be defective or damaged by system contents during inspection, intervals should be shortened until acceptable inspection results are obtained. Where test records and/or inspection history are not available, the inspection frequencies in Table 2.5.8 are suggested.

<table>
<thead>
<tr>
<th>Service</th>
<th>Inspection Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam</td>
<td>Annual</td>
</tr>
<tr>
<td>Air and clean dry gases</td>
<td>Every three years</td>
</tr>
<tr>
<td>Pressure relief valves in combination with rupture disks</td>
<td>Every five years</td>
</tr>
<tr>
<td>Propane, refrigerant</td>
<td>Every five years</td>
</tr>
<tr>
<td>All others</td>
<td>Per inspection history</td>
</tr>
</tbody>
</table>

2.5.8.1 ESTABLISHMENT OF INSPECTION AND TEST INTERVALS

Establishment of inspection and test intervals

Where a recommended test frequency is not listed, the valve user and Inspector must determine and agree on a suitable interval for inspection and test. Some items to be considered in making this determination are:

a) Jurisdictional requirements;
b) Records of test data and inspections from similar processes and similar devices in operation at that facility;
c) Recommendations from the device manufacturer. In particular, when the valve includes a non-metallic part such as a diaphragm or soft seat, periodic replacement of those parts may be specified;
d) Operating history of the system. Systems with frequent upsets where a valve has actuated require more frequent inspection;
e) Results of visual inspection of the device and installation conditions. Signs of valve leakage, corrosion or damaged parts all indicate more-frequent operational inspections;
f) Installation of a valve in a system with a common discharge header. Valves discharging into a common collection pipe may be affected by the discharge of other valves by the corrosion of parts in the outlet portion of the valve or the buildup of products discharged from those valves;
g) Ability to coordinate with planned system shutdowns. The shutdown of a system for other maintenance or inspection activities is an ideal time for the operational inspection and test of a pressure relief valve;
h) Critical nature of the system. Systems that are critical to plant operation or where the effects of the discharge of fluids from the system are particularly detrimental due to fire hazard, environmental damage, or toxicity concerns all call for more frequent inspection intervals to ensure devices are operating properly; and
i) Where the effects of corrosion, blockage by system fluid, or ability of the valve to operate under given service conditions are unknown (such as in a new process or installation), a relatively short inspection interval, not to exceed one year or the first planned shutdown, whichever is shorter, shall be established. At that time the device shall be visually inspected and tested. If unacceptable test results are obtained, the inspection interval shall be reduced by 50% until suitable results are obtained.

<table>
<thead>
<tr>
<th>NB16-0901</th>
<th>3.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, 3.1</td>
<td>This section describes damage mechanisms applicable to pressure-retaining items. Further information concerning metallurgical properties of steels and nonferrous alloys are described in ASME Section II, Part D, of the Boiler and Pressure Vessel Code, Non Mandatory Appendix A, titled Metallurgical Phenomena.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB13-1301</th>
<th>4.6 QUANTITATIVE ENGINEERING ASSESSMENTS INCLUDING FINITE ELEMENT ANALYSIS (FEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, 4.6</td>
<td>4.6.1 CALCULATIONS</td>
</tr>
<tr>
<td></td>
<td>This Section describes criteria to be considered by the Inspector in the review of calculations prior to acceptance of quantitative engineering assessments per industry standards (such as fitness-for-service) for in-service equipment, repairs, and alterations.</td>
</tr>
<tr>
<td></td>
<td>4.6.2 ENGINEER EXPERIENCE</td>
</tr>
<tr>
<td></td>
<td>For quantitative engineering used in assessments, repairs and alterations, all calculations shall be completed prior to the start of any physical work or fitness-for-service acceptance. All design calculations shall be completed by an engineer (as designated by the manufacturer, R-stamp organization, owner or user) experienced in the design portion of the code used for construction of the item. Refer to NBIC Part 3, Paragraphs 3.2.4, 3.2.5, and 3.2.6 for design and calculations requirements for repairs and alterations.</td>
</tr>
<tr>
<td></td>
<td>4.6.3 FINITE ELEMENT ANALYSIS (FEA) ENGINEER EXPERIENCE</td>
</tr>
<tr>
<td></td>
<td>Finite Element Analysis (FEA) may be used to support quantitative engineering assessments or design for repairs and alterations as follows:</td>
</tr>
<tr>
<td></td>
<td>a) When quantitative engineering analysis is used to demonstrate the structural integrity of an in-service component containing a flaw or damage.</td>
</tr>
<tr>
<td></td>
<td>b) Where the configuration is not covered by the available rules in the code used for construction.</td>
</tr>
<tr>
<td></td>
<td>c) When there are complicated loading conditions or when a thermal analysis is required.</td>
</tr>
<tr>
<td></td>
<td>Because the FEA method requires more extensive knowledge of, and experience with, pressure equipment design and the FEA software package involved, the analysis and report submitted to the Inspector for review shall be completed and certified by a Professional Engineer (PE) licensed and registered as required by the manufacturer, R-stamp organization, owner or user and the jurisdiction if applicable.</td>
</tr>
<tr>
<td></td>
<td>The Inspector may require an initial explanation of why the FEA is applicable before the analysis is performed. The Inspector should verify the validity of the FEA report: that it has been certified by a licensed and registered Professional Engineer and that it is available for review by the manufacturer, R-stamp organization, owner or user and the jurisdiction. Owing to the specialized nature of FEA, the report must be clear and concise. Further guidelines are found in NBIC Part 2 Supplement 11, Inspector Review Guidelines for Finite Element Analysis.</td>
</tr>
</tbody>
</table>
5.1 SCOPE

This section provides guidelines and requirements for stamping and documentation (forms) for in-service inspections of PRIs. This section also describes evaluation of inspection results and assessment methodologies.

5.2.1 AUTHORIZATION

a) When the stamping on a pressure-retaining item becomes indistinct or the nameplate is lost, illegible, or detached, but traceability to the original pressure-retaining item is still possible, the Inspector shall instruct the owner or user to have the nameplate or stamped data replaced. All re-stamping shall be done in accordance with the original code of construction, except as modified herein. Requests for permission to re-stamp data or replace nameplates shall be made to the Jurisdiction in which the nameplate or stamping is reapplied. Application must be made on the Replacement of Stamped Data Form, NB-136 (see NBIC Part 2, 5.3.2). Proof of traceability to the original nameplate or stamping and other such data, as is available, shall be furnished with the request. Permission from the Jurisdiction is not required for the reattachment of nameplates that are partially attached. When traceability cannot be established, the Jurisdiction shall be contacted, for approval prior to replacing a nameplate or re-applying a stamping. The completed Form NB-136 (see 5.3.2) shall be submitted to the National Board. The owner or user shall retain all documentation provided for traceability with the completed form NB-136 for as long as the pressure-retaining item is in their ownership or use. If the pressure-retaining item is sold, Form NB-136 along with the supporting documentation shall be provided to the new owner. The manufacturer of the pressure-retaining item, if available, should be contacted prior to replacing a nameplate or stamped data in order to verify applicable code requirements.

b) When there is no Jurisdiction, the documentation used for traceability shall be accepted and the replacement of the nameplate or stamped data shall be authorized and witnessed by a National Board Commissioned Inspector.

The completed Form NB-136 shall be submitted to the National Board.

5.2.2 REPLACEMENT OF NAMEPLATE OR STAMPED DATA

a) The re-stamping or replacement of data shall be witnessed by a National Board Commissioned Inspector.

b) The re-stamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

c) Replacement nameplates or stamped data shall be clearly marked “replacement.”

5.2.3 REPORTING

The completed Form NB-136 with a facsimile of the replacement stamping or nameplate as applied and appropriate signatures shall be filed with the Jurisdiction, if applicable, and the National Board by the owner, or user (if required) and the National Board or by the "R" Stamp Holder, if work was performed, bearing a facsimile of the replacement stamping or nameplate, as applied, and shall also bear the signature of the "R" Stamp Holder that performed the replacement and the National Board Commissioned Inspector who authorized and witnessed the replacement.

5.2.4 REPLACEMENT OF DUPLICATE NAMEPLATES

Replacement or re-attachment of duplicate nameplates is exempt from meeting the requirements above provided the information on the nameplate is identical to the original data existing on the pressure-retaining item.
<table>
<thead>
<tr>
<th>NB15-2105</th>
<th>Part 2, 5.2.4</th>
<th>The duplicate nameplate shall be marked duplicate. The jurisdiction where the pressure-retaining item is located and the original manufacturer of the item should be contacted for additional guidance and direction. When the Code symbol stamp cannot be applied, Form NB-136 shall be completed, signed by a National Board Commissioned Inspector, retained and a copy submitted to the National Board by the owner or user as described in 5.2.1 a).</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB14-1001</td>
<td>NB15-0204</td>
<td>NB15-2105</td>
</tr>
<tr>
<td>Part 2, 5.3.1</td>
<td>5.3.1 SCOPE</td>
<td></td>
</tr>
<tr>
<td>The following forms specified in 5.3.2 may be used for documenting specific requirements as indicated on the top of each form.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Note: Jurisdictions may have adopted other forms for the same purpose and may not accept these forms.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FORM NB-6 BOILER-FIRED PRESSURE VESSEL
REPORT OF INSPECTION
Standard Form for Jurisdictions Operating Under the ASME Code

1. DATE INSPECTED
   MO, DAY, YEAR
   CERT EXPIRATION
   DATE MO, YEAR
   CERTIFICATE POSTED
   YES NO
   OWNER NO.
   JURISDICTION NUMBER
   □ NAT'L ID NO. □ OTHER NO.

2. OWNER
   NATURE OF BUSINESS
   KIND OF INSPECTION
   □ INT □ EXT
   CERTIFICATE INSPECTION
   □ YES □ NO

   OWNER'S STREET ADDRESS
   NUMBER
   OWNER'S CITY
   STATE
   ZIP

3. USER'S NAME - OBJECT LOCATION
   SPECIFIC LOCATION IN PLANT
   OBJECT LOCATION - COUNTY

   USER'S STREET ADDRESS
   NUMBER
   OWNER'S CITY
   STATE
   ZIP

4. CERTIFICATE COMPANY NAME
   CERTIFICATE COMPANY CONTACT NAME
   EMAIL

   CERTIFICATE COMPANY ADDRESS
   CERTIFICATE COMPANY CITY
   STATE
   ZIP

5. TYPE
   □ FT □ WT □ 0 □ OTHER
   YEAR BUILT
   MANUFACTURER

6. USE
   □ POWER □ PROCESS □ STEAM □ HOT WATER □ OTHER
   FUEL
   METHOD OF FIRING
   PRESSURE GAUGE TESTED
   □ YES □ NO

7. PRESSURE ALLOWED
   SAWF ____________ THIS INSPECTION ____________
   SAFETY RELIEF VALVES
   SET AT ____________ TOTAL CAPACITY ____________
   HEATING SURFACE OR BTU (INPUT/OUTPUT)
   PRESSURE TEST

8. IS CONDITION OF OBJECT SUCH THAT A CERTIFICATE MAY BE ISSUED?
   □ YES □ NO (F NO, EXPLAIN FULLY UNDER CONDITIONS)
   HYDRO TEST
   □ YES ____________ DATE ____________
   □ NO

9. CONDITIONS: With respect to the internal surface, describe and state location of any scales, dirt or other deposits. Give location and extent of any corrosion and state whether active or inactive. State location and extent of any erosion, gouging, bulging, warping, cracking or similar condition. Report on any defective rivets, bowed, loose or broken stays. State condition of all tubes, tube ends, coils, nipples, etc. Describe any adverse conditions with respect to pressure gage, water column, gage glass, gage cocks, safety valves, etc. Report condition of setting, flanges, bolts, support, etc. Describe any major changes or repairs made since last inspection.

10. REQUIREMENTS: (LIST CODE VIOLATIONS)

11. NAME AND TITLE OF PERSON TO WHOM REQUIREMENTS WERE EXPLAINED:

I HEREBY CERTIFY THIS IS A TRUE REPORT OF MY INSPECTION

IDENT NO.
EMPLOYED BY
IDENT NO.

SIGNATURE OF INSPECTOR
58

**PART 2, SECTION 6**

**INSPECTION — SUPPLEMENTS**

### 6.1 SCOPE

a) This section contains detailed inspection requirements for specific pressure-retaining items identified as supplements.

b) Inspection of items described in these supplements may include application of additional inspection requirements.
Each supplement is numbered in sequential order and follows the same numbering system used for the main text preceded by the letter “S.” Each page of the supplement will identify the supplement name and number in the top heading.

### S1.1 SCOPE

This supplement provides requirements and guidelines for inspection and storage of steam locomotive firetube boilers operating on tracks gaged 24 in (610 mm) or greater or for steam locomotives under the requirements of the Federal Railroad Administration (FRA). These rules shall be used in conjunction with the applicable rules of the NBIC. See NBIC Part 2, Figures S1.1-a and S1.1-b.

### S1.3 FEDERAL RAILROAD ADMINISTRATION (FRA)

The FRA rules for steam locomotive boilers are published in the Code of Federal Regulations (CFR) 49CFR Part 230, dated November 17, 1999. All locomotives under FRA Jurisdiction are documented on FRA Form 4 as defined in 49CFR Part 230. This document is the formal documentation of the steam locomotive boiler and is required to be completed prior to the boiler being placed in service. This document shall be used as the data report for the boiler, applicable to all repairs and alterations performed. National Board “R” Certificate Holders shall document their repairs and/or alterations on National Board Forms R-1 or R-2. These reports shall be distributed to the owner or user of the boiler, who is required to incorporate them into the FRA Form 19, which becomes an attachment to the FRA Form 4. The design margin for all such repairs or alterations shall not be less than four, based on ultimate tensile strength of the material.

Steam locomotive inspection and maintenance standards, which are now codified at 49CFR Part 230, may be obtained at the FRA Website.

### S1.4.2.9 STAYBOLTS

Staybolts shall be inspected for:

- a) Cracks in or breakage of the body;
- b) Erosion of the driven head from corrosion or combustion gases;
- c) Staybolt head flush with or below the surface of the sheet;
- d) Plugging of telltale holes except as permitted by 49 CFR Part 230.41;
- e) Waterside corrosion; and
- f) Staybolt heads that have been covered over by welding; and
- g) Correct application of seal welding to staybolt heads.

Un-threaded fillet welded staybolts shall be inspected for corrosion wear of more than two tenths of the original dimensions of the head and shaft and leakage or signs of leakage. If leakage in excess of sweat porosity is indicated, the weld shall be removed and the staybolt rewelded, in accordance with NBIC Part 3.

**Notes:** An indicator of waterside corrosion on threaded staybolts is the lack of threads on the section of the staybolt body adjacent to just above the sheet.

Broken staybolts may be detected by leakage through telltale holes and by hammer testing. Both methods are most effective when the boiler is under hydrostatic pressure of at least 95% MAWP. If a hydrostatic test cannot be applied, the hammer test may be performed alone with the boiler drained.

When a broken staybolt is found, the staybolts adjacent to it should be examined closely because these may have become overstressed by addition of the load from the broken staybolt.

A telltale hole plugged by installation of a nail or pin may indicate the staybolt is broken and requires
The plugging of telltale holes by refractory to prevent buildup of foreign matter in the telltale hole is permitted for locomotives operating under FRA Jurisdiction per 49 CFR Section 230.41.

One indication that a threaded staybolt leaks during service is when the head of it is found to have been re-driven repeatedly.

<table>
<thead>
<tr>
<th>NB16-0809D</th>
<th>S2.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, S2.1</td>
<td>a) This supplement is provided as a guide to provide requirements and guidelines for inspection of historical steam boilers of riveted and/or welded construction not falling under the scope of NBIC Part 2, Supplement 1. These historical steam boilers would include: steam tractors, traction engines, hobby steam boilers, portable steam boilers, certain steam locomotive boilers, and other such boilers that are being preserved, restored, and maintained for demonstration, viewing, or educational purposes. (See Note below)</td>
</tr>
<tr>
<td>Note: This supplement is not to be used for steam locomotive boilers operating on tracks gaged 24 in. (610 mm) or greater or for steam locomotive boilers falling under the requirements of the Federal Railroad Administration (FRA). FRA rules for steam locomotive boilers are published in 49 CFR 230. Specific rules and special requirements for inspection, repairs, alterations, and storage of steam locomotive boilers are identified in NBIC Part 2, Supplement 1.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0204A</th>
<th>S2.4.4.1 NONDESTRUCTIVE EXAMINATION METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, S2.4.4.1</td>
<td>There are a variety of nondestructive examination methods that may be employed to assess the condition of historical boilers. Skill, experience, and integrity of personnel performing examinations are essential to obtaining meaningful results. Generally, some form of surface preparation will be required prior to the use of examination methods.</td>
</tr>
</tbody>
</table>

The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction for the pressure-retaining item. Weld repairs and alterations shall be subjected to the same nondestructive examination requirements as the original welds. Where this is not possible or practicable, alternative NDE methods acceptable to the Inspector and the Jurisdiction where the pressure-retaining item is installed, where required, may be used.

<table>
<thead>
<tr>
<th>Editorial Note: This paragraph was intended to be deleted for the 2015 Edition but was not removed due to a clerical error</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) To calculate MAWP, ultrasonic thickness testing results in areas of generalized thinning (3 in. [76 mm] in diameter or greater) or where grooved thinning is noted (2 in. [50 mm] in length or greater) are to be used in determining minimum thickness in accordance with S2.10. The MAWP calculation in S2.10 shall be completed based on the thickness data gathered.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB16-2301</th>
<th>f) Valves shall be used in the manner for which they were designed, and shall be used within the specified pressure-temperature ratings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, S2.9 f)</td>
<td>1) Valves shall be rated at or above the pressure setting of the boiler safety valve, denoted by the general or primary pressure class identification on the valve body and/or by the initials “WSP” or “S” to indicate working steam pressure or steam rating. Valves in cold-water service may be designated by the initials “WOG” to indicate water, oil, or gas rating and/or by the pressure class identification on the valve body; and</td>
</tr>
</tbody>
</table>

2) Valves shall operate freely and be in good working condition. Valves which are damaged, such as cracked or swelled from freezing, shall not be used. |
Each bottom blowoff pipe shall have at least one slow-opening valve. Blowoff valves may be Y-type globe valves, gate valves, or angle valves provided that they are so constructed and installed to prevent sediment collection. Ordinary globe valves, and other types of valves that have dams or pockets where sediment can collect, shall not be used on blowoff connections.

A slow-opening valve is a valve that requires at least five 360 deg turns of the operating mechanism to change from fully closed to fully opened.

### S2.10 MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)

The MAWP of a boiler shall be determined by computing the strength of each boiler component. The computed strength of the weakest component using the factor of safety allowed by these rules shall determine the MAWP.

**Note:** The rules of ASME Section I 1971 Edition, Part “PR” and “PFT” may be used for determining specific requirements of design and construction of boilers and parts fabricated by riveting.\(^3\)

\(^3\)Copies of ASME Section I 1971 Edition Part “PR” and “PFT” referenced section may be obtained by contacting the National Board of Boiler and Pressure Vessel Inspectors, 1055 Grupper Ave., Columbus, OH 43229

### S2.10.4 STAYED SURFACES

The maximum allowable working pressure for stayed flat plates and those parts which, by these rules, require staying as flat plates with stays or staybolts of uniform diameter, uniformly spaced, shall be calculated using the following formula or NBIC Part 2, Table S2.10.4.

When pitches of stays or staybolts of uniform diameter are symmetrical and form a rectangle, the equation may be replaced with the following equation:

\[
P = \frac{2 \times t^2 \times S \times C}{t^2 + w^2}
\]

See definitions of nomenclature in S2.10.6.
| Bolt
<table>
<thead>
<tr>
<th>Spacing</th>
<th>Actual Diameter of Corroded Staybolt, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>0.35</td>
</tr>
<tr>
<td>1.5</td>
<td>64</td>
</tr>
<tr>
<td>2.5</td>
<td>100</td>
</tr>
<tr>
<td>4.0</td>
<td>150</td>
</tr>
<tr>
<td>6.0</td>
<td>225</td>
</tr>
</tbody>
</table>

\[ TS = 7,500 \text{ psi} \]
\[ P = \frac{\pi \cdot d^2 \cdot TS}{1.1 \cdot p^2} \]
\[ d = \text{Minimum diameter of corroded staybolt} \]
\[ p = \text{Staybolt spacing, in.} \]

Table S2.10.4.1 [US Customary Units]

Maximum Allowable Working Pressure Based on Load Carrying Capacity of a Single-Corroded Staybolt
<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$\omega_1$</th>
<th>$\omega_2$</th>
<th>$\omega_3$</th>
<th>$\omega_4$</th>
<th>$\omega_5$</th>
<th>$\omega_6$</th>
<th>$\omega_7$</th>
<th>$\omega_8$</th>
<th>$\omega_9$</th>
<th>$\omega_{10}$</th>
<th>$\omega_{11}$</th>
<th>$\omega_{12}$</th>
<th>$\omega_{13}$</th>
<th>$\omega_{14}$</th>
<th>$\omega_{15}$</th>
<th>$\omega_{16}$</th>
<th>$\omega_{17}$</th>
<th>$\omega_{18}$</th>
<th>$\omega_{19}$</th>
<th>$\omega_{20}$</th>
<th>$\omega_{21}$</th>
<th>$\omega_{22}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
<td>270</td>
</tr>
<tr>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
</tr>
</tbody>
</table>

$T_{S} = 5$ kPa, $P = MAWDP_{kPa}$

\[
P = \frac{\pi \cdot d^2 \cdot T_{S}}{1.14 \cdot p^2}
\]

$d$ = Minimum diameter of corroded staybolt, mm

$p$ = Staybolt spacing, mm

Table S2.10.4.1 [Metric Units]

Maximum Allowable Working Pressure Based on Load Carrying Capacity of a Single-Corroded Staybolt
S2.10.5 CONSTRUCTION CODE

To address the many pressure-related components and features of construction encountered in firetube boilers, a reprint of the 1971 Edition of Section I of ASME Boiler Code, Part PFT, is provided. Copies of these referenced ASME sections may be obtained by contacting the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 or www.nationalboard.org. This section supplement may be used for actual repairs/alterations and inspection/evaluation of boilers.

S2.10.6 NOMENCLATURE

The nomenclature for the terms used in the above equations is:

- **p** = maximum pitch measured (inches or mm) between straight lines, (horizontal, vertical, or inclined) passing through the centers of staybolts in different rows.
- **l** = the pitch of stays in one row, passing through the center of staybolts, these lines may be horizontal, vertical, or inclined and measured in inches or mm.
- **w** = the distance between two rows of staybolts, inches or mm.
- **h** = the hypotenuse of a square or rectangle, defined as either \(\sqrt{2p^2+2l^2}\) or \(\sqrt{l^2+w^2}\), inches or mm.
- **d** = minimum diameter of corroded staybolt, inches or mm.
- **R** = inside radius of the weakest course of shell or drum, in inches or mm.
- **TS** = ultimate tensile strength of shell plates, psi (MPa)
- **t** = minimum thickness of shell plate in the weakest course, inches or mm.
- **P** = calculated MAWP psi (MPa).
- **S** = maximum allowable stress value, psi (MPa).
- **C** = 2.1 for welded stays or stays screwed through plates not over 7/16 in. (11 mm) in thickness with ends riveted over.
- **C** = 2.2 for welded stays or stays screwed through plates over 7/16 in. (11 mm) in thickness with ends riveted over.
- **C** = 2.5 for stays screwed through plates and fitted with single nuts outside of plate, or with inside and outside nuts, omitting washers.
- **C** = 2.8 for stays with heads not less than 1.3 times the diameter of the stays screwed through plates, or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have true bearing on the plate.
- **C** = 3.2 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than 0.4p and thickness not less than t.

**Note:** The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

**E** = the efficiency of the longitudinal riveted joint.

See Table S2.10.6 for efficiencies (E), which are the average for the different types of riveted joints.

S2.10.8 BOILER INSULATION AND JACKETING

- **a)** The pressure retaining item shall be subjected to ultrasonic thickness testing (UT) per S2.6.2 to establish a baseline thickness for all of the boiler components. The original Manufacturer's Data Report may be used to establish baseline thickness. Recurring UT inspections per S2.6.2 may be taken at the bottom of the barrel and around the bottom of the firebox.

- **b)** Should removal of the insulation and jacket be requested by the Inspector, agreement should be obtained by the owner or user, Inspector and jurisdiction if required.

S3.1 SCOPE

- **a)** The purpose of this supplement is to provide requirements and guidelines for in-service inspection of pressure equipment manufactured from impervious graphite materials.
### S3.3 OPERATIONS

The owner *should* maintain controlled conditions for use of graphite pressure equipment, including the use of temperature and pressure recorders and/or operating logs. The owner *should* maintain operating procedures, and ensure that pressure and temperature are controlled. A thermal or pressure spike may damage the graphite or metal components.

### S3.4 INSERVICE INSPECTION

a) The guidelines provided in NBIC Part 2, Section 1 shall apply to graphite pressure equipment, except as modified herein.

b) Graphite pressure vessels, pressure parts, and vessel components *should* receive an external visual examination biennially. All accessible surfaces should be chemically cleaned. Cleaning fluids containing strong oxidants *should* not be used.

c) Typical indicators that *should* necessitate graphite pressure equipment inspection, evaluation, and repair include:
   1) Cross-contamination of either process or service fluids;
   2) Observation of external leaking;
   3) Observation of reduced rate or excessive pressure drop; and
   4) Reduction of heat-transfer performance.

d) Cracks, bulges, blisters, delaminations, spalling conditions, and excessive erosion are cause for repair or replacement. Any surface discoloration should be recleaned and examined more closely to determine if a delamination or spalling condition exists.

e) Other typical discontinuities include chipping, erosion, baffle cutting due to vibration, and cement deterioration. All passageways are susceptible to fouling.

### S4.1 SCOPE

This supplement provides specific requirements and guidelines for inspection of fiber-reinforced thermosetting plastic pressure equipment.

### S4.10 PHOTOGRAPHS OF TYPICAL CONDITIONS

The figures listed in S4.11 contain photographs of typical conditions that may exist in inservice FRP vessels and piping. These surface conditions can be similar to or different from those encountered in practice. Also, differing causes of surface degradation can result in similar surface appearances.

**Note:** NBIC Part 2, Figures S4.7.2, S4.7.3-a, S4.7.3-b, and S4.10-j through S4.10-r, were reprinted with permission of the Copyright Owner, © MATERIALS TECHNOLOGY INSTITUTE, INC. (2002). The captions of the figures were revised by the NBIC Committee.

Color photographs are available on the National Board website, [www.nationalboard.org](http://www.nationalboard.org) under the ‘National Board Inspection Code’ tab.
FIGURE S4.7.2
STAR CRACK IN CORRODED LINER. POSSIBLE CAUSE IS EXTERNAL IMPACT.

FIGURE S4.7.3-a
GUSSET CRACK. POSSIBLE CAUSES ARE EXCESSIVE LOAD DUE TO UNSUPPORTED VALVE, PIPE, OR OVERSTRESS AND AGE.
FIGURE S4.7.3-b
CRACKED FLANGE. POSSIBLE CAUSES ARE INCORRECT MATCH-UP OF FLANGES, OVER-TORQUE OF BOLTS AT FIT-UP, MANUFACTURING DEFECT, OR EXCESSIVE PIPING LOADS.

FIGURE S4.7.3-c
CRACKED FLANGE. POSSIBLE CAUSE IS BOLTING DISIMILAR FLANGES TOGETHER (FULL-FACED FLANGE WITH RAISED-FACE FLANGE).
FIGURE S4.10-a
EXCESSIVE HEAT. POSSIBLE CAUSES ARE LOCALIZED HIGH-TEMPERATURE EXCURSIONS.

FIGURE S4.10-b
LAMINATE VOIDS AT OVERLAYS.
FIGURE S4.10-c
SURFACE DETERIORATIONS. POSSIBLE CAUSES ARE EXPOSURE TO HOT WATER AND/OR STEAM AND CHEMICAL ATTACK.

FIGURE S4.10-d
BLISTERS. POSSIBLE CAUSE IS EXPOSURE TO STEAM OR PURIFIED HOT WATER.
FIGURE S4.10-e
SURFACE EROSION. POSSIBLE CAUSES ARE HIGH FLOW RATE OF FLUIDS, EROSION DUE TO PARTICULATES IN FLUID, AND CHEMICAL ATTACK/SOFTENING OF RESIN.

FIGURE S4.10-f
CORROSION/EROSION.

Corrosion/Erosion
FIGURE S4.10-g
CRACKS. POSSIBLE CAUSE IS IMPACT FROM AN EXTERNAL SOURCE.

FIGURE S4.10-h
CORROSION (LOSS OF VEIL).
FIGURE S4.10-i
SHELL FRACTURE. POSSIBLE CAUSE IS EXTERIOR IMPACT.

FIGURE S4.10-j
CONCENTRATED SULFURIC ACID ATTACK.

Concentrated sulfuric acid attack.
FIGURE S4.10-k
BLISTER.

FIGURE S4.10-l
FIBER PROMINENCE. POSSIBLE CAUSE IS EXPOSURE TO SUNLIGHT AND NO UV PROTECTION.
FIGURE S4.10-m
COLOR CHANGE.

FIGURE S4.10-n
CUT EDGE EVALUATION.
FIGURE S4.10-o
EROSION IN THE LINER.

FIGURE S4.10-p
GOUGE. POSSIBLE CAUSE IS MECHANICAL DAMAGE.
FIGURE S4.10-q
CRACKS AT THE KNUCKLE. POSSIBLE CAUSE IS INADEQUATE ANCHORING OF VESSEL.

FIGURE S4.10-r
SULFURIC ACID ATTACK AND THERMAL SHOCK.
FIGURE S4.10-s
AIR BUBBLES BEHIND THE VEIL (SHOWN AFTER CHEMICAL EXPOSURE).

FIGURE S4.10-t
DELAMINATIONS AND BLISTERS. POSSIBLE CAUSES ARE EXPOSURE TO HIGH HEAT OR IMPROPER SURFACE PREPARATION OF LINER PRIOR TO STRUCTURAL APPLICATION.
FIGURE S4.10-u
FLANGE CRACKING.

FIGURE S4.10-v
ELASTOMERIC GASKET EXTRUDING. POSSIBLE CAUSES ARE EXCESSIVE BOLT TORQUE OR IMPROPER BOLTING SEQUENCE.
FIGURE S4.10-w
INCORRECT GUSSET ATTACHMENT. POSSIBLE CAUSES ARE GUSSETS NOT EXTENDING OUT FROM FLANGE A MINIMUM OF 30° FROM THE AXIS OF NOZZLE NECK, OR GUSSET ATTACHMENTS USED AS PART OF THE FLANGE THICKNESS.

FIGURE S4.10-x
STAR CRACK. POSSIBLE CAUSE IS EXTERNAL IMPACT.
S5.1 SCOPE

a) This supplement describes guidelines for the inservice inspection of a Yankee dryer. A Yankee dryer is a pressure vessel with the following characteristics:

- Pressure roll load (line or nip load) due to pressing the wet web onto the dryer.

5 Pressure roll load, line load, and nip load are terms that are used interchangeably to refer to the interaction between the pressure roll(s) and the Yankee dryer. It is called "nip" load because the pressure roll is rubber-covered and is pressed up against the Yankee with enough force to create a nip (or pinch) that forces the paper into line contact between the rolls and provides some mechanical dewatering. The paper then sticks onto the Yankee surface and follows the Yankee dryer for thermal dewatering by the steam-heated Yankee surface. This "nip load" is called a "line load" because the units are load (force) per length of line contact. The units are pounds per linear inch (PLI) and kilonewtons per meter (kN/m).

S6.1 SCOPE

This supplement provides rules, requirements, and guidelines for continued service inspections of transport tanks, i.e., cargo tanks, rail tanks, portable tanks, and ton tanks that transport dangerous goods as required in the Code of Federal Regulations, Title 49, Parts 100 through 185, and the United Nations Recommendations for Transport of Dangerous Goods - Model Regulations. This supplement, where applicable, shall be used in conjunction with other applicable Parts of the National Board Inspection Code (NBIC) and ASME Section XII, Transport Tanks, of the ASME Boiler and Pressure Vessel Code: Rules for Construction and Continued Service of Transport Tanks.

S6.2 TERMINOLOGY

a) The terminology used in this supplement in some cases may be in conflict with terms and definitions normally used in the Definition section includes a definition section, has incorporated listing definitions and terms specified in CFR 49, Parts 100 through 185.

b) When conflicts are identified between this part and the regulations of the Competent Authority regarding the examination, inspection, testing, repair, and maintenance for the continued qualification of transport tanks, the regulations of the Competent Authority take precedence.

c) Rules for repairs, alterations, and modifications of transport tanks are provided in NBIC Part 3, Repairs...
and Alterations, Supplement 6.

<table>
<thead>
<tr>
<th>NB07-0910</th>
<th>S6.4 INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 2, S6.4</strong></td>
<td>This section will establish the appropriate methods to be used for continued service inspections. Inspections for repairs and modifications of specific requirements for inspections of repairs, alterations, and modifications to transport tanks are located in NBIC Part 3, Repairs and Alterations, Supplement 6.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB07-0910</th>
<th>S6.4.2 GENERAL REQUIREMENTS FOR INSPECTORS</th>
</tr>
</thead>
</table>
| **Part 2, S6.4.2** | **a)** The Inspector shall be a **Registered Inspector and qualified as a National Board recognized Commissioned** Inspector, i.e., Authorized Inspector (AI), Qualified Inspector (QI), or a **Certified Individual** (CI), as applicable, to perform continued service inspections or a **Registered Inspector** (RI). The Registered Inspector is a position established by CFR 49 Parts 100 through 185 for Continued Service Inspections. This individual’s Inspector’s duties and responsibilities are subject to DOT and not ASME QAI-1, identified in this supplement and subject to DOT regulations, not ASME QAI-1. **b)** For continued service inspections, the owner or user’s designated and qualified Registered Inspector can be used to perform inspections and testing in accordance with the Code of Federal Regulations, Title 49, Parts 100 through 185, Transportation, as stated below. **c)** Inspections for continued service of transport tanks shall be performed by the type of inspector identified below for the specific class of vessel as defined in the applicable Modal Appendices of ASME Section XII and as required by the Competent Authority. Inspectors shall be a Registered Inspector and meet the following additional requirements:

1. **For Class 1 vessels,** Inspectors shall be designated as an Authorized Inspector regularly employed by an ASME accredited Authorized Inspection Agency (AIA). The AIA, supervisors, and inspectors shall meet the qualifications and duties as required in the latest edition of ASME QAI-1 Qualifications for Authorized Inspection.

2. **For Class 2 vessels,** Inspectors shall be designated as Qualified Inspectors regularly employed by an ASME accredited Qualified Inspection Organization (QIO). The QIO, supervisors, and inspectors shall meet the qualifications and duties as required in the latest edition of ASME QAI-1 Qualifications for Authorized Inspection.

3. **For Class 3 vessels,** Inspectors shall be designated a Certified Individual (CI) employed full or part time by an ASME Section VIII or Section XII Certificate Holder or contractor to the Certificate Holder manufacturing DOT Transport Tanks. The CI shall meet the qualifications and duties as required in the latest edition of ASME QAI-1, Qualification for Authorized Inspection.

4. Authorized Inspection Agencies may provide inspection services for Class 2 and Class 3 vessels. Qualified Inspection Organizations may provide inspection services for Class 3 vessels.

4.5 Users may perform continued service inspections including repairs and alterations if the user possesses a valid Owner-User Inspection Organization (OUIO) Certificate of Authorization (NB-371) issued by the National Board of Boiler and Pressure Vessel Inspectors, inspectors have a current and valid NB Commission, and are employed by the OUIO. |

<table>
<thead>
<tr>
<th>NB07-0910</th>
<th>S6.4.3 REGISTRATION OF INSPECTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 2, S6.4.3</strong></td>
<td>Each Registered Inspector performing duties and responsibilities for continued service inspections or inspections for repairs and modifications as specified in this section and 49 CFR Part 180 is required to</td>
</tr>
</tbody>
</table>
**S6.4.4 QUALIFICATIONS OF INSPECTORS**

Registered Inspector (RI) means a person registered with the US Department of Transportation (DOT) in accordance with Subpart F of Part 107 of 49 CFR who has the knowledge and ability to determine whether a cargo transport tank conforms to the applicable DOT specification. A Registered Inspector may or may not be an employee of the approved facility. In addition, Registered Inspector means a person who meets, at a minimum, any one of the following:

a) Has an engineering degree and one year of work experience;

b) Has an associate degree in engineering and two years of work experience;

c) Has a high school diploma or GED and three years of work experience; and

d) Has at least three years of experience in performing the duties of a Registered Inspector by September 1, 1991, and was registered with the DOT by December 31, 1995.

**S6.4.5 CODES OF CONSTRUCTION**

a) The Registered Inspector is responsible to ensure that all repairs, alterations or modifications (including re-rating) are performed in accordance with the original code of construction of the transport tank.

b) For repairs, alterations, or modifications, the original code of construction for DOT vessels shall be either ASME Section VIII Division I or Section XII.

**S6.9 REFERENCES TO OTHER CODES AND STANDARDS**

Other existing inspection codes, standards, and practices pertaining to the continued service inspection, i.e., CFR 49, Parts 100 through 185, ASME Section XII, etc., of transport tanks can provide useful information and references relative to the inspection techniques listed in this Appendix. Additionally, supplementary guidelines for assisting in the evaluation of inspection results and findings are also available. Some acceptable requirements and guidelines are as follows:

a) American Society of Mechanical Engineers — ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1 (Rules for Construction of Pressure Vessels).

b) American Society of Mechanical Engineers:
   1) ASME Section V (Nondestructive Examination)
   2) ASME Section IX (Welding and Brazing Qualifications).

c) Code of Federal Regulations, Title 49, Parts 100 through 185, Transportation.


e) ADR 2003, European Agreement Concerning the International Carriage of Dangerous Goods by Road. (Published by the UN Economic Commission for Europe, Information Service, Palais des Nations, CH-1211 Geneve, Suisse.)

f) CGA 6-4.1, Cleaning Equipment for Oxygen Service.

g) CGA S-1.2, Pressure Relief Device Standard, Part 2: Cargo and Portable Tanks for Compressed Gases. (Published by the Compressed Gas Association, Inc. [CGA], 4221 Walney Road, Chantilly, VA 20151.)

h) IMDG Code 2002, International Maritime Dangerous Goods Code (including Amendment 31-02). (Published by the International Maritime Organization [IMO], 4 Albert Embankment, London, SE1 7SR England.)
i) RID 2003, *Carriage of Dangerous Goods.* (Published by the Intergovernmental Organization for International Carriage by Rail [OTIF], Gypenhubelweg 30, CH-3006 Bern, Switzerland.)


k) SSPC Publication #91-12, *Coating and Lining Inspection Manual.* (Published by Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, PA 15212-2683.)

---

**S7.1 SCOPE**

This supplement provides requirements and guidelines for the inspection of pressure vessels in liquefied petroleum gas (LPG) service.

---

**a) Containers**

Pressure vessels designed for storing liquefied petroleum gas (LPG) can be stationary or can be mounted on skids. LPG is generally considered to be non-corrosive to the interior of the vessel. NBIC Part 2, Supplement 7 is provided for guidance. This supplement provides guidelines of a general nature for the owner, user, or jurisdictional authority. There may be occasions where more detailed procedures will be required such as changing from one service to another (e.g., above ground to underground; or containers that are commercially refurbished).

---

**b) Application of this Supplement**

When evidence of structural damage to the vessel has been observed, leakage has been determined, or the tank has been dug up, and is to be reinstalled. Special consideration will be given to containers that are going to be commercially refurbished (see NBIC Part 2, S7.9).

---

**S7.2 PRE-INSPECTION ACTIVITIES**

a) A review of the known history of the container should be performed. This should include a review of information, such as:

1) Operating conditions;
2) Historical contents of the vessel;
3) Results of any previous inspection;
4) Current jurisdictional inspection certificate, if required;
5) ASME Code symbol stamping or mark of code of construction, if required; and
6) National Board and/or jurisdictional registration number, if required.

b) The container shall be sufficiently cleaned to allow for visual inspection. For commercially refurbished containers, see NBIC Part 2, S7.9.

---

**S7.3 INSERVICE INSPECTION FOR VESSEL PRESSURE VESSELS IN LP GAS SERVICE**

The type of inspection given to pressure vessels should take into consideration the condition of the vessel and the environment in which it operates. The inspection may be external or internal, and use a variety of nondestructive examination methods. Where there is no reason to suspect an unsafe condition or where there are no inspection openings, internal inspections need not be performed. When service conditions change from one service to another, i.e., above ground to underground; or containers that are commercially refurbished, an internal inspection may be required. The external inspection may be performed when the container is pressurized or depressurized, but shall provide the necessary information that the essential sections of the vessel are of a condition to operate.

---

**S7.3.1 NONDESTRUCTIVE EXAMINATION (NDE)**

Listed below are a variety of methods that may be employed to assess the condition of the pressure vessel. These examination methods should be implemented by experienced and qualified individuals. Generally, some form of surface preparation will be required prior to the use of these examination methods: visual, magnetic particle, liquid penetrant, ultrasonic, radiography, radioscopy, eddy current, metallographic examination, and acoustic emission. When there is doubt as to the extent of a defect or detrimental
<table>
<thead>
<tr>
<th>Condition found in a container pressure vessel, additional NDE may be required.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S7.4 EXTERNAL INSPECTION</strong></td>
</tr>
<tr>
<td>The container pressure vessel shall be inspected for corrosion, distortion, cracking, or other conditions as described in this section. In addition, the following should be reviewed, where applicable:</td>
</tr>
<tr>
<td><strong>a) Insulation or Coating</strong></td>
</tr>
<tr>
<td>If the insulation or coating is in good condition and there is no reason to suspect an unsafe condition behind it, then it is not necessary to remove the insulation or coating in order to inspect the vessel pressure vessel. However, it may be advisable to remove a small portion of the insulation or coating in order to determine its condition and the condition of the container pressure vessel surface. For commercially refurbished containers, see NBIC Part 2, S7.9.</td>
</tr>
<tr>
<td><strong>b) Evidence of Leakage</strong></td>
</tr>
<tr>
<td>Any leakage of vapor or liquid shall be investigated. Leakage coming from behind insulation or coating, supports, or evidence of past leakage shall be thoroughly investigated by removing any insulation necessary until the source is established.</td>
</tr>
<tr>
<td><strong>c) Structural Attachments</strong></td>
</tr>
<tr>
<td>The pressure vessel mountings should be checked for adequate allowance for expansion and contraction, such as provided by slotted bolt holes or unobstructed saddle mountings. Attachments of legs, saddles, skirts, or other supports should be examined for distortion or cracks at welds.</td>
</tr>
<tr>
<td><strong>d) Vessel Pressure Vessel Connections</strong></td>
</tr>
<tr>
<td>Components that are exterior to the vessel pressure vessel and are accessible without disassembly shall be inspected as described in this paragraph. Manholes, reinforcing plates, nozzles, couplings, or other connections shall be examined for cracks, deformation, or other defects. Bolts or nuts should be examined for corrosion or defects. Weep holes in reinforcing plates shall remain open to provide visual evidence of leakage as well as to prevent pressure buildup between the vessel pressure vessel and the reinforcing plate. Accessible flange faces should be examined for distortion. It is not intended that flanges or other connections be opened unless there is evidence of corrosion to justify opening the connection.</td>
</tr>
<tr>
<td><strong>e) Fire Damage</strong></td>
</tr>
<tr>
<td>Pressure vessels shall be carefully inspected for evidence of fire damage. The extent of fire damage determines the repair that is necessary, if any. (See NBIC Part 2, S7.7).</td>
</tr>
<tr>
<td><strong>S7.5 INTERNAL INSPECTION</strong></td>
</tr>
<tr>
<td>When there is a reason to suspect an unsafe condition, the suspect parts of the vessel pressure vessel shall be inspected and evaluated. The vessel pressure vessel shall be prepared and determined to be gas-free and suitable for human entry prior to internal inspection. (See NBIC Part 2, 2.3.4).</td>
</tr>
<tr>
<td><strong>S7.6 LEAKS</strong></td>
</tr>
<tr>
<td>Leakage is unacceptable. When leaks are identified, the vessel pressure vessel shall be removed from service until repaired by a qualified repair organization or permanently removed from service.</td>
</tr>
<tr>
<td><strong>S7.7 FIRE DAMAGE</strong></td>
</tr>
<tr>
<td>a) Vessel Pressure vessels in which bulging exceeds the limits of NBIC Part 2, S7.8.3 or distortion that exceeds the limits of the original code of construction (e.g., ASME Section VIII, Div. 1), shall be removed from service until repaired by a qualified repair organization or permanently removed from service.</td>
</tr>
<tr>
<td>b) Common evidence of exposure to fire is:</td>
</tr>
<tr>
<td>1) Charring or burning of the paint or other protective coat;</td>
</tr>
<tr>
<td>2) Burning or scarring of the metal;</td>
</tr>
<tr>
<td>3) Distortion; or</td>
</tr>
<tr>
<td>4) Burning or melting of the valves.</td>
</tr>
</tbody>
</table>
c) A pressure vessel that has been subjected to action of fire shall be removed from service until it has been properly evaluated. The general intent of this requirement is to remove from service pressure vessels which have been subject to action of fire that has changed the metallurgical structure or the strength properties of the steel. Visual examination with emphasis given to the condition of the protective coating can be used to evaluate exposure from a fire. This is normally determined by visual examination as described above with particular emphasis given to the condition of the protective coating. If there is evidence that the protective coating has been burned off any portion of the pressure vessel surface, or if the pressure vessel is burned, warped, or distorted, it is assumed that the pressure vessel has been overheated. If, however, the protective coating is only smudged, discolored, or blistered, and is found by examination to be intact underneath, the pressure vessel shall not be considered affected within the scope of this requirement. Containers/Panels that have been involved in a fire and show no distortion shall be requalified for continued service by retesting using the liquid pressure test procedure applicable at the time of original fabrication.

d) Subject to the acceptance of the Jurisdiction and the Inspector, alternate methods of pressure testing may be used.

<table>
<thead>
<tr>
<th>NB16-0201</th>
<th>Part 2, S7.8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S7.8 ACCEPTANCE CRITERIA</strong></td>
<td></td>
</tr>
<tr>
<td>The acceptance criteria for LPG Pressure vessels is based on successfully passing inspections without showing conditions beyond the limits shown below.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB16-0201</th>
<th>Part 2, S7.8.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S7.8.1 CRACKS</strong></td>
<td></td>
</tr>
<tr>
<td>Cracks in the pressure boundary (e.g., heads, shells, welds) are unacceptable. When a crack is identified, the Pressure vessel shall be removed from service until the crack is repaired by a qualified repair organization or permanently retired from service. (See NBIC Part 3, Repairs and Alterations).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB16-0201</th>
<th>Part 2, S7.8.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S7.8.2 DENTS</strong></td>
<td></td>
</tr>
</tbody>
</table>
| a) Shells  
The maximum mean dent diameter in shells shall not exceed 5% of the shell diameter, and the maximum depth of the dent shall not exceed 5% of the mean dent diameter. The mean dent diameter is defined as the average of the maximum dent diameter and the minimum dent diameter. If any portion of the dent is closer to a weld than 5% of the shell diameter, the dent shall be treated as a dent in a weld area, see b) below. |
| b) Welds  
The maximum mean dent diameter on welds (i.e., part of the deformation includes a weld) shall not exceed 10% of the shell diameter. The maximum depth shall not exceed 5% of the mean dent diameter. |
| c) Head  
The maximum mean dent diameter on heads shall not exceed 10% of the shell diameter. The maximum depth shall not exceed 5% of the mean dent diameter. The use of a template may be required to measure dents on heads. |
| d) When dents are identified which exceed the limits set forth in these paragraphs, the Pressure vessel shall be removed from service until the dents are repaired by a qualified repair organization or permanently retired from service. |

<table>
<thead>
<tr>
<th>NB16-0201</th>
<th>Part 2, S7.8.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S7.8.3 BULGES</strong></td>
<td></td>
</tr>
</tbody>
</table>
| a) Shells  
If a bulge is suspected, the circumference shall be measured at the suspect location and in several places remote from the suspect location. The variation between measurements shall not exceed 1%. |
| b) Heads  
1) If a bulge is suspected, the radius of curvature shall be measured by the use of templates. At any point the radius of curvature shall not exceed 1.25% of the diameter for the specified shape of the head.  
2) When bulges are identified that exceed the limits set forth in these paragraphs, the Pressure vessel shall be removed from service until the bulges are repaired by a qualified repair organization or permanently retired from service. |
permanently retired from service.

<table>
<thead>
<tr>
<th>NB16-0201</th>
<th>S7.8.4 CUTS OR GOUGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, S7.8.4</td>
<td>When a cut or a gouge exceeds 25% of the thickness of the vessel, the vessel shall be removed from service until it is repaired by a qualified repair organization or permanently removed from service.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-0201</th>
<th>NB16-0201</th>
<th>S7.8.5 CORROSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, S7.8.5</td>
<td>a) Line and Crevice Corrosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For line and crevice corrosion, the depth of the corrosion shall not exceed 25% of the original wall thickness.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Isolated Pitting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) Isolated pits may be disregarded provided that:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) Their depth is not more than 25% the required thickness of the container wall;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3) The total area of the pits does not exceed 7 sq. in. (4,500 sq. mm) within any 8 in. (200 mm) diameter circle; and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4) The sum of their dimensions along any straight line within this circle does not exceed 2 in. (50 mm).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) General Corrosion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For a corroded area of considerable size, the thickness along the most damaged area may be averaged over a length not exceeding 10 in. (250 mm). The thickness at the thinnest point shall not be less than 75% of the required wall thickness, and the average shall not be less than 90% of the required wall thickness. When general corrosion is identified that exceeds the limits set forth in this paragraph, the vessel shall be removed from service until it is repaired by a qualified &quot;R&quot; Stamp holder or permanently removed from service unless an acceptable for service evaluation is performed in accordance with NBIC Part 2, 4.4.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) When general, localized or pitting corrosion exceeds the specified corrosion/erosion allowance, but meets the requirements of b) and c), consideration should be given to previous inspections. Patterns of corrosion and damage that are expected to occur over the future service life should be used to determine a specific inspection plan. Repairs may be necessary to maintain a safe and satisfactory operating condition.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-2103</th>
<th>NB16-0201</th>
<th>S7.8.6 ANHYDROUS AMMONIA SERVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2, S7.8.6, S7.9</td>
<td>Pressure vessels of 3000 gal. (11.4 m³) water capacity or less used to store anhydrous ammonia, except for pressure vessels used in cargo tank vehicle service, shall not be converted to LPG service.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cargo tank pressure vessels less than 3000 gal. (11.4 m³) water capacity to be converted from ammonia to LPG service shall be wet-fluorescent magnetic particle tested (WFMT) on all internal surfaces (see NBIC Part 2, 2.3.6.4).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Containers that have been previously used in anhydrous ammonia service shall not be converted to LPG service. Any blue coloring of the brass valves indicates that the container has been in anhydrous ammonia service.</td>
<td></td>
</tr>
</tbody>
</table>
S7.9 ASME LPG CONTAINERS PRESSURE VESSELS LESS THAN 2000 GALLONS BEING REFURBISHED BY A COMMERCIAL SOURCE.

Commercially refurbished containers are used that are temporarily taken out of service for repair and or renewal and sent to a company which specializes in this type of work. Because the history of some of these containers is unknown, special attention shall be given to inspection and repair before returning any of these containers back to service. ASME LPG containers less than 2,000 gal. (7,570 l) may be refurbished subject to the following conditions:

a) A complete external inspection shall be completed under the guidelines of this supplement. If any defects are found, as defined in S7.8.1 through S7.8.5, the defect shall be repaired under NBIC Part 3, Repairs and Alterations, by qualified personnel or permanently removed from service;

b) Containers of this size that have been previously used in anhydrous ammonia service shall not be converted to LPG service. See NBIC Part 2, S7.8.6;

c) The coating on the outside of the container shall be removed down to bare metal so that an inspection can be performed under the guidelines of this supplement; and

d) Verify that there is no internal corrosion if the tank has had its valves removed or is known to have been out of service for an extended period.

S7.10 REQUIREMENTS FOR CHANGE OF SERVICE FROM ABOVE GROUND TO UNDERGROUND SERVICE

ASME LPG storage vessels may be altered from above ground (AG) service to underground (UG) service subject to the following conditions.

a) Vessel that have been previously used in anhydrous ammonia service are not permitted to be converted to LPG service.

b) The outside surface of the vessel shall be cleaned to bare metal for an external inspection of the vessel under the guidelines of this supplement. Prior to placing underground, the outside surface of the vessel shall be prepared consistent with the paint manufactures specification and coated with a coating suitable for UG service. Any touch-up coating shall be the same coating material. All corrosion shall be repaired in accordance with the NBIC.

c) Verify that there is no internal corrosion due to valves having been removed while the container is out or service.

d) Any unused connections located on the vessel shall be closed by seal welding around a forged plug or removed using a flush patch. If a flush patch is used the material shall be the same material thickness and material grade as the original code of construction.

e) All connections on top of the vessel, except for the liquid withdrawal opening, shall be replaced with a riser pipe with multi-valve suitable for UG LPG service. The valve shall be enclosed in a protective housing and placed underground in accordance with jurisdictional requirements.

f) The liquid withdrawal opening shall be located within the protective housing.

g) The liquid level tube in the multivalve shall be the length required according to jurisdictional requirements.

h) The NBIC nameplate shall be made of stainless steel and continuous welded to the vessel wall. The nameplate shall also have the information from the original nameplate. This shall include the manufactures name, serial number, National Board number, (if registered with the National Board) MAWP, year built, head and shell thickness, be stamped for “UG service”, the “liquid level tube length = inches” and the National Board “R” stamp. The original manufacturer's nameplate shall remain attached to the vessel. See Part 2, Section 5.2 of this Part and NBIC, Part 3, Section 5.7 for additional stamping requirements.
i) The support legs and lifting lugs may remain in place and shall be welded around the entire periphery to prevent crevices that create a potential area for corrosion. Unused attachments shall be removed and welds ground flush.

j) A connection shall be added for the attachment of an anode for cathodic protection, per NFPA, 58.

k) All welding shall be performed by a holder of a current “R” Certificate of Authorization, using a qualified welding procedure, in accordance with NBIC Part 3.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>S8.1</th>
<th>SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB16-0809D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 2, S8.1</td>
<td><strong>This supplement provides guidelines for determining the pressure differential between the pressure relief valve setting and the boiler or pressure vessel operating pressure.</strong> If a safety valve or safety pressure relief valve is subjected to pressure at or near its set pressure, it will tend to weep or simmer, and deposits may accumulate in the seat and disk area. Eventually, this can cause the valve to freeze closed and thereafter the valve could fail to open at the set pressure. Unless the source of pressure to the boiler or pressure vessel is interrupted, the pressure could exceed the rupture pressure of the vessel. It is important that the pressure differential between the valve set pressure and the boiler or pressure vessel operating pressure is sufficiently large to prevent the valve from weeping or simmering.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>S8.2</th>
<th>HOT-WATER HEATING BOILERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB15-3201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 2, S8.2</td>
<td>For hot-water heating boilers, the recommended pressure differential between the pressure relief valve set pressure and the boiler operating pressure should be at least 10 psi (70 kPa), or 25% of the boiler operating pressure, whichever is greater. Two examples follow:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) If the <strong>safety pressure</strong> relief valve of a hot-water heating boiler is set to open at 30 psi (200 kPa), the boiler operating pressure should not exceed 20 psi (140 kPa).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) If the <strong>safety pressure</strong> relief valve of a hot water heating boiler is set to open at 100 psi (700 kPa), the boiler operating pressure should not exceed 75-80 psi (520-550 kPa). Section IV of the ASME Code does not require that pressure relief valves used on hot water heating boilers have a specified blowdown. Therefore, to help ensure that the pressure relief valve will close tightly after opening and when the boiler pressure is reduced to the normal operating pressure, the pressure at which the valve closes should be well above the operating pressure of the boiler.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>S8.3</th>
<th>STEAM HEATING BOILERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB16-0809D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part 2, S8.3</td>
<td>For steam heating boilers, the recommended pressure differential between the <strong>safety pressure relief</strong> valve set pressure and boiler operating pressure should be at least 5 psi (35 kPa), i.e., the boiler operating pressure should not exceed 10 psi (70 kPa).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Since some absorption-type refrigeration systems use the steam heating boiler for their operation, the boiler operating pressure may exceed 10 psi (70 kPa). If the boiler operating pressure is greater than 10 psi (70 kPa), it should not exceed 15 psi (100 kPa), minus the blowdown pressure of the pressure relief valve.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This recommendation can be verified by increasing the steam pressure in the boiler until the pressure relief valve pops, then slowly reducing the pressure until it closes, to ensure that this closing pressure is above the operating pressure.</td>
<td></td>
</tr>
</tbody>
</table>
S8.4 POWER BOILERS

For power boilers (steam), the recommended pressure differentials between the safety-pressure relief valve set pressure and the boiler operating pressure (see NBIC Part 2, Table S8.4).

### TABLE S8.4

**MINIMUM PRESSURE DIFFERENTIAL AS PERCENTAGE OF BOILER DESIGN PRESSURE**

| DESIGN PRESSURE : | over 15 psi to 300 psi  
10% but not less than 7 psi | (100 KPa to 2.10 MPa)  
(50 KPa) |
|-------------------|--------------------------|--------------------------|
|                   | over 300 psi to 1,000 psi  
7% but not less than 30 psi | (2.14 MPa to 6.89 MPa)  
(200 KPa) |
|                   | over 1000 psi to 2,000 psi  
5% but not less than 70 psi | (6.89 MPa to 13.8 MPa)  
(480 KPa) |
|                   | over 2,000 psi  
per designer’s judgment | (13.8 MPa) |

**Note 1:**
Above 2,000 psi (13.8 MPa) the pressure differential between operating pressure and the maximum allowable working pressure is a matter for the designer’s judgement, taking into consideration such factors as satisfactory operating experience and the intended service conditions.

**Note 2:**
Safety Pressure relief valves in hot water service are more susceptible to damage and subsequent leakage than safety-pressure relief valves relieving steam. It is recommended that the maximum allowable working pressure of the boiler and safety-pressure relief valve setting for high-temperature hot-water boilers be selected substantially higher than the desired operating pressure, so as to minimize the time the safety-pressure relief valve must lift.

**Note 3:**
For organic fluid vaporizers, a pressure differential of 40 psi (280 kPa) is recommended.

S8.5 PRESSURE VESSELS

Due to the variety of service conditions and the various designs of pressure relief valves, only general guidelines can be given regarding differentials between the set pressure of the valve and the operating pressure of the vessel. Operating difficulty will be minimized by providing an adequate differential for the application. The following is general advisory information on the characteristics of the intended service and of the pressure relief valves that may bear on the proper pressure differential selection for a given application. These considerations should be reviewed early in the system design since they may dictate the maximum allowable working pressure of the system.

To minimize operational problems it is imperative that the user consider not only normal operating
conditions of the fluids (liquids or gases), pressures, and temperatures, but also start-up and shutdown conditions, process upsets, anticipated ambient conditions, instrument response time, and pressure surges due to quick-closing valves, etc. When such conditions are not considered, the pressure relief devices may become, in effect, a pressure controller, a duty for which they were not designed. Additional consideration should be given to the hazard and pollution associated with the release of the fluid. Larger differentials may be appropriate for fluids which are toxic, corrosive, or exceptionally valuable.

The blowdown characteristics and capabilities are the first consideration in selecting a compatible valve and operating margin. After a self-actuated release of pressure, the valve must be capable of reclosing above the normal operating pressure. For example: if the valve is set at 100 psi (700 kPa) with a 7% blowdown, it will close at 93 psi (640 kPa). The operating pressure must be maintained below 93 psi (640 kPa) in order to prevent leakage or flow from a partially open valve. Users should exercise caution regarding the blowdown adjustment of large, spring-loaded valves. Test facilities, whether owned by the manufacturer, repair house, or user, may not have sufficient capacity to accurately verify the blowdown setting. The setting cannot be considered accurate unless made in the field on an actual installation.

Pilot operated valves represent a special case from the standpoint of both blowdown and tightness. The pilot portion of some pilot operated valves can be set at blowdowns as short as 2%. This characteristic is not, however, reflected in the operation of the main valve in all cases. The main valve can vary considerably from the pilot depending on the location of the two components in the system. If the pilot is installed remotely from the main valve, significant time and pressure lags can occur, but reseating of the pilot ensures reseating of the main valve. The pressure drop in connecting piping between the pilot and the main valve must not be excessive, otherwise the operation of the main valve will be adversely affected.

Tightness capability is another factor affecting valve selection, whether spring-loaded or pilot operated. Tightness varies somewhat depending on whether metal or resilient seats are specified and also on such factors as corrosion and temperature. The required tightness and test method should be specified to comply at a pressure not lower than the normal operating pressure of the process. It should be remembered that any degree of tightness obtained should not be considered permanent. Service operation of a valve almost invariably reduces the degree of tightness.

The following minimum pressure differentials are recommended unless the pressure relief valve has been designed or tested in a specific or similar service and a smaller differential has been recommended by the manufacturer:

<table>
<thead>
<tr>
<th>Set Pressure</th>
<th>Recommended pressure differential</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 70 psi (480 kPa)</td>
<td>5 psi (35 kPa)</td>
</tr>
<tr>
<td>70 – 1000 psi (480 kPa – 6.89 MPa)</td>
<td>10% of set pressure</td>
</tr>
<tr>
<td>Above 1000 psi (6.89 MPa)</td>
<td>7% of set pressure</td>
</tr>
</tbody>
</table>

NB15-2103 Part 2, S9.4

<table>
<thead>
<tr>
<th>Change</th>
<th>Some Factors to Consider</th>
</tr>
</thead>
</table>
| LP Gas to Ammonia | • PWHT of Vessel During Construction Wet-fluorescent magnetic particle testing (WFMT) on all internal surfaces
• Internal access of vessel is necessary, may need to install manhole
• NFPA-58 should be consulted |
| Ammonia to LP Gas | • NFPA-58 should be consulted for restrictions.
### S10.1 SCOPE

This supplement provides specific requirements and guidelines for inspection of high-pressure composite pressure vessels, hereafter referred to as vessels. This supplement is applicable to pressure vessels with a design pressure that exceeds 3,000 psi (21 MPa) but not greater than 15,000 psi (103 MPa), and is applicable to the following four types of pressure vessels:

a) Metallic vessel with a hoop Fiber Reinforced Plastic (FRP) wrap over the straight shell cylindrical part of the vessel (both load sharing).

b) Fully wrapped FRP vessel with a non-load sharing metallic liner.

c) Fully wrapped FRP vessel with a non-load sharing non-metallic liner.

d) Fully wrapped FRP vessel with load sharing metallic liner.

This supplement is intended for inspection of ASME Section X, Class III, vessels and ASME Section VIII, Division 3, Composite Reinforced Pressure Vessels (CRPVs). However, it may be used for inspection of similar vessels manufactured to other construction codes with approval of the jurisdiction in which the vessels are installed.

### S10.3 INSPECTOR QUALIFICATIONS

a) The Inspector referenced in this supplement is a National Board Commissioned Inspector complying with the requirements of NB-263, RCI-1 Rules for Commissioned Inspector.

b) The Inspector shall be familiar with vessel construction and qualified by training and experience to conduct such inspections. The Inspector should have a thorough understanding of all required inspections, tests, test apparatus, inspection procedures, and inspection techniques and equipment applicable to the types of vessels to be inspected. The Inspector should have basic knowledge of the vessel material types and properties. Refer to NBIC Part 2, S4.2 and S4.5. The inspector shall be familiar with vessel construction and qualified by training and experience as described in NBIC Part 2, S4.5 to conduct such inspections. The inspector shall have a thorough understanding of all required inspections, tests, test apparatus, inspection procedures, and inspection techniques and equipment applicable to the types of vessels to be inspected. The inspector shall have basic knowledge of the vessel material types and properties. Refer to Part 2, S4.2 and S4.5.

The acoustic emission technician conducting the examination required per S10.5(c) and in accordance with S10.10 shall be certified per the guidelines of ASNT SNT-TC-1A or CP-189 AE Level II or III. A technician performing this test shall have training in and experience with measuring $C_e$ and $C_f$ in composites and identifying wave modes.

b) The visual examination of the vessel requires that the identity of the vessel must be verified. This should include the construction code (ASME) to which the vessel was constructed, vessel serial number, maximum allowable operating pressure, date of manufacture, vessel manufacturer, date of expiration of the service life of the vessel, and any other pertinent information shown on the vessel or available from vessel documents. The overall condition of the vessel should be noted.
S10.8  EXTERNAL INSPECTION

a) Vessel Service Life
Vessels have been designed and manufactured for a limited lifetime; this is indicated on the vessel marking. This marking should shall first be checked to ensure that such vessels are within their designated service lifetime.

b) Identification of External Damage
The external surface should shall be inspected for damage to the laminate. Damage is classified into two levels as shown in Table S10.7-a or Table S10.7-b of this supplement. The acceptance/rejection criteria shown in Table S10.7-a or Table S10.7-b of this supplement shall be followed, as a minimum.

The external surface of the vessel is subject to mechanical, thermal, and environmental damage. The external surface of a vessel may show damage from impacts, gouging, abrasion, scratching, temperature excursions, etc. Areas of the surface that are exposed to sunlight may be degraded by ultraviolet light which results in change in the color of the surface and may make the fibers more visible. This discoloration does not indicate a loss in physical properties of the fibers. Overheating may also cause a change in color. The size (area or length and depth) and location of all external damage shall be noted. Vessel support structures and attachments should shall be examined for damage such as cracks, deformation, or structural failure.

c) Types of External Damage should shall

1) General
Several types of damage to the exterior of vessels have been identified. Examples of specific type of damage are described below. The acceptance/rejection criteria for each type of damage are described in Table S10.7-a or Table S10.7-b of this supplement.

2) Abrasion Damage
Abrasion damage is caused by grinding or rubbing away of the exterior of the vessel. Minor abrasion damage to the protective outer coating or paint will not reduce the structural integrity of the vessel. Abrasion that results in flat spots on the surface of the vessel may indicate loss of composite fiber overwrap thickness.

3) Damage from Cuts
Cuts or gouges are caused by contact with sharp objects in such a way as to cut into the composite overwrap, reducing its thickness at that point.

4) Impact Damage
Impact damage may appear as hairline cracks in the resin, delamination, or cuts of the composite fiber overwrap.

5) Delamination
Delamination is a separation of layers of fibers of the composite overwrap. It may also appear as a discoloration or a blister beneath the surface of the fiber.

6) Heat or Fire Damage
Heat or fire damage may be evident by discoloration, charring or burning of the composite fiber overwrap, labels, or paint. If there is any suspicion of damage, the vessel shall be qualified fit for service using an acoustic emission examination.

7) Structural Damage
Structural damage will be evidenced by bulging, distortion, or depressions on the surface of the vessel.

8) Chemical Attack
Some chemicals are known to cause damage to composite materials. Environmental exposure or direct contact with solvents, acids, bases, alcohols, and general corrosives can cause damage to vessels. Long-term contact with water can also contribute to corrosive damage.
<table>
<thead>
<tr>
<th><strong>Chemicals can dissolve, corrode, remove, or destroy vessel materials. Chemical attack can result in a significant loss of strength in the composite material. Chemical attack can appear as discoloration and in more extreme cases the composite overwrap can feel soft when touched. If there is any suspicion of damage, the vessel shall be re-qualified using acoustic emission examination.</strong></th>
</tr>
</thead>
</table>

### NB15-2201
**Part 2, S10.9**

#### S10.9 INTERNAL EXAMINATION

**a) Requirements for Internal Visual Examination**

Internal visual examination is normally not required. When vessels have been filled only with pure fluids, corrosion of the interior of the liner should not occur. Internal visual examination of the tanks *should* be carried out when:

1. There is evidence that any commodity except a pure fluid has been introduced into the tank. In particular, any evidence that water, moisture, compressor cleaning solvents, or other corrosive agents have been introduced into the vessel *will* require an internal visual examination.
2. There is evidence of structural damage to the vessel, such as denting or bulging.
3. The vessel valve is removed for maintenance or other reason. Internal examination in this case is limited to examination of the threads and sealing surface. When an internal visual examination is conducted, the following procedures *should* be followed.

**b) Identification of Internal Damage**

1. **Vessels with Metallic Liners**
   
   For vessels with metallic liners, the objective of the internal visual examination is primarily to detect the presence of any corrosion or corrosion cracks.
   
   The internal surface of the vessel shall be examined with adequate illumination to identify any degradation or defects present. Any foreign matter or corrosion products *should* be removed from the interior of the vessel to facilitate inspection. Any chemical solutions used in the interior of the vessel *should* be selected to ensure they do not adversely affect the liner or composite overwrap materials. After cleaning the vessel *should* be thoroughly dried before it is examined.
   
   All interior surfaces of the vessel *should* be examined for any color differences, stains, wetness, roughness, or cracks. The location of any degradation *should* be noted.
   
   Any vessel showing significant internal corrosion, dents or cracks *shall* be removed from service.

2. **Vessels with Non-metallic Liners or No Liners**
   
   Vessels with non-metallic liners may show corrosion on the plastic liner or metal boss ends.
   
   Vessels with non-metallic liners or no liners may also show internal degradation in the form of cracks, pitting, exposed laminate, or porosity.
   
   The internal surface of vessels *should* be examined with adequate illumination to identify any degradation or defects present. Any foreign matter or corrosion products *should* be removed from the interior of the vessel to facilitate examination. Chemical solutions used in the interior of the vessel *should* be selected to ensure they do not adversely affect the liner or composite overwrap materials. After cleaning the vessel *should* be thoroughly dried before it is examined.
   
   The Inspector *should* look for cracks, porosity, indentations, exposed fibers, blisters, and any other indication of degradation of the liner and/or laminate. Deterioration of the liner may include softening of the matrix or exposed fibers.
FIGURE S10.10.4-a
ROLLING BALL IMPACT CALIBRATION SETUP

* Editorial Note: Figure changed to grayscale; Figure should be moved into body of S10.10.4 Section

---

**S10.10.2 AE TECHNICIAN REQUIREMENTS**

The acoustic emission technician conducting the examination required per S10.10.1 and in accordance with S10.10 shall be certified per the guidelines of ASNT SNT-TC-1A or CP-189 AE Level II or III. A technician performing this test shall have training in and experience with measuring $C_e$ and $C_f$ in composites and identifying wave modes.

---

**S10.10.32 TEST PROCEDURE**

* Editorial Note: All following paragraphs in Supplement 10 must be renumbered because of this change

AE transducers shall be acoustically coupled to the vessel under test and connected to waveform recording equipment. Waveforms shall be recorded and stored on digital media as the vessel is pressurized. All analysis shall be done on the waveforms. The waveforms of interest are the E (Extensional Mode) and F (Flexural Mode) plate waves.

Prior to pressurization, the velocities of the earliest arriving frequency in the E wave and the latest arriving frequency in the F wave shall be measured in the circumferential direction in order to characterize the material and set the sample time (the length of the wave window).

The E and F waves **must** be digitized and stored for analysis. The test pressure shall be recorded simultaneously with the AE events. Permanent storage of the waveforms is required for the life of the vessel.
S10.10.43  EQUIPMENT

a) Testing System
   A testing system shall consist of:
   1) sensors;
   2) preamplifiers;
   3) high pass and low pass filters;
   4) amplifier;
   5) A/D (analog-to-digital) converters;
   6) a computer program for the collection of data;
   7) computer and monitor for the display of data; and
   8) a computer program for analysis of data.

Examination of the waveforms event by event must always be possible and the waveforms for each event must correspond precisely with the pressure and time data during the test. The computer program shall be capable of detecting the first arrival channel. This is critical to the acceptance criteria below.

Sensors and recording equipment shall be checked for a current calibration sticker or a current certificate of calibration.

b) Sensor Calibration

Sensors shall have a flat frequency response from 50 kHz to 400 kHz. Deviation from flat response (signal coloration) shall be corrected by using a sensitivity curve obtained with a Michelson interferometer calibration system similar to the apparatus used by NIST (National Institute for Standards and Technology). Sensors shall have a diameter no greater than 0.5 in. (13 mm) for the active part of the sensor face. The aperture effect must be taken into account. Sensor sensitivity shall be at least 0.1 V/nm.

c) Scaling Fiber Break Energy

The wave energy shall be computed by the formula:

\[
U = \int V^2 dt / Z
\]

FIGURE S10.10.43-b
FRONT END WAVEFORM
which is the formula for computing energy in the AE signal, where V is the voltage in volts (V) and Z is the input impedance in ohms (Ω). A rolling ball impactor shall be used to create an acoustical impulse in an aluminum plate. The measured energy in the wave shall be used to scale the fiber break energy. This scaling is illustrated later on.

The impact setup, an example of which is shown in Figure S10.10.a, shall be arranged as follows. The steel ball shall be ½ inch (13 mm) in diameter. The steel ball is a type typically used in machine shops for measuring taper and is commercially available. The ball shall be made of chrome steel alloy hardened to R/C 63, ground and lapped to a surface finish of 1.5 micro-inch (0.0000381 mm), within 0.0001 inch (0.0025 mm) of actual size and sphericity within 0.000025 inch (0.00064 mm). The plate shall be made of 7075 T6 aluminum, be at least 4 ft x 4 ft (1200 mm X 1200 mm) in size, the larger the better to avoid reflections, be 1/8 inch (3.2 mm) in thickness and be simply supported by steel blocks. The inclined plane shall be aluminum with a machined square groove 3/8 inch (9.5 mm) wide which supports the ball and guides it to the impact point. The top surface of the inclined plane shall be positioned next to the edge of the plate and stationed below the lower edge of the plate such that the ball impacts with equal parts of the ball projecting above and below the plane of the plate. A mechanical release mechanism shall be used to release the ball down the plane.

The ball roll length shall be 12 inch (305 mm) and the inclined plane angle shall be 6 degrees. The impact produces an impulse that propagates to sensors coupled to the surface of the plate 12 inches (305 mm) away from the edge. The sensors shall be coupled to the plate with vacuum grease. The energy of the leading edge of the impulse, known as the wave front shall be measured. The vertical position of the ball impact point shall be adjusted gradually in order to “peak up” the acoustical signal, much as is done in ultrasonic testing where the angle is varied slightly to peak up the response. The center frequency of the first cycle of the E wave shall be confirmed as 125 kHz ± 10 kHz. See Figure S10.10.44-b. The energy value in joules of the first half cycle of the E wave shall be used to scale the fiber break energy in criterion 2, as illustrated there. This shall be an “end to end” calibration meaning that the energy shall be measured using the complete AE instrumentation (sensor, cables, preamplifiers, amplifiers, filters and digitizer) that are to be used in the actual testing situation.

Front end of waveform created by rolling ball impact calibration setup described herein. Fast Fourier transform (FFT) shows center frequency of first cycle is approximately 125kHz. The energy linearity of
the complete AE instrumentation (sensor, cables, preamplifiers, amplifiers, filters and digitizer) shall be measured by using different roll lengths of 8, 12 and 16 inches (203, 305, and 406 mm). The start of the E wave shall be from the first cycle of the waveform recognizable as the front end of the E wave to the end of the E wave which shall be taken as 10 microsecond (μs) later. (The time was calculated from the dispersion curves for the specified aluminum plate.) A linear regression shall be applied to the energy data and a goodness of fit $R^2 > 0.9$ shall be obtained.

d) Preamplifiers and Amplifiers - See ASME Section V, Article 11.

e) Filters

A high pass filter of 20 kHz shall be used. A low pass filter shall be applied to prevent digital aliasing that occurs if frequencies higher than the Nyquist frequency (half the sampling rate) are in the signal.

f) A/D

The sampling speed and memory depth (wave window length) are dictated by the test requirements and calculated as follows: Vessel length = L inches (meters). Use $C_E = 0.2$ in./μs (5080 m/s) and $C_F = 0.05$ in./μs (1270 m/s), the speeds of the first arriving frequency in the E wave and last arriving frequency in the F wave, respectively, as a guide. The actual dispersion curves for the material shall be used if available.

$L / C_E = T_1 \mu s$. This is when the first part of the direct E wave will arrive.
$L / C_F = T_2 \mu s$. This is when the last part of the direct F wave will arrive.

$(T_2 - T_1) \times 1.5$ is the minimum waveform window time and allows for pretrigger time.

The recording shall be quiescent before front end of the E wave arrives. This is called a "clean front end". Clean is defined in S10.10.6 b) 2) below.

The sampling rate, or sampling speed, shall be such that aliasing does not occur.

The recording system (consisting of all amplifiers, filters and digitizers beyond the sensor) shall be calibrated by using a 20 cycle long tone burst with 0.1 V amplitude at 100, 200, 300, and 400 kHz.

The system shall display an energy of $U = \frac{V^2NT}{2Z}$ joules at each frequency, where

$V=0.1$ volts, $N=20$, $Z$ is the preamplifier input impedance in ohms (Ω) and $T$ is the period of the cycle in seconds (s).

---

* Editorial Note: Move Figure S10.10.5 Sensor Spacing and Pattern (previously Figure S10.10.4) after the sentence ending “… recording systems are readily available.”

Editorial
Part 2, Figure S10.10.4

4) Apply exponential fits by channel for pressure hold time and display both data and fit. The values are determined by the fit $t_{0-t_0} y = a e^{Bt} + C y = A e^{Bt} + C$.

The B value is the shape factor of the cumulative curves. C is an intercept and A is a scale factor. The time $t$ shall be equal intervals during the hold with events binned by time interval. Record exponents and goodness of fit ($R^2$). Plot energy decay curves. One third or one fourth of hold time shall be used.
for event energy binning (cumulative energy). The formula is $y = ae^{bt}$.

The sequence of energy values must monotonically decrease.

This is similar to using other energy criteria, such as Historic Index. A sequence that is not properly decreasing will be indicated by a low $R^2$ value.

---

**b) Definitions**

Energies (U) in the ranges are defined as:

- 50 – 400 kHz: $U_0$
- 100 – 200 kHz: $U_1$
- 250 – 400 kHz: $U_2$

The criteria for determining if high frequency spectrum events have occurred is given by the following formulas:

\[
\frac{U_0}{U_{FBB}} \geq 10\%
\]

\[
\frac{U_2}{U_1 + U_2} \geq 15\%
\]

\[
\frac{U_2}{U_0} \geq 10\%
\]

$U_{FBB}$ is the energy of a fiber bundle break calculated using the average breaking strength from the manufacturer’s data or independent test data. The manufacturer’s data shall be used if available. The formula that shall be used for calculating average fiber break energy in joules (J) is

\[
U_{FB} = \frac{E \times A \times l \times \varepsilon^2}{2}
\]

where $E$ is the Young’s modulus of the fiber in pascals (Pa), $\varepsilon$ is the strain to failure of the fiber, $A$ is area of the fiber in square meters ($m^2$), and $l$ is the ineffective fiber length in meters (m) for the fiber and matrix combination. If the ineffective length is not readily available, four times the fiber diameter shall be used. Set $U_{FBB} = 100 \times U_{FB}$, where $U_{FB}$ has been calculated and scaled by the rolling ball impact energy as in the examples below. If these criteria are met, fiber bundle break damage has occurred during the test and the vessel shall be removed from service.

---

**PART 2, SUPPLEMENT 11**

**INSPECTOR REVIEW GUIDELINES FOR FINITE ELEMENT ANALYSIS (FEA)**

**S11.1 SCOPE**

This Supplement provides guidelines to be followed when a finite element analysis (FEA) is submitted as part of a quantitative engineering assessment for in-service equipment, or a repair or alteration for a pressure retaining item for review by the Inspector, and the jurisdiction if required. Refer to NBIC Part 2, 4.6.

**S11.2 TERMINOLOGY**

a) Finite element analysis (FEA) as applied in engineering is a computational tool for performing engineering analysis. It includes the use of mesh generation techniques for dividing a complex problem into small elements for simulation, as well as the use of software program coded with finite element method algorithms.

b) Quantitative engineering assessment refers to methodologies whereby flaws contained within a
pressure retaining item are assessed in order to determine the adequacy of the structure for continued service without failure. The result of the assessment provides guidance on structural integrity, inspection methods and intervals, and shapes decisions to operate, repair, monitor or replace the structure/pressure retaining item.

S11.3 CHECKLIST

The following is a checklist of areas to consider and discuss with the FEA practitioner engineer performing the analysis and may be used to familiarize the Inspector with the FEA approach and method as part of validating the FEA report.

S11.3.1 PRESSURE RETAINING ITEM INFORMATION

a) Vessel type, size, region/section and component(s) under FEA consideration
b) Materials of construction and materials properties (including those as a function of temperature)
c) Original code of construction
d) Repair and alteration history
e) Known extent of degradation and associated damage mechanisms (if available/any)
f) Operating conditions (temperature and heat flux, pressure including vacuum, cyclical service, etc.)
g) Other loads (seismic, earthquake, etc.)

S11.3.2 SCOPE OF THE FEA

a) The objective of the FEA analysis (to be used to support quantitative engineering analysis, repair, alteration, etc.)
b) The justification for use of FEA rather than rules in the code of construction. Refer to NBIC PART 2 4.6.1.2

S11.3.3 FEA SOFTWARE AND MODELLING

a) The software version to be used for the analysis
b) The type of analysis (e.g., stress, static, dynamic, elastic, plastic, small or large deformations, heat transfer, etc.)
c) The modelling approach that will be used (e.g., solids, shells, simplification of geometry, mesh generation, solver technique, division into elements and element size, boundary restraints, etc.)
d) The geometries to be modeled (e.g., non-corroded, corroded and future corrosion allowance, bulge, dent, groove, crack, etc.)

S11.4 REPORT REQUIREMENTS

The following checklist of areas to consider and discuss with the FEA practitioner engineer completing the certified report may be used to define what should be included in the report. An alternate useful reference is the following presentation: Proceedings of the ASME 2014 Pressure Vessels & Piping Conference, PVP2014-28958, Writing and Reviewing FEA Reports Supporting ASME Section VIII, Division 1 and 2 Designs – Practical Considerations and Recommended Good Practice.

S11.4.1 SECTIONS TO BE INCLUDED IN THE REPORT

a) An introduction and/or executive summary
b) A description of the model
c) A presentation of the results
d) An analysis of the results and conclusions

S11.4.2 LISTING OF INFORMATION THAT MAY BE INCLUDED IN THE FEA REPORT
S11.4.2.1 ANALYSIS METHOD

a) State the scope of the FEA and the justification for using it; give the program and version
b) Note whether or not the problem is linear.
c) Give an overview of how the analysis is conducted, for example:
   1) Calculations are done to simplify radiation boundary conditions so that the problem is linear.
   2) Thermal loads are applied to the FEA model and temperatures generated
   3) Temperatures at select locations are compared to the radiation simplification calculations
   4) Mechanical loads are added
   5) Stresses are generated
   6) Stress classification results are generated
   7) Results are verified by comparison to something (e.g., BPVVC Section VIII Division 2 Part 5 Design by Analysis)
   8) Results are compared to the construction code
d) Note if any of the geometry is not included in the stress model

S11.4.2.2 STRUCTURAL DESCRIPTION/MESH/STRESS/CLASSIFICATION LINE LOCATIONS

a) Reference the geometry source or show a drawing or sketch with dimensions that relate the model geometry to the actual structure in the FEA analysis
b) Name all the parts, usually best done with a sketch
c) Note any symmetry
d) Give the type of element used for each component
e) Describe the mesh type (e.g., h, p, 2D, 3D), shape, and order (2nd order or above) and show plots of the mesh
f) Show the top and bottom of shells or beam orientations and indicate if they are thick or thin elements
g) Show the cross sections with stress recovery points for beams
h) Describe any boundary conditions such as supports, restraints, loads, and forces as well as the method of restraining the model to prevent rigid body motion.
i) Describe parts that are connected by node sharing or contact and tell whether the connections are thermal, mechanical, or both
j) Give the stress classification line locations (usually best done with a sketch)

S11.4.2.3 MATERIAL PROPERTIES

a) List properties used for every component, references to other sources are not sufficient. They must be explicitly listed. Show the values of any properties modified for the sake of the model. For example, the model density is often modeled.
b) Show calculations for properties that are modified for the sake of the model.
c) Discuss any given artificial properties for the analysis (e.g., the modulus was set to 1000 psi so that the component would not influence the mechanical model. Or, above 1200°F the properties are assumed to be constant).
d) Reference the source for all material properties.

S11.4.2.4 RESTRAINTS AND LOADS

a) Show all restraints and loads
b) Discuss the justification for all restraints and loads, and give calculations if they were done to determine the restraints or loads (e.g., end pressure).
c) Discuss any contact regions.
d) Give initial or default temperatures.

S11.4.2.5 VALIDATION

a) Describe how the model was validated.
b) Describe the accuracy of the model digitization either by use of convergence or to the accuracy of
previous successful models.

S11.4.2.6 RESULTS

For each model the following should be presented:

a) Give temperature plots.
b) Give deformed geometry plots.
c) Give stress classification line results and comparison to Code allowable.
d) Relate the results of the model to the defined allowable stresses of the original Code of construction.
e) Refer to ASME Section VIII, Division 2, Part 2, 2.3.3.1 (c) (2) Documentation requirements of design-by-analysis calculations in Part 5.

S11.4.2.7 REFERENCE DOCUMENTS USED

Typical reference documents could include:

a) ASME BPVC II-D
b) ASME BPVC Section VIII Division 1
c) ASME BPVC Section VIII Division 2
d) ASME/API-579
e) Drawings
f) User Design Specification (UDS)
a) ASCE

PART 2, SUPPLEMENT 12
INSPECTION OF LIQUID CARBON DIOXIDE STORAGE VESSELS

S12.1 SCOPE

This supplement provides guidelines for owners or users for the inspection of Liquid Carbon Dioxide Storage Vessels (LCDSVs), fill boxes, fill lines and pressure relief discharge/vent circuits used for carbonated beverage systems, swimming pool pH control systems and other fill in place systems storing liquid CO2.

S12.2 GENERAL REQUIREMENTS (ENCLOSED AND UNENCLOSED AREAS)

The inspection should verify that LCDSVs are:

a) not located within 10 feet (3050 mm) of elevators, unprotected platform ledges or other areas where falling would result in dropping distances exceeding half the container height;
b) installed with clearance to satisfactorily allow for filling, operation, maintenance, inspection and replacement of the vessel parts or appurtenances;
c) not located on roofs;
d) adequately supported to prevent the vessel from tipping or falling, and to meet seismic requirements as required by design;
e) not located within 36 in. (915 mm) of electrical panels; and
f) located outdoors in areas in the vicinity of vehicular traffic are protected with barriers designed to prevent accidental impact by vehicles.

S12.3 ENCLOSED AREA LCDSV INSTALLATIONS

The inspection should verify that:

a) LCDSV installations that are not periodically removed with remote fill connections:
   1) Are equipped with a gas detection system installed in accordance with paragraph S12.5 of this supplement;
   2) Have signage posted in accordance with paragraph S12.6 of this supplement; and
3) Are equipped with fill boxes, fill lines and safety relief/vent valve circuits installed in accordance with paragraph S12.4 of this supplement.

b) Portable LCDSV installations with no permanent remote fill connection:
   Warning: LCDSVs shall not be filled indoors or in enclosed areas under any circumstances. Tanks must always be moved to the outside to an unenclosed, free airflow area for filling.
   1) Are equipped with a gas detection system installed in accordance with paragraph S12.5 of this supplement;
   2) Have signage posted in accordance with paragraph S12.6 of this supplement,
   3) Have a safety relief/vent valve circuit connected at all times except when the tank is being removed for filling. Connections may be fitted with quick disconnect fittings meeting the requirements of paragraph S12.4 of this supplement.
   4) Are provided with a pathway that provides a smooth rolling surface to the outdoor, unenclosed fill area. There shall not be any stairs or other than minimal inclines in the pathway.

S12.4 FILL BOX LOCATION / SAFETY RELIEF / VENT VALVE CIRCUIT TERMINATION

The inspection should verify that fill boxes and/or vent valve terminations are installed above grade, outdoors in an unenclosed, free airflow area, and that the fill connection is located so not to impede means of egress or the operation of sidewalk cellar entrance doors, including during the delivery process and that they are:

a) At least three (3) feet (915 mm) from any door or operable windows;*
b) At least three (3) feet (915 mm) above grade;*
c) Not located within ten (10) feet (3050 mm) from side to side at the same level or below, from any air intakes;*
d) Not located within ten (10) feet (3050 mm) from stair wells that go below grade.

*Note: Many systems installed prior to 1/1/2014 do not meet the above requirements and the local Jurisdiction should be consulted for guidance.

S12.5 GAS DETECTION SYSTEMS

A continuous gas detection system shall be provided in the room or area where container systems are filled and used, in areas where the heavier than air gas can congregate and in below grade outdoor locations. Carbon dioxide (CO2) sensors shall be provided within 12 inches (305mm) of the floor in the area where the gas is most likely to accumulate or leaks are most likely to occur. The system shall be designed to detect and notify at a low level alarm and high level alarm.

a) The threshold for activation of the low level alarm shall not exceed a carbon dioxide concentration of 5,000 ppm (9,000 mg/m3) Time Weighted Average (TWA) over 8 hours. When carbon dioxide is detected at the low level alarm, the system shall activate a signal at a normally attended location within the building.

b) The threshold for activation of the high level alarm shall not exceed a carbon dioxide concentration 30,000 ppm (54,000 mg/m3). When carbon dioxide is detected at the high level alarm, the system shall activate an audible and visual alarm at a location approved by the jurisdiction having authority.

The inspection should verify that the gas detection system and audible alarm is operational and tested in accordance with manufacturer’s guidelines.

The inspection should verify that audible alarms are placed at the entrance(s) to the room or area where the carbon dioxide storage vessel and/or fill box is located to notify anyone who might try to enter the area of a potential problem.

S12.6 SIGNAGE

The inspection should verify that hazard identification signs are posted at the entrance to the building, room, enclosure, or enclosed area where the container is located. The warning sign shall be at least 8 in (200mm) wide and 6 in. (150mm) high and indicate:

Figure S12.6
S12.7 VALVES, PIPING, TUBING AND FITTINGS

a) Materials – The inspection should verify that the materials selected for valves, piping, tubing, hoses and fittings used in the LCDSV system meet following requirements:

1) Components shall be rated for the operational temperatures and pressures encountered in the applicable circuit of the system.
2) All valves and fittings used on the LCDSV shall be rated for the maximum allowable working pressure (MAWP) stamped on the tank.
3) All piping, hoses and tubing used in the LCDSV system shall be rated for the working pressure of the applicable circuit in the system and have a burst pressure rating of at least four times the MAWP of the piping, hose or tubing.

b) Relief Valves – The inspection should verify that each LCDSV shall have at least one ASME/NB stamped & certified relief valve with a pressure setting at or below the MAWP of the tank. The relief valve shall be suitable for the temperatures and flows experienced during relief valve operation. The minimum relief valve capacity shall be designated by the manufacturer. Additional relief valves that do not require ASME stamps may be added per Compressed Gas Association pamphlet, CGA S-1.3 Pressure Relief Device Standards Part 3, Stationary Storage Containers for Compressed Gases, recommendations. Discharge lines from the relief valves shall be sized in accordance with NBIC Part 2, Tables S12.7-a and S12.7-b.

Note: Due to the design of the LCDSV the discharge line may be smaller in diameter than the relief valve outlet size.

Caution: Company’s and or individuals filling or refilling LCDSV’s shall be responsible for utilizing fill equipment that is acceptable to the manufacturer to prevent over pressurization of the vessel.

c) Isolation Valves – The inspection should verify that each LCDSV shall have an isolation valve installed on the fill line and tank discharge, or gas supply line in accordance with the following requirements:

1) Isolation valves shall be located on the tank or at an accessible point as near to the storage tank as possible.
2) All valves shall be designed or marked to indicate clearly whether they are open or closed.
3) All valves shall be capable of being locked or tagged in the closed position for servicing.
4) Gas supply and liquid CO2 fill valves shall be clearly marked for easy identification.

d) Safety Relief/Vent Lines – The inspection, where possible, should verify the integrity of the pressure relief/vent line from the pressure relief valve to outside vent line discharge fitting. All connections shall be securely fastened to the LCDSV. The minimum size and length of the lines shall be in accordance with NBIC Part 2, Tables S12.7-a and S12.7-b. Fittings or other connections may result in a localized reduction in diameter have been factored into the lengths given by the NBIC Part 2, Tables S12.7-a and S12.7-b.

**TABLE S12.7-a**

MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (METALLIC)

<table>
<thead>
<tr>
<th>Tank Size (Pounds)</th>
<th>Fire Flow Rate Requirements (Pounds per Minute)</th>
<th>Maximum length of 3/8 inch ID Metallic Tube Allowed</th>
<th>Maximum length of 1/2 inch ID Metallic Tube Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 500</td>
<td>2.60 maximum</td>
<td>80 feet</td>
<td>100 feet</td>
</tr>
</tbody>
</table>
### TABLE S12.7-b
**MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (PLASTIC/POLYMER)**

<table>
<thead>
<tr>
<th>Tank Size (Pounds)</th>
<th>Fire Flow Rate Requirements (Pounds per Minute)</th>
<th>Maximum length of 3/8 inch ID plastic/polymer Tube Allowed</th>
<th>Maximum length of 1/2 inch ID plastic/polymer Tube Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 500</td>
<td>2.60 maximum</td>
<td>100 feet</td>
<td>100 feet</td>
</tr>
<tr>
<td>500 - 750</td>
<td>3.85 maximum</td>
<td>100 feet</td>
<td>100 feet</td>
</tr>
<tr>
<td>Over 750 – 1,000</td>
<td>5.51 maximum</td>
<td>N/A see 1/2 inch</td>
<td>100 feet</td>
</tr>
</tbody>
</table>

### TABLE S12.7M-a
**METRIC MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (METALLIC)**

<table>
<thead>
<tr>
<th>Tank Size (kg)</th>
<th>Fire Flow Rate Requirements (kg per Minute)</th>
<th>Maximum length of 10 mm ID Metallic Tube Allowed</th>
<th>Maximum length of 13 mm ID Metallic Tube Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 227</td>
<td>1.18 maximum</td>
<td>24 feet</td>
<td>30.5 m</td>
</tr>
<tr>
<td>227 - 340</td>
<td>1.75 maximum</td>
<td>17 feet</td>
<td>30.5 m</td>
</tr>
<tr>
<td>Over 340 - 454</td>
<td>2.5 maximum</td>
<td>5.5 feet</td>
<td>30.5 m</td>
</tr>
</tbody>
</table>

### TABLE S12.7M-b
**METRIC MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (PLASTIC/POLYMER)**

<table>
<thead>
<tr>
<th>Tank Size (kg)</th>
<th>Fire Flow Rate Requirements (kg per Minute)</th>
<th>Maximum length of 10 mm ID plastic/polymer Tube Allowed</th>
<th>Maximum length of 13 mmID plastic/polymer Tube Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 227</td>
<td>1.80 maximum</td>
<td>30.5 m</td>
<td>30.5 m</td>
</tr>
<tr>
<td>Diameter</td>
<td>Maximum Flowrate</td>
<td>Relief Valve Outlet Size</td>
<td>Allowable Discharge Pressure</td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>227 - 340</td>
<td>1.75 maximum</td>
<td>30.5 m</td>
<td>30.5 m</td>
</tr>
<tr>
<td>Over 340 - 454</td>
<td>2.50 maximum</td>
<td>N/A see 13 mm</td>
<td>30.5 m</td>
</tr>
</tbody>
</table>

**Note:**
Due to the design of the LCDSV, the discharge line may be smaller in diameter than the relief valve outlet size but shall not be smaller than that shown in tables NBIC Part 2, S12.7-a and -b.

**NB13-1303**  
**Part 2, Supplement 13**  
**Inspection of Biomass Fired Boiler Installations**

**S13.1 – Scope**

a) This supplement provides guidelines for continued inspection of biomass fired boilers and the additional equipment utilized in these installations. In this context Biomass is intended to mean various types of organic fiber wastes, or organic fiber byproducts.

b) Many of the requirements of the earlier sections of Part 2 are common to all boiler installations irrespective of the fuel being fired; therefore this supplement will address the differences that occur when solid fuels, such as biomass, are being used. Thus the primary thrust of this section will be directed toward the inspection of the fuel handling and distribution systems, and the impact these systems may have on the pressure vessel itself.

**S13.2 – Assessment of Installation**

a) A general assessment of the complete installation shall be undertaken, including observable results of operating and maintenance practices. The assessment includes the general cleanliness of the boiler room, including rafters and beams.

b) The combustion air inlet shall be free of any debris or dust particle build up, and where moveable louvered intakes exist, the actuating mechanisms shall be clean and operate freely. Corrective action is required when non-compliance is noted.

c) The flue gas venting system shall be checked for tightness, with no observable signs of leakage. Corrective action is required if leakage is noted.

d) The intakes of the various fans or blowers shall be free of fuel particle build up or signs of other debris. Corrective action in terms of cleaning is required when discrepancies are noted.

e) The fuel metering equipment and the fuel transportation system shall be free from signs of particulate or dust leakage. Corrective action in terms of cleaning and repair work is required as necessary.

f) Electrical equipment and controls shall be properly protected from the ingress of dust by ensuring that all cover plates are properly installed and all panel doors are intact, operable and closed.

g) Verify that all guards for rotating equipment (shafts, bearings, drives) are correctly installed and fan inlet screens are in place.

h) On the boiler, generally check for signs of potential problems, including, but not limited to:

1. Water leaks
2. Ash Leaks
3. Condition of insulation and lagging.
4) Casing leaks or cracks
5) All safety valves do not have a bypass
6) Ensure the inspection plugs are capped
7) The drain lines are piped to a safe point of discharge
8) Missing or misaligned pieces or parts (e.g., twisted, misaligned or bound up buck stays, missing linkage bolting).
9) Condition of support systems
10) Provision of “Danger” or “Caution” signs
11) Excess vibration
12) Excess noise.

i) Verify that the Owner/User has established function test, inspection, requirements, maintenance and testing of all controls and safety devices in accordance with the manufacturer’s recommendations. Verify that these activities are conducted at assigned intervals in accordance with written procedures, nonconformances which impact continued safe operation of the boiler are corrected and the results are properly documented. These activities shall be at a frequency recommended by the manufacturer, or frequency required by the jurisdiction. Where no frequencies are recommended, or prescribed, the activity should be conducted at least annually.

S13.3 – Boiler Room Cleanliness

a) While boiler room cleanliness is of primary importance in all boiler rooms it is of particular importance in biomass fired boiler rooms. Biomass can contain fine particulate, which if allowed to leak from the transportation system into the surrounding boiler room, will eventually be drawn into fans, resulting in the possibility of combustion air systems becoming plugged.

b) Boiler rooms containing quantities of fine dusts are susceptible to fire or explosion, again emphasizing the need for high standards of cleanliness.

S13.4 – Emission Control Requirements

a) Emission control is dependent upon the fuel being fired and the emission requirements prevailing at the location of the boiler installation. As such they are a part of the initial design and installation process, and apart from ensuring that they are kept in top working condition, so that emission requirements are not violated; there is little that can be done from the inspector’s point of view.

b) When Continuous Emissions Monitors (CEM’s) are in use, they should be demonstrated to be functioning properly and have a current calibration sticker.

c) Delta-P pressure gauges which measure the pressure drop across the various elements of the emission control system should all be functioning correctly.

d) There should be no sign of erosion caused by entrained particulate matter, in any part of the breaching, ductwork, stack or the individual emission control elements.

a) On systems in which the emissions control system incorporates a baghouse, appropriate fire detection and suppression systems shall be incorporated and functioning properly.
1.1 SCOPE

a) This part provides general requirements and guidelines that apply when performing repairs and alterations to pressure-retaining items.

b) This part describes the administrative requirements for the accreditation of repair organizations.

c) The National Board administers three specific accreditation programs:

   “R” — Repairs and Alterations to Pressure-Retaining Items
   “VR” — Repairs to Pressure Relief Valves
   “NR” — Repair and Replacement Activities for Nuclear Items

d) Additional administrative requirements can be found in:

   1) NB-415, Accreditation of “R” Repair Organizations
   2) NB-417, Accreditation of “NR” Repair Organizations
   3) NB-514, Accreditation of “VR” Repair Organizations

2 Caution: Some jurisdictions may independently administer a program of authorization for organizations to perform repairs and alterations within that Jurisdiction.

1.2 CONSTRUCTION STANDARDS FOR PRESSURE RETAINING ITEMS

b) If the pressure-retaining item was not constructed to a construction code or standard, or when the standard governing the original construction is not the ASME Code or ASME RTP-1, repairs or alterations shall conform, insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practicable, it is permissible to use other codes, standards, or specifications, including the ASME Code or ASME RTP-1, provided the “R” or “NR” Certificate Holder has the concurrence of the Inspector and the Jurisdiction where the pressure-retaining item is installed.

c) For historical boilers, the 1971 Edition of ASME Code, Section I of ASME Boiler Code, Part PR and PFT provides rules for design the many pressure-related components and features of construction encountered in firetube boilers.

d) For pressure relieving devices the applicable standard for new valves to be used for reference during repairs is the ASME Code. ASME Code Cases shall be used for repairs when they were used in the original construction of the valve. ASME Code Cases may be used when they have been accepted for use by the NBIC Committee and the Jurisdiction where the pressure-retaining item is installed.

For pressure relieving devices the code case number shall be noted on the repair document and, when required by the code case, stamped on the repair nameplate.

The Jurisdiction where the pressure-retaining item is installed shall be consulted for any unique requirements it may have established.

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4
### ACCREDITATION PROCESS

**a)** The National Board administers accreditation programs for authorization of organizations performing repairs and alterations to pressure-retaining items in accordance with NB-415, Accreditation of "R" Repair Organizations and/or pressure relief valves.

**b)** Any organization may apply to the National Board to obtain a Certificate of Authorization for the requested scope of activities. A review shall be conducted to evaluate the organization's quality system. The individual assigned to conduct the evaluation shall meet the qualification requirements prescribed by the National Board. Upon completion of the evaluation, any deficiencies within the organization's quality system will be documented and a recommendation will be made to the National Board regarding issuance of a Certificate of Authorization.

**c)** As part of the accreditation process, an applicant's quality system is subject to a review. National Board procedures provide for the confidential review resulting in recommendations to issue or not issue a Certificate of Authorization.

**d)** The accreditation programs provide requirements for organizations performing repairs and alterations to pressure-retaining items. Depending upon the expected scope of activities at the time of review, organizations may be authorized to perform design only, metallic or non-metallic repairs, and/or alterations either in the shop only, field only, or shop and field. Repairs and/or alterations to metallic and non-metallic pressure-retaining items are made by welding, bonding and/or mechanical assembly.

**e)** Organizations desiring to renew or obtain a National Board Certificate of Authorization shall apply to the National Board using forms obtained from the National Board. Application for renewal shall be made prior to the expiration date of the Certificate of Authorization.

**f)** When an organization has plants or shops in more than one location, the organization shall submit separate applications for each plant or shop. The organization may perform repairs or alterations in its plants, shops, or in the field, provided such operations are described in the organization's Quality System.

**g)** The Jurisdiction, as defined in Part 3, Section 9, may audit the Quality System and activities of an organization upon a valid request from an owner, user, inspection agency, or the National Board.

**h)** The NBIC Committee may at any time change the rules for the issuance of Certificates of Authorization and use of the "R" Symbol Stamp. These rules shall become binding on all
certified holders.

\* Jurisdiction: The National Board member jurisdiction where the organization is located. Alternatively, where the Jurisdiction elects not to perform the review or where there is no Jurisdiction or where the Jurisdiction is the organization’s Authorized Inspection Agency, The National Board of Boiler and Pressure Vessel Inspectors will represent the Jurisdiction. At the Jurisdiction’s discretion, the Jurisdiction may choose to be a member of the review team if the Jurisdiction chooses not to be the team leader.

### NB14-0203 Part 3, 1.5.2

<table>
<thead>
<tr>
<th>1.5.2 NATIONAL BOARD “R” SYMBOL STAMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) All “R” Symbol Stamps shall be obtained from The National Board of Boiler and Pressure Vessel Inspectors. Authorization to use the “R” Symbol Stamp may be granted by the National Board at its absolute discretion to the certificate holder.</td>
</tr>
<tr>
<td>b) The “R” Symbol Stamp is furnished on loan by the National Board for a nominal fee. Each organization shall agree if authorization to use the “R” Symbol Stamp is granted, that the “R” Symbol Stamp is at all times the property of the National Board and will be promptly returned upon demand. If the organization discontinues the use of the “R” Symbol Stamp, inspection agreement with an Authorized Inspection Agency, or if the Certificate of Authorization has expired and no new certificate has been issued, the “R” Symbol Stamp shall be returned to the National Board.</td>
</tr>
<tr>
<td>c) The organization’s Quality System shall provide for adequate control of the “R” Symbol Stamp. Provisions may be made for the issuance of the “R” Symbol Stamp for use at various field locations.</td>
</tr>
<tr>
<td>d) The holder of a Certificate of Authorization may obtain more than one “R” Symbol Stamp provided the organization’s Quality System describes how the use of such stamps is controlled from the location shown on the certificate.</td>
</tr>
<tr>
<td>e) An organization shall not permit others to use the “R” Symbol Stamp loaned to it by the National Board.</td>
</tr>
<tr>
<td>f) Additional requirements shall be met in accordance with NB-415, Accreditation of “R” Repair Organizations.</td>
</tr>
</tbody>
</table>

### NB14-0203 Part 3, 1.6.1 n)

<table>
<thead>
<tr>
<th>Acceptance and Inspection of Repair or Alteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>The manual shall specifically indicate that before the work is started, acceptance of the repair/alteration shall be obtained from an Inspector who will make the required inspections and confirm NBIC compliance by signing and dating the applicable NBIC Report Form 4 upon completion of the work.</td>
</tr>
<tr>
<td>The manual shall specifically address allowance for acceptance of the inspector for application of the “R” symbol stamp to a pressure retaining item.</td>
</tr>
<tr>
<td>The manual shall provide for adequate control of the “R” Symbol Stamp.</td>
</tr>
</tbody>
</table>

### NB15-2305 Part 3, 1.6.1 p)

<table>
<thead>
<tr>
<th>Report of Repair or Alteration Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>The manual shall indicate the title of the individuals responsible for preparing, signing, and presenting the NBIC Report Forms to the Inspector. The distribution of the NBIC Report Forms shall be described in the manual.</td>
</tr>
<tr>
<td>NBIC Report Form: National Board Form R-1 for Repair, Form R-2 for Alterations, Form R-3 for Fabricated Parts, or Form R-4 Report Supplementary Sheet.</td>
</tr>
</tbody>
</table>

### NB11-0401 Part 3, 1.7

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

ACCREDITATION OF “VR” REPAIR ORGANIZATIONS
**NB11-0401**

**Part 3, 1.7.1**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.1 **SCOPE**

These administrative rules and procedures are provided by the National Board for those who wish to obtain National Board Certificate of Authorization for use of the “VR” (Repair of Pressure Relief Valves) symbol stamp. It should be noted that the issuance of the “VR” stamp is not restricted to companies whose primary business is the repair of pressure relief valves, nor to manufacturers or assemblers that hold an ASME “V,” “HV,” “UV,” or “NV” Code Symbol Stamp. Owners and users of boilers and pressure vessels and other organizations that qualify in accordance with the National Board Rules and Regulations may also obtain the “VR” Certificate and stamp.

**NB11-0401**

**Part 3, 1.7.2**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.2 **JURISDICTIONAL PARTICIPATION**

The National Board member jurisdiction in which the “VR” organization is located is encouraged to participate in the review and demonstration of the applicant’s quality system. The Jurisdiction may require participation in the review of the repair organization and the demonstration and acceptance of the repair organization’s quality system manual.

**NB11-0401**

**Part 3, 1.7.3**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.3 **ISSUANCE AND RENEWAL OF THE “VR” CERTIFICATE OF AUTHORIZATION**

**NB11-0401**

**Part 3, 1.7.3.1**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.3.1 **GENERAL**

Authorization to use the stamp bearing the official National Board “VR” symbol as shown in NBIC Part 3, Section 5, will be granted by the National Board pursuant to the provisions of the following administrative rules and procedures.

**NB11-0401**

**Part 3, 1.7.3.2**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.3.2 **ISSUANCE OF CERTIFICATE**

Repair organizations, manufacturers, assemblers, or users that make repairs to the American Society of Mechanical Engineers (ASME) Code symbol, stamped or marked (as applicable), and The National Board of Boiler and Pressure Vessel Inspectors (National Board) capacity certified pressure relief valves may apply to the National Board for a Certificate of Authorization to use the “VR” symbol.

**NB11-0401**

**Part 3, 1.7.4**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.4 **USE OF THE “VR” AUTHORIZATION**

**NB11-0401**

**Part 3, 1.7.4.1**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

1.7.4.1 **TECHNICAL REQUIREMENTS**

The administrative requirements of NBIC Part 3, 1.7 for use of the “VR” stamp shall be used in conjunction with the technical requirements for valve repair as described in NBIC Part 3, Supplement 7. Those requirements shall be mandatory when a “VR” repair is performed.
**1.7.4.2 STAMP USE**

Each "VR" symbol stamp shall be used only by the repair firm within the scope, limitations, and restrictions under which it was issued.

**1.7.5 QUALITY SYSTEM**

Each applicant for a new or renewed "VR" Certificate of Authorization shall have and maintain a quality system which shall establish that all of these rules and administrative procedures and applicable ASME Code requirements, including material control, fabrication, machining, welding, examination, setting, testing, inspection, sealing, and stamping will be met.

**1.7.5.1 GENERAL**

Each applicant for a new or renewed "VR" Certificate of Authorization shall have and maintain a quality system which shall establish that all of these rules and administrative procedures and applicable ASME Code requirements, including material control, fabrication, machining, welding, examination, setting, testing, inspection, sealing, and stamping will be met.

**1.7.5.2 WRITTEN DESCRIPTION**

A written description, in the English language, of the system the applicant will use shall be available for review and shall contain, as a minimum, the features set forth in NBIC Part 3, 1.7.5.4. This description may be brief or voluminous, depending upon the projected scope of work, and shall be treated confidentially. In general, the quality system shall describe and explain what documents and procedures the repair firm will use to validate a valve repair.

**1.7.5.3 MAINTENANCE OF CONTROLLED COPY**

Each applicant to whom a "VR" Certificate of Authorization is issued shall maintain thereafter a controlled copy of the accepted quality system manual with the National Board. Except for changes that do not affect the quality system, revisions to the quality system manual shall not be implemented until such revisions are accepted by the National Board.

**1.7.5.4 OUTLINE OF REQUIREMENTS FOR A QUALITY SYSTEM**

The following establishes the minimum requirements of the written description of the quality system. It is required that each valve repair organization develop its own quality system that meets the requirements of its organization. For this reason it is not possible to develop one quality system that could apply to more than one organization. The written description shall include, as a minimum, the following features:

**Title Page**

The title page shall include the name and address of the company to which the National Board Certificate of Authorization is to be issued.

**Revision Log**
A revision log is required to ensure revision control of the quality system manual. The log should contain sufficient space for date, description and section of revision, company approval, and National Board acceptance.

Contents Page

The contents page should list and reference, by paragraph and page number, the subjects and exhibits contained therein.

Statement of Authority and Responsibility

A statement of authority and responsibility shall be dated and signed by an officer of the company. It shall include:
A statement that the “VR” stamp shall be applied only to pressure relief valves that meet both of the following conditions:
  - Are stamped with an ASME “V”, “UV”, or “NV” Code symbol or marked with an ASME “HV” symbol and have been capacity certified by the National Board; and
  - Have been disassembled, inspected, and repaired by the Certificate Holder such that the valves’ condition and performance are equivalent to the standards for new valves.
The title of the individual responsible for ensuring that the quality system is followed and who has authority and freedom to affect the responsibility;
A statement that if there is a disagreement in the implementation of the written quality system, the matter is to be referred to a higher authority in the company for resolution; and
The title of the individual authorized to approve revisions to the written quality system and the method by which such revisions are to be submitted to the National Board for acceptance before implementation.

Organization Chart

A chart showing the relationship between management, purchasing, repairing, inspection, and quality control personnel is required and shall reflect the actual organization in place.

Scope of Work

The scope of work section shall indicate the scope and type of valve repairs, including conversions the organization is capable of and intends to perform. The location of repairs (shop, shop and field, or field only), ASME Code Section(s) to which the repairs apply, the test medium (air, gas, liquid, or steam, or combinations thereof), and special processes (machining, welding, postweld heat treatment, or nondestructive examination, or combinations thereof) shall be specifically addressed.
The types and sizes of valves to be repaired, pressure ranges and other limitations, such as engineering and test facilities, should also be addressed.

Drawings and Specification Control

The drawings and specification control system shall provide procedures assuring that the latest applicable drawings, specifications, and instructions required are used for valve repair, including
conversions, inspection, and testing.

Material and Part Control

The material and part control section shall describe purchasing, receiving, storage, and issuing of parts.

State the title of the individual responsible for the purchasing of all material.
State the title of the individual responsible for certification and other records as required.
All incoming materials and parts shall be checked for conformance with the purchase order and, where applicable, the material specifications or drawings. Indicate how material or part is identified and how identity is maintained by the quality system.

Repair and Inspection Program

The repair and inspection program section shall include reference to a document (such as a report, traveler, or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure relief valves. Repair procedures shall require verification that the critical parts meet the valve manufacturer's specification. NBIC Part 3, S7.14 outlines recommended procedures covering some specific items. Provisions shall be made to retain this document for a period of at least five years.

Each valve or group of valves shall be accompanied by the document referred to above for processing through the plant. Each valve shall have a unique identifier (e.g., repair serial number, shop order number, etc.) appearing on the repair documentation and repair nameplate such that traceability is established.
The document referred to above shall describe the original nameplate information, including the ASME Code symbol stamping and the repair nameplate information, if applicable. In addition, it shall include material checks, replacement parts, conversion parts (or both), reference to items such as the welding procedure specifications (WPS), fit-up, NDE technique, heat treatment, and pressure test methods to be used. Application of the “VR” stamp to the repair nameplate shall be recorded in this document. Specific conversions performed with the new Type/Model Number shall be recorded on the document. There shall be a space for “signoffs” at each operation to verify that each step has been properly performed.
The system shall include a method of controlling the repair or replacement of critical valve parts. The method of identifying each spring shall be indicated.
The system shall also describe the controls used to ensure that any personnel engaged in the repair of pressure relief valves are trained and qualified in accordance with NBIC Part 3, Supplement 7.

Welding, NDE, and Heat Treatment (when applicable)

The quality system manual shall indicate the title of the person(s) responsible for and describe the system used in the selection, development, approval, and qualification of welding procedure specifications, and the qualification of welders and welding operators in accordance with the provisions of NBIC Part 3, S7.12 and S7.13.
The quality system manual may include controls for the “VR” Certificate Holder to have the pressure relief valve part repaired by a National Board “R” Certificate Holder, per NBIC Part 3, S7.3.

The completed Form R-1 shall be noted on and attached to the “VR” Certificate Holder’s document required in NBIC Part 3, 1.7.5.4. i). Similarly, NDE and heat treatment techniques must be covered in the quality system manual. When outside services are used for NDE and heat treatment, the quality system manual shall describe the system whereby the use of such services meet the requirements of the applicable section of the ASME Code.

Valve Testing, Setting, and Sealing

The system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code Section and the National Board. The seal shall identify the “VR” Certificate Holder making the repair. Abbreviations or initials shall be permitted, provided such identification is acceptable to the National Board.

Valve Repair Nameplates

An effective valve stamping system shall be established to ensure proper stamping of each valve as required by NBIC Part 3, 5.12.2. The manual shall include a description of a nameplate or a drawing.

Calibration

The manual shall describe a system for the calibration of examination, measuring, and test equipment used in the performance of repairs. Documentation of these calibrations shall include the standard used and the results.

All calibration standards shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

Manual Control

The quality system shall include:

Measures to control the issuance of and revisions to the quality system manual;
Provisions for a review of the system in order to maintain the manual current with these rules and the applicable sections of the ASME Code;
The title(s) of the individual(s) responsible for control, revisions, and review of the manual;
Provision of a controlled copy of the written quality system manual to be submitted to the National Board; and

Revisions shall be submitted for acceptance by the National Board prior to being implemented.

Nonconformities

The system shall establish measures for the identification, documentation, evaluation, segregation, and disposition of nonconformities. A nonconformity is a condition of any material, item, product, or process in which one or more characteristics do not conform to the established requirements.
These may include, but are not limited to, data discrepancies, procedural and/or documentation deficiencies, or material defects. Also, the title(s) of the individual(s) involved in this process shall be included.

**Exhibits**

Forms used in the quality system shall be included in the manual with a written description. Forms exhibited should be marked “SAMPLE” and completed in a manner typical of actual valve repair procedures.

**Testing Equipment (See NBIC Part 3, Supplement 8)**

The system shall include a means to control the development, addition, or modification of testing equipment to ensure the requirements of NBIC Part 3, 4.5.1 b) are met.

**Field Repairs (See NBIC Part 3, S7.7)**

If field repairs are included in the scope of work, the system shall address any differences or additions to the quality system required to properly control this activity, including the following:

- Provisions for annual audits of field activities shall be included;
- Provisions for receipt and inspection of replacement parts, including parts received from the owner-user, shall be addressed;
- If owner-user personnel will assist with repairs, provisions for the use of owner-user personnel shall be included; and
- Provisions for use of owner-user measurement and test equipment, if applicable, shall be addressed.

<table>
<thead>
<tr>
<th>NB15-2305</th>
<th><strong>1.8.1 SCOPE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, 1.8.1</td>
<td>a) This section provides requirements that must be met for an organization to obtain a National Board Certificate of Authorization to use the “NR” Symbol Stamp for repair/replacement activities to nuclear items constructed in accordance with the requirements of the ASME Code or other internationally recognized codes or standards for construction or in-service inspection of nuclear facilities.</td>
</tr>
<tr>
<td></td>
<td>b) For administrative requirements to obtain or renew a National Board “NR” Certificate of Authorization and the “NR” Symbol Stamp, refer to National Board Procedure NB-417, Accreditation of “NR” Repair Organizations.</td>
</tr>
</tbody>
</table>

5 Requirements for Accreditation of “NR” Repair Organizations NB-417, may be found on the NB website www.nationalboard.org under tab “Stamps and Marks.”

<table>
<thead>
<tr>
<th>NB15-1204 NB16-0602</th>
<th><strong>1.8.2 GENERAL</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, 1.8.2</td>
<td>a) An organization applying for an “NR” Certificate of Authorization shall have a written Quality Assurance Program (QAP) that details the specific requirements to be met based on the intended category of activities selected by that organization as described below and shown in Table 1.8.2. Controls used, including electronic capabilities, in the Quality Assurance Program shall be documented in a Quality Assurance Manual (QAM). Controls required to be included within the QAM shall include who, what, when, where, why and how with an understanding that the how can be a reference to an implementation procedure or</td>
</tr>
</tbody>
</table>
Section 1.8.5 of this part. Applicants shall address all requirements in their Quality Assurance Program based on the category of activity and scope of work to be performed (organization’s capabilities) to which certification is requested.

1) Category 1

Any ASME Code certified item or system requiring repair/replacement activities irrespective of physical location and installation status prior to fuel loading.

2) Category 2

After fuel loading, any item or system under the scope of ASME Section XI requiring repair/replacement activities irrespective of physical location. Based on regulatory or jurisdictional acceptance, Category 2 may be used prior to fuel loading.

3) Category 3

Items constructed to codes or standards other than ASME, requiring repair/replacement activities irrespective of physical location, installation status and fuel loading.

b) Repair organizations performing repairs of pressure relief devices in nuclear service shall meet the additional requirements of NBIC Part 4, Section 4 and NBIC Part 4, Supplement 6.

---

### TABLE 1.8.2

**“NR” QUALITY ASSURANCE PROGRAM (QAP) REQUIREMENTS**

<table>
<thead>
<tr>
<th>Category of Activity</th>
<th>Owner</th>
<th>Organizations other than Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>10 CFR Part 50 Appendix B(^1,2) and ASME Section III NCA-4000</td>
<td>10 CFR Part 50 Appendix B(^1,2) and ASME Section III NCA-4000</td>
</tr>
<tr>
<td>Category 2</td>
<td>10 CFR Part 50, Appendix B(^1,2) or NQA-1, Part 1 and ASME Section XI, IWA-4142</td>
<td>10 CFR Part 50, Appendix B(^1,2), supplemented as needed with Owner’s QA program; or ASME NQA-1, Part 1; or ASME Section III, NCA-4000</td>
</tr>
<tr>
<td>Category 3</td>
<td>ASME NQA-1, or Specify the Standard to which certification is desired</td>
<td>ASME NQA-1, or Specify the Standard to which certification is desired</td>
</tr>
</tbody>
</table>

**Note 1:**

**Note 2:**
10 CFR 50 Appendix B – Title 10 of the Code of Federal Regulations Part 50 Appendix B describes the quality assurance criteria for nuclear plants and fuel reprocessing plants.
1.8.2.1 DEFINITIONS

The **NBIC** terms and definitions used within this section shall be as specified below:

1) For Category 1 terms and definitions shall be as specified in ASME Section III

2) For Category 2 terms and definitions shall be as specified in ASME Section XI

For Category 3 terms and definitions shall be as specified in ASME NQA-1 and other standards specified by the Regulatory Authority shall be supplemented, as applicable, by the terms and definitions of ASME Section III, Section XI, NQA-1, or other standards specified by the Regulatory Authority.

The following terms are as defined in the NBIC Glossary of Terms Section 9:

a) Authorized Inspection Agency

b) Authorized Nuclear Inspection Agency

c) Jurisdiction

d) “NR” Certificate Holder

<table>
<thead>
<tr>
<th>ASME</th>
<th>American Society of Mechanical Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>NB-263_RCI-1</td>
<td>Rules for National Board Inservice and New Construction-Commissioned Inspectors</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>WA</td>
<td>ASME Section III, Division 3, Subsection WA, General Requirements</td>
</tr>
</tbody>
</table>

1.8.3 PREREQUISITES FOR ISSUING A NATIONAL BOARD “NR” CERTIFICATE OF AUTHORIZATION

Before an organization can obtain a National Board “NR” Certificate of Authorization, the organization shall:

a) Have and maintain an inspection agreement with an Authorized Nuclear Inspection Agency accepted in accordance with NB-360\(^\text{6}\), Criteria for Acceptance of Authorized Inspection Agencies for New Construction or accredited in accordance with NB-369\(^\text{2}\), Qualifications and Duties for Authorized Inspection Agencies (AIAs) Performing Inservice Inspection Activities and Qualification of Inspectors of Boilers and Pressure Vessels.

b) Have a written Quality Assurance Program that complies with the requirements of this section and address all controls for the intended category and scope of activities.

c) Have a current edition of the NBIC.

d) Have available ASME Section XI, the code of construction and referenced code sections and standards appropriate for the scope of work to be performed. ASME Section XI and codes of construction (Editions/Addenda) shall meet the requirements of the Regulatory Authority\(^\text{6}\) and the owner.

---

\(^{6}\) NB-360, Criteria for Acceptance of Authorized Inspection Agencies for New Construction.

\(^{2}\) NB-369, Qualifications and Duties for Authorized Inspection Agencies (AIAs) Performing Inservice Inspection Activities and
Qualification of Inspectors of Boilers and Pressure Vessels.

A Regulatory Authority, a government agency, such as the United States Nuclear Regulatory Commission, empowered to issue and enforce regulations concerning the design, construction, and operation of nuclear power plants.

g) These rules set forth the requirements for planning, managing, and implementing the organization's Quality Assurance Program to control and ensure quality is performed and maintained during repair/replacement activities of components, items, parts, and systems for nuclear facilities. These rules are to be the basis for evaluating such programs prior to the issuance or renewal of the National Board "NR" Certificate of Authorization. Rules identified in subsections 1.8.6, 1.8.7 and 1.8.8 of this section detail the Quality Assurance Program requirements for each category of activity. These rules are established to meet and follow the requirements specified in NBIC Part 3, Table 1.8.2-4 of this section.

Forms NR-1 and NVR-1 as applicable shall be completed by the “NR” Certificate Holder upon completion of all repair/replacement activities. Completion of forms, registrations and stamping of the “NR” symbol stamp shall meet the requirements of NBIC Part 3, Section 5. A log shall be maintained in accordance with NBIC Part 3, 5.6; and

s) Authorized Nuclear Inspector

Measures shall be taken to reference the commissioned rules for National Board Authorized Nuclear Inspector, in accordance with NB-263, RCI-1, Rules for National Board Inservice and New Construction Commissioned Inspectors. The “NR” Certificate Holder shall ensure that the latest documents including the Quality Assurance Manual, procedures and instructions are made available to the Authorized Nuclear Inspector. The Authorized Nuclear Inspector shall be consulted prior to the issuance of a repair/replacement plan by the “NR” Certificate Holder in order that the Authorized Nuclear Inspector may select any in-process inspection or hold points when performing repair/replacement activities. The “NR” Certificate Holder shall keep the Authorized Nuclear Inspector informed of progress of the repair/replacement activity so that inspections may be performed. The Authorized Nuclear Inspector shall not sign Form NR-1 or Form NVR-1, as applicable, unless satisfied that all work carried out is in accordance with this Section. The Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor shall have access to areas where work is being performed including subcontractors facilities in order to perform their required duties. The ANI shall be involved in dispositions and verification for non-conformances and corrective actions involving quality or code requirements.

g) Control of Purchased Material, Items, and Services

1) When the owner performs repair/replacement activities, purchase of materials and small products shall meet the requirements specified in ASME Section XI, IWA 4142. Measures shall be established to ensure that purchased material, items, and services conform to the owner’s requirements and applicable edition and addenda of the code of construction and ASME Section XI. These measures shall include identification for material traceability. Provisions shall be identified for source evaluation and objective evidence shall be provided evidencing quality standards for material examination upon receipt.

f) Nondestructive examination reports, including results of examinations, shall identify the ASNT, SNT-TC-1A, CP-189, or ACCP certification level of personnel interpreting the examination results. Final radiographs shall be included where radiography has been performed. Radiographs may be microfilmed or digitally reproduced in accordance with the requirements listed in ASME Section V, Article 2, Mandatory Appendix VI. The accuracy of the reproduction
<table>
<thead>
<tr>
<th>NB16-0606 Part 3, 1.8.7.2 n) 5)</th>
<th>5) The original of the completed Form NR-1 or Form NVR-1, as applicable, shall be registered with the National Board and, if required, a copy forwarded to the Jurisdiction where the nuclear power plant is located. <strong>A log shall be maintained in accordance with NBIC Part 3, 5.6.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>NB15-2106 Part 3, 1.8.7.2 s)</td>
<td>s) Authorized Nuclear Inspector Measures shall be taken to reference the commissioned rules for National Board Authorized Nuclear Inspector, in accordance with NB-263, <em>RCI-1 Rules for National Board Inservice and New Construction Commissioned Inspectors</em>. The “NR” Certificate Holder shall ensure that the latest documents including the Quality Assurance Manual, procedures and instructions are made available to the Authorized Nuclear Inspector. The Authorized Nuclear Inspector shall be consulted prior to the issuance of a repair/replacement plan by the “NR” Certificate Holder in order that the Authorized Nuclear Inspector may select any in process inspection or hold points when performing repair/replacement activities. The “NR” Certificate Holder shall keep the Authorized Nuclear Inspector informed of progress of the repair/replacement activity so that inspections may be performed. The Authorized Nuclear Inspector shall not sign Form NR-1 or Form NVR-1, as applicable, unless satisfied that all work carried out is in accordance with this section. The Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor shall have access to areas where work is being performed including subcontractors facilities in order to perform their required duties. The ANI shall be involved in dispositions and verification for nonconformances and corrective actions involving quality or code requirements.</td>
</tr>
<tr>
<td>NB15-1407 NB16-0606 Editorial Part 3, 1.8.8.2</td>
<td><strong>1.8.8.2 QUALITY PROGRAM ELEMENTS</strong> a) Organization Persons and organization shall have authority and freedom to identify quality problems; initiate, recommend or provide solutions and verify implementation of solutions. b) QAP Shall account for special controls, processes, test equipment, tools and skills to obtain quality and for verification of quality by inspections and tests. Indoctrination, training and maintaining proficiency of personnel effecting quality shall be described. The status and adequacy of the QAP shall be regularly reviewed. The scope shall be included within the written QAM. The “NR” Certificate Holder shall make a current controlled copy of the Quality Assurance Manual available to the Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor. The “NR” Certificate Holder shall address in their QAM the requirements for interfacing with the owner specified in 1.8.9 of this section. c) Design Control Established measures to assure approximate quality standards are specified and included in design documents. Any deviations shall be identified and controlled. d) Document Control Documents for procurement of material, equipment and services shall ensure regulatory requirements, design bases and other quality requirements and are included or referenced. Procurement documents shall require contractors or subcontractors provide a Quality Assurance Program consistent with the provisions specified in this NBIC Part 3, 1.8.8.</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>e)</td>
<td><strong>Instructions, Procedures and Drawings</strong>&lt;br&gt;Activities affecting quality shall be accomplished in accordance with prescribed instructions, procedures or drawings and shall include approximate quantitative or qualified acceptance criteria to determine activities are satisfactorily accomplished.</td>
</tr>
<tr>
<td>f)</td>
<td><strong>Document Control</strong>&lt;br&gt;Shall define measures to control the preparation, issuance, use, approval, revisions and distribution of all documents related to quality.</td>
</tr>
<tr>
<td>g)</td>
<td><strong>Control of Purchases, Materials, Items and Services</strong>&lt;br&gt;Purchased material, items and services shall conform to the procurement documents. Measures shall be established for source evaluation and selection, objective evidence of quality, inspections at the source and examination of products upon delivery. Effectiveness of quality shall be assessed by the applicant or designee at specified intervals.</td>
</tr>
<tr>
<td>h)</td>
<td><strong>Identification and Control of Items</strong>&lt;br&gt;Specified controls shall ensure only correct and acceptable items, parts and components are used and installed.</td>
</tr>
<tr>
<td>h)</td>
<td><strong>Control of Processes</strong>&lt;br&gt;Documents used to control processes and conform to specified acceptance criteria shall include spaces for signatures, initials, stamps and dates for activities performed by the Certificate Holders’ representative and the Authorized Nuclear Inspector.</td>
</tr>
<tr>
<td>h)</td>
<td><strong>Examinations, Tests and Inspections</strong>&lt;br&gt;A repair / replacement plan shall address all required information for performing examinations, tests and inspections including but not limited to:&lt;br&gt;&lt;br&gt;1) Establishing hold points&lt;br&gt;2) Identifying procedures, methods, acceptance criteria&lt;br&gt;3) Defects identified, removal methods, welding, brazing, fusing, and material requirements, reference points used for identification&lt;br&gt;4) Evaluations of results</td>
</tr>
<tr>
<td>i)</td>
<td><strong>Test Control</strong>&lt;br&gt;Tests performed to written procedures identifying acceptance limits, calibration, equipment, personnel qualifications, environmental conditions, and documentation required.</td>
</tr>
<tr>
<td>i)</td>
<td><strong>Control of Measuring and Test Equipment</strong>&lt;br&gt;Procedures, methods and frequency of calibration shall be described for all types of measuring and test equipment used to verify quality. Any discrepancies shall be identified and resolved.</td>
</tr>
<tr>
<td>i)</td>
<td><strong>Handling, Storage and Shipping</strong>&lt;br&gt;Processes or procedures shall be established to prevent damage, deterioration or misuse of material, items or components used and stored.</td>
</tr>
<tr>
<td>i)</td>
<td><strong>Records</strong>&lt;br&gt;1) All quality related records shall be classified, identified, verified, maintained, distributed, retraceable, and accessible. When the “NR” Certificate Holder is the owner, designated records and reports received by the owner, shall be filed and maintained in a manner to allow access by the Authorized Nuclear Inservice Inspector (ANII). Suitable protection from deterioration and damage shall be provided by the owner. These records and reports shall be retained as specified</td>
</tr>
</tbody>
</table>
in the owner’s QAP for the lifetime of the component or system.

The original of the completed Form NR-1 or Form NVR-1, as applicable, shall be registered with the National Board and, if required, a copy forwarded to the Jurisdiction where the nuclear power plant is located. A log shall be maintained in accordance with NBIC Part 3, 5.6.

Corrective Action

Measures established to assure conditions adverse to quality are promptly identified and corrected and action taken to preclude repetition.

Inspection or Test Status

Measures shall be established to indicate inspection and test status of parts, items or components during repair/replacement activity. Measures shall include identification, procedures, control indicators (acceptable, unacceptable) and responsibility of personnel.

Nonconforming Material or Items

Measures to control material or items, nonconforming to specified criteria shall be established. Measures shall include identifying, controlling, documenting, reviewing, verifying, dispositioning and segregation when practical.

Audits

A system of planned and periodic audits shall be established to verify compliance of the Quality Assurance Program. Audits shall include; written procedures, checklists, trained/qualified personnel not having direct responsibility for areas being audited, documentation, review by management and follow up actions when required.

Authorized Nuclear Inspector

Qualifications and duties shall be as specified in ASME QAI-1 and NB-263 for the Authorized Inspection Agencies, Authorized Nuclear Inspector and the Authorized Nuclear Inspector Supervisor. Additional requirements are specified in Sections 1.8.6.2 s), 1.8.7.2 s), and 1.8.9.

Exhibits

Quality related forms and exhibits described in the Quality Assurance Program shall be identified, controlled and where applicable included as a reference document within the QAM or referenced procedures.

<table>
<thead>
<tr>
<th>NB16-0809B</th>
<th>2.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, 2.1</td>
<td>This section provides general and specific requirements and guidelines for welding and heat treating when performing welded repairs and alterations to pressure-retaining items. Careful consideration shall be given to pressure-retaining items that have been fabricated of either creep strength enhanced ferritic materials or ferritic materials enhanced by heat treatment. The tensile and creep strength properties of these materials can be degraded by not following specific welding and heat treatment requirements. The user is cautioned to seek technical guidance for welding and heat treating requirements in accordance with the original code of construction.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Editorial</th>
<th>2.3 STANDARD WELDING PROCEDURE SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, 2.3</td>
<td>One or more SWPSs from NBIC Part 3, Table 2.3 may be used as an alternative to one or more WPS documents qualified by the organization making the repair or alteration, provided the organization accepts by certification (contained therein) full responsibility for the application of the SWPS in conformance with the application as stated in the SWPS. When using SWPSs, all variables listed on the Standard Welding</td>
</tr>
</tbody>
</table>
Procedure are considered essential and, therefore, the repair organization cannot deviate, modify, amend, or revise any SWPSs. US Customary Units or metric units may be used for all SWPSs in NBIC Part 3, Table 2.3, but one system shall be used for application of the entire SWPS in accordance with the metric conversation table contained in the SWPS. The user may issue supplementary instructions as allowed by the SWPS. Standard Welding Procedures Specifications shall not be used in the same product joint together with the other Standard Welding Procedure Specifications or other welding procedure specifications qualified by the organization.

The AWS reaffirms SWPSs in accordance with ANSI procedures. When reaffirmation occurs without revision to the SWPS, the letter “R” is added to the SWPS designation following prior to the year. Such designation is considered to be identical with the previously published version and may be used pending incorporation herein, on the same basis as the version listed in NBIC Part 3, Table 2.3.

<table>
<thead>
<tr>
<th>NB16-0701</th>
<th>Part 3, Table 2.3</th>
<th>GTAW — Gas Tungsten Arc Welding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding (Consumable Insert) of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, INMs1 and ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Application.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding with Consumable Insert Root of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1-1/2 in. (38 mm) Thick, INMs-1, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Applications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GTAW/SMAW Combination of Welding Processes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, ER70S-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, ER70S-2 and E7018, As-Welded or PWHT Condition, Primarily Pipe Applications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2), 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, ER70S-2 and E7018, As-Welded or PWHT Condition, Primarily Pipe Applications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding (Consumable Insert) Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard Welding Procedure Specification for Gas Tungsten Arc Welding with Consumable Insert Root Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1)</td>
</tr>
</tbody>
</table>
### Austenitic Stainless Steel — (M8/P8/S8 Materials)

#### GTAW — Gas Tungsten Arc Welding

| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition. | B2.1-8-024-94 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) Thick, ER3XX, As-Welded Condition. | B2.1-8-024:2001 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) Thick, ER3XX, As-Welded Condition. | B2.1-8-212-97 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) thick, ER3XX, As-Welded Condition. | B2.1-8-212:2001 |

#### Combination Processes GTAW/SMAW

| Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) | B2.1-8-025-94 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding With Consumable Insert Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) thick, IN3XX, ER3XX, and E3XX-XX As-Welded | B2.1-8-216-1998 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding with Consumable Insert Root followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E309(L)-15, -16, or -17, As- Welded | B2.1-8-216:2001 R2012 |

#### Combination of Carbon Steel (P-1 Material) To Austenitic Stainless Steel (P-8 Material)

| SMAW — Shielded Metal Arc Welding |
| Standard Welding Procedure Specifications for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E309(L)-15, -16, or -17, As-Welded | B2.1-1/8-228:2002 R2013 |
| GTAW — Gas Tungsten Arc Welding |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 1/2 in. (38 mm) Thick, ER309(L), As-Welded | B2.1-1/8-227:2002 R2013 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding with Consumable Insert Root of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 1/2 in. (38 mm) Thick, IN309 and ER309(L), As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-230:2002 R2013 |

**GTAW/SMAW Combination of Welding Processes**

| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, ER309(L) and E309(L)-15, -16, or -17, As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-229:2002 R2013 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding with Consumable Insert Root followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 1/2 in. (38 mm) Thick, IN309 and ER309(L), As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-231:2002 R2015 |

**Chromium Molybdenum Steel (M4/P4 and M5a/P5A Materials)**

**SMAW — Shielded Metal Arc Welding**

| Standard Welding Procedure Specifications for Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), E8018-B2, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-4-218:1999 R2009 |

| Standard Welding Procedure Specifications for Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5a/P-5a), E9018-B3, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-5A-223:1999 R2009 |

**GTAW — Gas Tungsten Arc Welding**

| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding of Chromium- Molybdenum Steel (M-4/P-4, Group 1 or 2), ER80S-B2, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-4-217:1999 R2009 |

| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding (Consumable Insert Root) of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), E8018-B2, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, IN515 and ER80S-B2, Primarily Pipe Applications. | B2.1-4-220:1999 R2009 |

| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding of Chromium- Molybdenum Steel (M-5a/P-5a), ER90S-B3, 1/8 in. (3.2 mm) through 1 1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-5A-222:1999 R2009 |

| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding (Consumable Insert Root) of Chromium-Molybdenum Steel (M-5a/P-5a), 1/8 in. (3.2 mm) through 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-5A-225:1999 R2009 |
b) Postweld heat treatment shall be performed by heating either the entire item or a circumferential band around the item. When heating a circumferential band, the heat treatment procedure shall specify the soak band (SB) width, the heated band (HB) width, the gradient control band (GCB) width, the location of thermocouples and method of attachment of thermocouples in addition to the heating rate, holding time, temperature and cooling rate. Figures S2.5.2-2 and S2.5.2-2b show these bands. AWS A5.10, Recommended Practices for Local Heating of Welds in Piping and Tubing may be referred to for further information.

c) The detailed welding methods listed in the following subsections may be used as an alternative to postweld heat treatment (PWHT). NBIC Part 3, 2.5.3.1 is a method in which the welding procedure requires an elevation of the preheat temperature. In contrast, NBIC Part 3, 2.5.3.2 through 2.5.3.56 are methods in which the welding procedure requires the use of a temper-bead welding technique. Welding Method 6 as described in 2.5.3.6 requires use of a controlled fill technique. In 2.5.3.5 is a method in which the welding procedure used for joining dissimilar materials requires either an elevation of the preheat temperature or a temper-bead welding technique, depending on the chemical composition of the base metal that is joined to an austenitic steel. Temper-bead welding procedure nomenclature is defined in Section IX of the ASME Boiler and Pressure Vessel Code. Typically, this technique minimizes heat input of the initial beads, thus limiting heat beyond the weld heat-affected zone (HAZ) of the base metal. Heat input shall be increased for successive beads in accordance with the rules of QW-290 for temper bead welding in ASME Section IX. The Welding Procedure and Welder Performance Qualifications shall, in all cases, be in accordance with the requirements of the latest Edition of Section IX of the ASME Boiler and Pressure Vessel Code.

e) The test material for the welding procedure qualification shall be of the same material specification (including specification type, grade, class, and condition of heat treatment) as the material being repaired. In the event that the notch toughness of the material to be repaired is unknown, evidence from tests of that material or from another acceptable source (see NBIC Part 3, 2.5.3) may be used for the base metal notch toughness when qualifying the WPS as required in NBIC Part 3, 2.5.3.2 h). In the event that the original material specification is obsolete, the test material used should conform as closely as possible to the original material used for construction based on nominal composition and
| NB15-3401  
Part 3,  
2.5.3.2 i) | 2.5.3.2  
WELDING METHOD 2  
| d) For the welding process in NBIC Part 3, 2.5.3.2(c), use of austenitic or ferritic filler metals is permitted. For ferritic filler metals, use only electrodes and filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower for the FCAW and SMAW processes. When shielding gases are used with a process, the gas shall exhibit a dew point that is below -60°F (-50°C). Surfaces on which welding will be done shall be maintained in a dry condition during welding and be free of rust, mill scale, and hydrogen producing contaminants such as oil, grease, and other organic materials; |

| NB15-3401  
Part 3,  
2.5.3.3 g)  
2) | 2.5.3.3  
WELDING METHOD 3  
| 2) For the welding processes in NBIC Part 3, 2.5.3.3 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower may be used for the FCAW and SMAW processes. |

| NB15-3401  
Part 3,  
2.5.3.4 g)  
2) | 2.5.3.4  
WELDING METHOD 4  
| 2) For the welding processes in NBIC Part 3, 2.5.3.4 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower for the FCAW and SMAW processes. |

| NB15-0509  
NB15-1402  
NB15-1902  
Part 3,  
2.5.3.6 | 2.5.3.6  
WELDING METHOD 6  
| This welding method provides guidance requirements for welding only Grade 91 tube material within the steam boiler setting and when it's impracticable to perform local postweld heat treatment (PWHT). This repair method utilizes a controlled fill technique. When using this welding method, the following is required:  
a) This method is limited to butt welds in tubing NPS 5 (DN 125) or less in diameter and ½ in. (13 mm) or less in wall thickness for which the applicable rules of the original code of construction did not require notch toughness testing;  
b) Application shall be limited to only boiler tube repairs at a location internal to the boiler setting; |
c) Upon the completion of weld repair, the repair region shall be kept from humid or moist environments until the return to service area shall be kept above the dew point temperature so that condensation does not form on the repair surface before returned to service or a moisture-barrier coating shall be applied to the surface.

1) The material shall be limited to P-No 15E, Group 1, Grade 91, creep strength enhanced ferritic steel (CSEF).

2) The welding shall be limited to the SMAW or GTAW processes, manual or automatic, using suitably controlled maintenance procedures to avoid contamination by hydrogen producing sources. The surface of the metal shall be free of contaminants and kept dry.

3) The test material for the welding procedure qualification test coupon shall be P-No 15 E, Group 1, Grade 91 for the repair.

4) Qualification thickness for the test plates and repair groove depth limits of base metal and weld deposit thickness shall be in accordance with ASME Section IX, QW-451.

5) The Welding Procedure Specification (WPS) shall be qualified in accordance with the requirements of ASME Section IX except that no postweld heat treatment shall be applied to the test coupon. Additionally, the WPS shall include the following requirements:
   - The minimum preheat for the GTAW process shall be 200°F (93°C). The minimum preheat for the SMAW process shall be 300°F (150°C). The preheat temperature shall be checked to ensure the minimum preheat temperature is maintained during welding and until welding is completed. The maximum interpass temperature shall be 400°F (200°C).
   - When the SMAW process is specified for a fill pass layer as a controlled filled welding technique, the electrode diameter is restricted to a maximum size of 1/8 in. (3.2 mm). When the GTAW-process is specified any limits in filler size is to be reflected in the qualified PQR and shown on the WPS.
   - Regardless of the welding process (SMAW or GTAW), only the use of stringer beads shall be permitted.
   - The filler metal shall be limited to an austenitic, nickel-base filler metal having a designation F-No. 43 and limited to the following consumables: ERNiCr-3 (e.g., Filler Metal 82), ENiCrFe-3 (e.g., INCONEL Welding Electrode 182), ENiCrFe-2 (e.g., INCO-WELD A), ASME B&PV Code Cases 2733 and 2734 (e.g., EPRI P87), or a martensitic, iron-base filler metal having a designation F-No. 4 or F-No. 6 and limited to the following consumables: E8015-B8, E8018-B8 or ER80S-B8.

<table>
<thead>
<tr>
<th>Editorial NB16-0809B</th>
<th>3.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, 3.1</td>
<td>This section provides general and specific requirements and guidelines for materials, replacement parts, and methods used when performing repairs and alterations to pressure-retaining items. Specific repair or alteration methods for other types of pressure equipment are in NBIC Part 3, Section 76.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB12-0501</th>
<th>Part 3, 3.2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>d) When the original code of construction is other than ASME Code, replacement parts subject to internal or external pressure, fabricated by welding, shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction, as required by the original code of construction or equivalent, shall be supplied with the item. When this is not possible or practicable, the organization fabricating the part shall have a National Board “R” Certificate of Authorization; replacement parts shall be documented on Form R-3 and the “R” Symbol Stamp applied as described in NBIC Part 3, Section 5.</td>
<td></td>
</tr>
<tr>
<td>e) Replacement parts addressed by 3.2.2 c) or d) above shall receive a pressure test as required by the original code of construction. If replacement parts have not been pressure tested as required by the</td>
<td></td>
</tr>
</tbody>
</table>
original code of construction prior to installation they may be installed without performing the original code of construction pressure test provided the owner, the Inspector and, when required, the Jurisdiction accept the use of one or a combination of the examination and test methods shown in Part 3, Section 4, paragraph 4.4.1 (for repairs) or 4.4.2 (for alterations). The R Certificate Holder responsible for completing the R Form shall note in the Remarks section of the R Form the examination(s) and test(s) performed, and the reason the replacement part was not tested in accordance with the original code of construction.

| NB14-0701 Part 3, 3.2.2 c) | When ASME Code is the original code of construction, replacement parts subject to internal or external pressure fabricated by welding, which require inspection by an Authorized Inspector shall be fabricated by an organization having an appropriate ASME Certificate of Authorization. The item shall be inspected and stamped as required by the applicable section of the ASME Code. A completed ASME Manufacturer’s Partial Data Report shall be supplied by the manufacturer. ASME stamping and completion of an ASME Manufacturer’s Partial Data Report is not required for parts fabricated by the “R” Certificate Holder that will be used on pressure retaining items being repaired or altered by the same “R” Certificate Holder. The controls for this activity shall be described in the quality control system. The “R” Certificate Holder, using replacement parts fabricated and certified to an ASME Code edition and addenda different from that used for the original construction, shall consider and seek technical advice, where appropriate, for change or conflicts in design, materials, welding, heat treatment, examinations and tests to ensure a safe repair/alteration is performed. Note that work once classified as a repair could now be considered an alteration.

| NB14-0702 NB15-1801 Part 3, 3.3.2 e) | The following repairs may be considered as routine repairs and shall be limited to these categories: Repairs falling within one or more of the following categories may be considered routine:
1) Welded repairs or replacements of valves, fittings, tubes, or pipes NPS 5 (DN 125) in diameter and smaller, or sections thereof, where neither postweld heat treatment nor NDE other than visual is required by the original code of construction. This includes their attachments such as clips, lugs, skirts, etc., but does not include nozzles to pressure-retaining items;
2) The addition or repair of nonload bearing attachments to pressure-retaining items where postweld heat treatment is not required;
3) Weld buildup of wasted areas in heads, shells, flanges and fittings not exceeding an area of 100 sq. inches (64,520 sq. mm) or a thickness of 25% of nominal wall thickness or ½ inch (13 mm), whichever is less;
4) Corrosion resistance weld overlay not exceeding 100 sq. in. (64,520 sq. mm).
5) Seal welding a mechanical connection for leak tightness where by-design, the pressure retaining capability is not dependent on the weld for strength and requires no postweld heat treatment.

| NB16-2601 Part 3, 3.3.3 f) | Replacement or plugging of boiler and heat exchanger tubes where welding is involved;
Editorial Part 3, 3.3.4.2 b)

FIGURE 3.3.4.2-b
RIVET AND STAYBOLT HOLE CRACKS

Circumferential Cracks at Girth Seams
Fire Cracks at Girth Seams

Fire Cracks at Door Openings
Cracks in Stayed Plates

Editorial Part 3, Figure 3.3.4.3-c

FIGURE 3.3.4.3-c
EXTERNAL OVERLAY TERMS AND DEFINITIONS
L = length of area to be repaired along the axis of the component  
C = length of area to be repaired along outside circumference of the component  
W = the completed thickness of the overlay  
\( \alpha \) = the angle between the component and the overlay (maximum 45°)  
B = \( \frac{3}{4} (R - t)^{0.5} \) minimum  
R = nominal outside radius of the component  
D = the nominal outside diameter of the component  
t = nominal wall thickness of the component  
\( \mu \) = remaining wall thickness of the component shall be \( \frac{1}{16} \) in. (1.6 mm) or greater  
r = minimum radius, not less than the overlay thickness

<table>
<thead>
<tr>
<th>NB15-2601</th>
<th>3.3.4.6 PATCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3,</td>
<td>a) Flush Patches</td>
</tr>
<tr>
<td>3.3.4.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) The weld around a flush patch shall be a full penetration weld and the accessible surfaces shall be ground flush where required by the applicable original code of construction. Examples of flush welded patches are shown in NBIC Part 3, Figure 3.3.4.6-a. The welds shall be subjected to the nondestructive examination method used in the original code of construction or an alternative acceptable to the Inspector.</td>
</tr>
<tr>
<td></td>
<td>2) Before installing a flush patch, the defective material should be removed until sound material is reached. The patch should be rolled to the proper shape or curvature. The edges should align without overlap. In stayed areas, the weld seams should come between staybolt rows or riveted seams. Patches shall be made from a material whose composition and thickness meet the intended service. Patches may be any shape or size. If the patch is rectangular, a minimum radius of not less than three times the material thickness an adequate radius should shall be provided at the corners. Square corners should be avoided are not permitted. The completed welds shall meet the requirements of the original code of construction.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-2305</th>
<th>3.4.1 RE-RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB16-2101</td>
<td>Except as provided for Yankee dryers in Supplement 5, this code does not provide rules for de-rating boilers or pressure vessels; however, when the MAWP and/or allowable temperature of a boiler or pressure</td>
</tr>
</tbody>
</table>

---

\( t \) = thickness of the overlay
### Part 3, 3.4.1

vessel is reduced, the Jurisdiction where the object is installed should be contacted to determine if specific procedures should be followed. Re-rating of a pressure-retaining item by increasing the maximum allowable working pressure (internal or external) or temperature or decreasing the minimum design metal temperature below which notch toughness testing is required by the original code of construction, shall be done only after the following requirements have been met to the satisfaction of the Jurisdiction at the location of the installation:

a) Revised calculations verifying the new service conditions shall be prepared in accordance with the “R” Certificate Holder’s Quality Control System. Establishing a higher joint efficiency to re-rate a pressure-retaining item is not permitted;

b) All re-ratings shall be established in accordance with the requirements of the construction standard to which the pressure-retaining item was built;

c) Current inspection records verify that the pressure-retaining item is satisfactory for the proposed service conditions;

d) The pressure-retaining item has been pressure tested, as required, for the new service conditions. Any insulation, coatings, or coverings that may inhibit or compromise a meaningful pressure test shall be removed, to the extent identified by the Inspector. The pressure test may be waived if the original pressure test as recorded on the Manufacturer’s Data Report is at least equal to the calculated test pressure required to verify the integrity of the pressure-retaining item for the new conditions.

e) In lieu of pressure testing, alternative methods can be used to ensure the structural integrity of the re-rated pressure-retaining item. The alternative methods shall be documented and subject to review and approval by the Jurisdiction.

12 Re-rating: Except as provided for Yankee dryers in Supplement 5, this code does not provide rules for de-rating boilers or pressure vessels; however, when the MAWP and/or allowable temperature of a boiler or pressure vessel is reduced, the Jurisdiction where the object is installed should be contacted to determine if specific procedures should be followed.

### NB14-0301

<table>
<thead>
<tr>
<th>Part 3, 3.4.3</th>
</tr>
</thead>
</table>

**ENCAPSULATION**

Encapsulation is a method used to maintain the pressure retaining capability of pipe, nozzles, fittings and valves an item (with the exception of fire tube boilers) by fabricating a new pressure containing boundary over the item in the form of a “welded leak box” as described by ASME PCC-2, Article 2.4.

a) Except as required in 3.4.3 c)(1), ASME PCC-2 should be used as a guideline for the design of the welded leak box and fabrication shall be in accordance with the original code of construction, when practicable. Design of the encapsulation shall consider original design conditions, taking into account current service conditions and damage mechanisms. Use of this method shall be acceptable to the inspector and when required, the jurisdiction.

b) The “R” Certificate Holder responsible for the design of the encapsulation shall ensure a Fitness for Service Assessment (FFSA) has been performed on the portion of the item being encapsulated in accordance with NBIC, Part 2, 4.4.1, supporting the continued service of the item. The leak box shall not remain in place beyond the calculated remaining life of the encapsulated portion of the pressure retaining item.

1) The remaining life of the encapsulated pressure retaining item shall be documented on the Report of FFSA in the Remarks section. The Report of FFSA Form shall be affixed to the Form R-2 and identified in the Remarks section.
2) The leak box shall fully encapsulate the thinned or leaking area, as specified in the FFSA, to the distance where the minimum required metal thickness is verified. Wall thickness shall be verified in the area to be welded.

3) A welded leak box shall not be used to encapsulate a crack unless it has been removed and repaired in accordance with Part 3, Paragraph 3.3.4.2 a).

c) Hazards associated with welding on degraded components should be addressed with the Owner-User by the use of engineering controls, administrative controls and personal protective equipment.

1) When the pressure retaining item will remain in service while implementing this method, the requirements and limitations described within ASME PCC-2, Part-1 shall be used in conjunction with ASME PCC-2, Part-2, Article 2.10.

2) API RP-2201, “Safe Hot Tapping Practices in the Petroleum and Petrochemical Industries” may be used as a guideline for identifying hazards associated with welding to a component that is under pressure, including service restrictions.

d) Visual examination shall be in accordance with the NBIC, Part 3.4.4.1 e).

ea) Completion of the Form R-2 shall follow the requirements for preparation, distribution, and registration as described in Part 3, Section 5.

### EXAMPLES OF ALTERATIONS

**3.4.4**

| (a) | An increase in the maximum allowable working pressure (internal or external) or temperature of a pressure-retaining item regardless of whether or not a physical change was made to the pressure-retaining item; |
| (b) | A decrease in the minimum temperature; |
| (c) | The addition of new nozzles or openings in a boiler or pressure vessel except those classified as repairs; |
| (d) | A change in the dimensions or contour of a pressure-retaining item; |
| (e) | In a boiler, an increase in the heating surface or steaming capacity as described on the original Manufacturer’s Data Report; |
| (f) | The addition of a pressurized jacket to a pressure vessel; |
| (g) | Except as permitted in NBIC Part 3, 3.3.3 s); replacement of a pressure retaining part in a pressure retaining item with a material of different allowable stress or nominal composition from that used in the original design; |
| (h) | The addition of a bracket or an increase in loading on an existing bracket that affects the design of the pressure-retaining item to which it is attached; |
| (i) | The replacement of a pressure relieving device (PRD) as a result of work completed on a pressure-retaining item (PRI) that changes the resultant capacity to exceed the minimum required relieving capacity (MRRC) required by the original code of construction as described on the original Manufacturer’s Data Report. |
| (j) | Performing postweld heat treatment where none was originally performed on the pressure retaining item. |
| (k) | The installation of a welded leak box. |

**NB15-2801**

| Part 3, 4.2 b) | NDE personnel shall be qualified and certified in accordance with the requirements of the original code of construction. When this is not possible or practicable, NDE personnel may be qualified and certified in accordance with their employer’s written practice. ASNT SNT-TC-1A, *Recommended Practice Nondestructive Testing Personnel Qualification and Certification* (2006 edition), or ANSI/ASNT CP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel* (2006 edition), shall be used as a guideline for employers to establish their written practice. *The ASNT Central Certification*
Program (ACCP, Rev. 3, Nov. 1997) may be used to fulfill the examination and demonstration requirements of the employer’s written practice. Provisions for training, experience, qualification, and certification of NDE personnel shall be described in the “R” Certificate Holder’s written quality system.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, 4.5</strong></td>
<td><strong>PRESSURE RELIEF VALVE PERFORMANCE TESTING AND TESTING EQUIPMENT</strong></td>
</tr>
<tr>
<td>Each pressure relief valve to which the “VR” repair symbol stamp is to be applied shall be subjected to the following tests by the repair certificate holder.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, 4.5.1</strong></td>
<td><strong>TEST MEDIUM AND TESTING EQUIPMENT</strong></td>
</tr>
<tr>
<td>Valves marked for steam service, or having special internal parts for steam service, shall be tested on steam. Valves marked for air, gas, or vapor service shall be tested with air or gas. Valves marked for liquid service shall be tested with water or other suitable liquid. ASME Code, Section IV hot-water valves, shall be tested on water, steam, or air.</td>
<td></td>
</tr>
<tr>
<td>Each valve shall be tested to demonstrate the following:</td>
<td></td>
</tr>
<tr>
<td>Set pressure (as defined by the valve manufacturer and as listed in NB-18, Pressure Relief Device Certifications);</td>
<td></td>
</tr>
<tr>
<td>Response to blowdown, when required by the original code of construction;</td>
<td></td>
</tr>
<tr>
<td>Seat tightness; and</td>
<td></td>
</tr>
<tr>
<td>For valves designed to discharge to a closed system, the tightness of the secondary pressure zone shall be tested as required by the original code of construction.</td>
<td></td>
</tr>
<tr>
<td>The equipment used for the performance testing prescribed above shall meet the following requirements:</td>
<td></td>
</tr>
<tr>
<td>The performance testing equipment shall include a pressure vessel of adequate volume and pressure source capacity to ensure compliance with NBIC Part 3, 4.5.1 a) 1);</td>
<td></td>
</tr>
<tr>
<td>Prior to use, all performance testing equipment shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark testing, comparisons to equipment used for verification testing as specified in the quality system, or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation for a period of at least five years after the testing equipment is retired.</td>
<td></td>
</tr>
<tr>
<td>Documentation of this qualification shall include, but not be limited to:</td>
<td></td>
</tr>
<tr>
<td>Schematic of the performance test equipment;</td>
<td></td>
</tr>
<tr>
<td>Size and pressure ranges of valves to be tested and the test fluid to be used;</td>
<td></td>
</tr>
<tr>
<td>Dimensions of test vessels;</td>
<td></td>
</tr>
<tr>
<td>Accuracy of pressure measuring equipment;</td>
<td></td>
</tr>
<tr>
<td>Size and design type of valves used to control flow; and</td>
<td></td>
</tr>
<tr>
<td>Method of qualifying.</td>
<td></td>
</tr>
<tr>
<td>Prior to the implementation of any addition or modification to the testing equipment that would alter the contents of the document required in NBIC Part 3, 4.5.1 b) 2), the certificate holder shall re-qualify the performance test equipment in accordance with NBIC Part 3, 4.5.1 b) 2). If the equipment changed was used to satisfy the requirements of verification testing, the certificate holder shall notify the National Board and additional verification testing, in accordance with the quality system, may be required.</td>
<td></td>
</tr>
</tbody>
</table>
4.5.2 **OWNER-USER ASME CODE SECTION VIII STEAM TESTING**

When ASME Code Section VIII valves are repaired by the owner for the owner’s own use, valves for steam service may be tested on air for set pressure and, if possible, blowdown adjustment, provided the valve manufacturer’s corrections for differential in set pressure between steam and air are applied to the set pressure.

4.5.3 **LIFT ASSIST TESTING**

A device may be used to apply an auxiliary lifting load on the spring of a repaired valve to establish the set pressure in lieu of the tests required in NBIC Part 3, 4.5.1 a) 1) when such testing at full pressure:

- May cause damage to the valve being tested;
- Is impractical when system design considerations preclude testing at full pressure.

While actual valve blowdown and valve performance characteristics cannot be verified, valve set pressure may be determined to an acceptable degree of accuracy using this testing technique provided, as a minimum, that:

- Equipment utilized is calibrated as required in the quality system; including, but not limited to:
  - System pressure measurement equipment;
  - Lifting force measurement equipment; and
- Other measuring elements required by the device manufacturer;
- The device and test procedures that have proved to give accurate results are used and followed;
- A static inlet pressure is applied with the test medium specified in NBIC Part 3, 4.5.1; and
- Adjustments are made in accordance with the valve manufacturer’s recommendations to ensure proper lift and blowdown.

Prior to use, all lift assist devices shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation for a period of at least five years after the lift assist device is retired.

Documentation of this qualification shall include but not be limited to:

- A description of the lift assist device including model number, serial number and manufacturer.
- Size and pressure ranges of valves to be tested with the lift assist device and the test fluid to be used.
- Method of qualifying.

**Note**: Maximum set pressure is determined by available lift force and system pressure.

4.5.4 **PRESSURE TEST OF PARTS**

Parts used in repaired valves shall be pressure tested and documentation provided according to the following categories:
**Replacement Parts**

The "VR" Certificate Holder is responsible for documentation that the appropriate pressure test has been completed as required by the original code of construction.

**Parts Repaired by Welding**

These parts shall be subjected to a pressure test required by the original code of construction. The "VR" Certificate Holder shall be responsible for documentation of such test.

Parts repaired by re-machining within part specifications, lapping, or polishing do not require a pressure test.

---

**NB15-1903**

**Part 3, 5.3 and 5.4**

### DISTRIBUTION OF FORM R-1

a) Legible copies of completed Form R-1, together with attachments, shall be distributed to the owner or user, the Inspector, and the Jurisdiction, if required, and **shall be provided to the Inspector and the inservice Authorized Inspection Agency of the pressure retaining item upon request**

b) Distribution of Form R-1 and attachments shall be the responsibility of the organization performing the repair.

### DISTRIBUTION OF FORM R-2

a) Distribution of completed Form R-2 shall be the responsibility of the “R” Certificate Holder who performed the construction portion of the alteration. When no construction work is performed (e.g., a re-rating with no physical changes), the “R” Certificate Holder responsible for the design shall distribute the form.

b) Legible copies of the completed Form R-2, together with attachments, shall be distributed to the Inspector, the authorized inspection agency responsible for the inservice inspection of the pressure-retaining item, the owner-user, the “R” Certificate Holder responsible for design, and the Jurisdiction, if required, **and shall be provided to the Inspector and inservice Authorized Inspection Agency of the pressure retaining item upon request.**

---

**NB15-1201**

**Part 3, 5.5**

### REGISTRATION OF “R” FORMS — GENERAL

a) When registration of the Form “R” Report is required, the “R” Certificate Holder performing a repair or alteration shall submit the completed Form “R” Report, meeting the requirements of the codeNBIC, to the National Board.

b) When registration of the Form “R” Report is not required by the code, the “R” Certificate Holder may register the completed Form “R” Report, meeting the requirements of the codeNBIC, with the National Board.

c) The “R” or “NR” Certificate Holder should be aware that some Jurisdictions may require registration of repairs and alterations with the National Board.

---

**NB15-1201**

**Part 3, 5.5.4**

### REGISTRATION FOR NUCLEAR REPAIR/REPLACEMENT ACTIVITIES

Organizations performing repair/replacement activities under the “NR” or “NVR” stamp program shall register forms with the National Board.

---

**NB15-1201**

**Part 3, 5.6**

### FORM “R” LOG FORM REGISTRATION LOG

The “R” or “NR” Certificate Holders shall maintain a **single log or multiple logs** documenting unique and
sequentially numbered Form "R" Reports (e.g., R-1, R-2, and R-3) that are registered with the National Board. The logs shall include, as a minimum, form type (R-1, R-2, NR-1, etc.), description of work performed, date completed, and date report sent to the National Board.

**NB11-0401 Part 3, Figure 5.7.5-e**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

**FIGURE 5.7.5-e**

REQUIRED MARKINGS FOR REPAIR OF ASME/NATIONAL BOARD "V," "UV," AND "HV"-STAMPED PRESSURE RELIEF VALVES

Note 1: To be indicated only when changed.

**NB16-1501 Part 3, Figure 5.7.5-f**

**FIGURE 5.7.5-f**

REQUIRED MARKINGS FOR NUCLEAR REPAIRS OR REPLACEMENTS

Note: To be indicated only when changed.

**NB11-0401 Part 3, Figure 5.7.5-g**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

**FIGURE 5.7.5-g**

REQUIRED MARKINGS FOR REPAIR OR REPLACEMENT OF NUCLEAR PRESSURE RELIEF VALVES
Required Markings for Repair or Replacement of Nuclear Pressure Relief Valves

**Note 1:**
Not required when the scope of work does not change the Minimum Required Relieving Capacity.

**Note 2:**
If the line identifying Minimum Required Relieving Capacity is represented on the nameplate and the scope of work does not affect the Minimum Required Relieving Capacity, the line shall be “X’d” to represent “no change.”

**Note 3:**
Minimum Required Relieving Capacity may be abbreviated to M.R.R.C.

---

**FIGURE 5.7.5-g**

**REQUIRED MARKINGS FOR REPAIR OR REPLACEMENT OF NUCLEAR PRESSURE RELIEF VALVES**

<table>
<thead>
<tr>
<th>NATIONAL BOARD CERTIFICATE NO.</th>
<th>CERTIFICATE HOLDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NATO REFERENCES</td>
<td>COMPLETED IN ACCORDANCE WITH ASME SECTION XI</td>
</tr>
<tr>
<td>REPAIR</td>
<td>SET PRESSURE</td>
</tr>
<tr>
<td>REPLACEMENT</td>
<td>CAPACITY (IF CHANGED IN SET PRESSURE)</td>
</tr>
<tr>
<td>NOTCH</td>
<td>AUS CRI</td>
</tr>
</tbody>
</table>

---

**Part 3, 5.12**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

**5.12 STAMPING REQUIREMENTS FOR PRESSURE RELIEF DEVICES**

**Part 3, 5.12.1**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

**5.12.1 NAMEPLATES**

Proper marking and identification of tested or repaired valves is critical to ensuring acceptance during subsequent inspections, and also provide for traceability and identification of any changes made to the valve. All operations that require the valve’s seals to be replaced shall be identified by a nameplate as described in NBIC Part 3, 5.12.2 or 5.12.4.

**Part 3, 5.12.2**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

**5.12.2 REPAIR NAMEPLATE**

When a pressure relief valve is repaired, a metal repair nameplate stamped with the information required below shall be securely attached to the valve adjacent to the original manufacturer’s stamping or nameplate. If not mounted directly on the valve, the nameplate shall be securely attached so as not to interfere with valve operation and sealed in accordance with the quality system.

Prior to attachment of the repair nameplate, the previous repair nameplate, if applicable, shall be removed from the repaired valve.

As a minimum, the information on the valve repair nameplate (see NBIC Part 3, Figure 5.7.5-e) shall include:

The name of the repair organization preceded by the words “repaired by:”
The "VR" repair symbol stamp and the "VR" certificate number;
Unique identifier (e.g., repair serial number, shop order number, etc.);
Date of repair;
Set pressure;
Capacity and capacity units (if changed from original nameplate due to set pressure or service fluid change);
Type/Model number (if changed from original nameplate by a conversion. See NBIC Part 3, S7.2); and
When an adjustment is made to correct for service conditions of superimposed back pressure and/or temperature or the differential between popping pressure between steam and air (see NBIC Part 3, 4.5.2), the information on the valve repair nameplate shall include the:
Cold Differential Test Pressure (CDTP); and
Superimposed Back Pressure (BP) (only when applicable).

NB11-0401 Part 3, 5.12.3
* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

5.12.3 CHANGES TO ORIGINAL PRESSURE RELIEF VALVE NAMEPLATE INFORMATION

If the set pressure is changed, the set pressure, capacity, and blowdown, if applicable, on the original nameplate or stamping shall be marked out, but left legible. The new capacity shall be based on that for which the valve was originally certified.
If service fluid is changed, the capacity, including units, on the original nameplate or stamping shall be marked out, but left legible. The new capacity shall be based on that for which the valve was originally certified, or if a conversion has been made, as described in NBIC Part 3, S7.2 on the capacity certification for the valve as converted.
If the Type/Model number is changed, the Type/Model number on the original nameplate shall be marked out, but left legible.
If the blowdown is changed, the blowdown on the original nameplate or stamping shall be marked out, but left legible. The new blowdown may be based on the current ASME Code requirements.
Incorrect information on the original manufacturer’s nameplate shall be marked out, but left legible. Corrected information shall be indicated on the repair nameplate and noted on the document as required by the quality system.

NB11-0401 Part 3, 5.12.4
* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

5.12.4 TEST ONLY NAMEPLATE

Where a valve has been tested and adjusted to restore the nameplate set pressure, as permitted by NBIC Part 3, S7.10.1, but not otherwise repaired, a “Test Only" nameplate shall be applied that contains the following information:
Name of responsible organization;
Date of test;
Set Pressure; and
Identification, such as “Test Only.”
A “Test Only" nameplate is also recommended when periodic testing has been performed, even when no adjustments have been made, for the purpose of identifying the date the valve was tested.
The existing repair nameplates, if applicable, shall not be removed during such testing.

NB11-0401 Part 3, 5.12.5
* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

5.12.5 REPLACEMENT OF ILLEGIBLE OR MISSING NAMEPLATES

a) Illegible Nameplates

When information on the original manufacturer’s or assembler’s nameplate or stamping is illegible, but traceability can be confirmed, the nameplate or stamping will be augmented by a nameplate
furnished by the “VR” Stamp Holder stamped “Duplicate.” It shall contain all information that originally appeared on the nameplate or valve, as required by the applicable section of the ASME Code, except the “V,” “HV,” or “UV” symbol and the National Board mark. The repair organization’s nameplate, with the “VR” stamp and other required data specified in NBIC Part 3, 5.12.2, will make the repairer responsible to the owner and the Jurisdiction that the information on the duplicate nameplate is correct.

b) Missing Nameplates

When the original valve nameplate is missing, the repair organization is not authorized to perform repairs to the valve under the “VR” program, unless positive identification can be made to that specific valve and verification that the valve was originally stamped with an ASME “V” or “UV” symbol or marked with an ASME “HV” symbol. Valves that can be positively identified will be equipped with a duplicate nameplate, as described in this section, in addition to the repairer’s “VR”-stamped nameplate. The repairer’s responsibilities for accurate data, as defined in NBIC Part 3, 5.12.5 a) shall apply.

c) Marking of Original Code Stamp

When a duplicate nameplate is affixed to a valve, as required by this section, it shall be marked “Sec. I,” “Sec. IV,” or “Sec. VIII,” as applicable, to indicate the original ASME Code stamping.
1. **WORK PERFORMED BY:**
   (name of repair organization)
   (address)

2. **OWNER:**
   (name)
   (address)

3. **LOCATION OF INSTALLATION:**
   (name)
   (address)

4. **ITEM IDENTIFICATION:**
   (boiler, pressure vessel, or piping)
   **NAME OF ORIGINAL MANUFACTURER:**

5. **IDENTIFYING NOS:**
   (Infra serial no.)
   (National Board no.)
   (jurisdiction no.)
   (other) (year built)

6. **NBIC EDITION/ADDENDA:**
   (edition)
   (addenda)

   Original Code of Construction for Item:
   (name / section / division)
   (edition / addenda)

   Construction Code Used for Repair Performed:
   (name / section / division)
   (edition / addenda)

7. **REPAIR TYPE:**
   - [ ] welded
   - [ ] graphite pressure equipment
   - [ ] FRP pressure equipment
   - [x] DOT

8. **DESCRIPTION OF WORK:**
   - [ ] Form R-4, Report Supplementary Sheet is attached
   - [ ] FFSA Form (NB-403) is attached
   - [ ] Other (use Form R-4, if necessary)

9. **REPLACEMENT PARTS:** (Attached are Manufacturer’s Partial Data Reports or Form R-3 if properly completed for the following items of this report):
   (name of part, item number, data report type or certificate of Conformance, ltd./name and identifying stamp)

10. **REMARKS:**

---

Liquid, Pneumatic, Vacuum, Leak

Pressure Test, if applied: __________ psi
M A W P: __________ psi

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors - 1055 Crupper Avenue, Columbus, Ohio 43229-1183
CERTIFICATE OF COMPLIANCE

I, ____________________________, certify that to the best of my knowledge and belief the statements made in this report are correct and that all material, construction, and workmanship on this Repair conforms to the National Board Inspection Code. National Board "R" Certificate of Authorization No. ____________________________, expires on ____________________________, Name of repair organization: ____________________________, Authorized representative: ____________________________,

Date ____________________________, Signed ____________________________,

CERTIFICATE OF INSPECTION

I, ____________________________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of ____________________________, and employed by ____________________________, have inspected the work described in this report on ____________________________, and state that to the best of my knowledge and belief, this work complies with the applicable requirements of the National Board Inspection Code. By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Date ____________________________, Signed ____________________________,

(Inspector) ____________________________, (National Board and Jurisdiction no., including endorsement)
<table>
<thead>
<tr>
<th>1a. DESIGN PERFORMED BY:</th>
<th>(name of &quot;R&quot; organization responsible for design)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(ID no., job no., etc.)</td>
</tr>
<tr>
<td></td>
<td>(address)</td>
</tr>
<tr>
<td>1b. CONSTRUCTION PERFORMED BY:</td>
<td>(name of &quot;R&quot; organization responsible for construction)</td>
</tr>
<tr>
<td></td>
<td>(address)</td>
</tr>
<tr>
<td>2. OWNER OF PRESSURE RETAINING ITEM:</td>
<td>(name)</td>
</tr>
<tr>
<td></td>
<td>(address)</td>
</tr>
<tr>
<td>3. LOCATION OF INSTALLATION:</td>
<td>(name)</td>
</tr>
<tr>
<td></td>
<td>(address)</td>
</tr>
<tr>
<td>4. ITEM IDENTIFICATION:</td>
<td>NAME OF ORIGINAL MANUFACTURER:</td>
</tr>
<tr>
<td>(boiler, pressure vessel, or piping)</td>
<td></td>
</tr>
<tr>
<td>5. IDENTIFYING NOS:</td>
<td>(National Board no.)</td>
</tr>
<tr>
<td>(ref. serial no.)</td>
<td>(jurisdiction no.)</td>
</tr>
<tr>
<td>(other)</td>
<td>(year built)</td>
</tr>
<tr>
<td>6. NBIC EDITION/ADDENDA:</td>
<td>(edition)</td>
</tr>
<tr>
<td>(addenda)</td>
<td></td>
</tr>
<tr>
<td>Original Code of Construction for Item:</td>
<td>(name / section / division)</td>
</tr>
<tr>
<td>(edition / addenda)</td>
<td></td>
</tr>
<tr>
<td>Construction Code Used for Alteration Performed:</td>
<td>(name / section / division)</td>
</tr>
<tr>
<td>(edition / addenda)</td>
<td></td>
</tr>
<tr>
<td>7a. DESCRIPTION OF DESIGN SCOPE:</td>
<td>☐ Form R-4, Report Supplementary Sheet is attached</td>
</tr>
<tr>
<td>7b. DESCRIPTION OF CONSTRUCTION SCOPE:</td>
<td>☐ Form R-4, Report Supplementary Sheet is attached</td>
</tr>
<tr>
<td>Pressure Test, if applied</td>
<td>psi</td>
</tr>
<tr>
<td>MAWP</td>
<td>psi</td>
</tr>
</tbody>
</table>

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors - 1855 Grupper Avenue, Columbus, Ohio 43220-1183.
8. REPLACEMENT PARTS: (Attached are Manufacturer’s Partial Data Reports or Form R-3’s properly completed for the following items of this report):

   (name of part, item number, data report type or Certificate of Compliance, etc., name and identifying stamp)

9. REMARKS:

   

   ![Design Certification]

   ![Certificate of Design Change Review]

   ![Construction Certification]

   ![Certificate of Inspection]

   National Board and Jurisdiction No. including endorsement
# FORM R-3 REPORT OF PARTS FABRICATED BY WELDING

In accordance with provisions of the National Board Inspection Code

1. MANUFACTURED BY: 
   (name of “NB” certificate holder) 
   (address) 

2. MANUFACTURED FOR: 
   (name) 
   (address) 

3. DESIGN CONDITION SPECIFIED BY: 
   CODE DESIGN BY: 

4. DESIGN CODE: 

5. REPAIR/ALTERATION/MODIFICATION ACTIVITIES 

<table>
<thead>
<tr>
<th>Name of Part</th>
<th>Qty.</th>
<th>Line No.</th>
<th>Manufacturer’s Identifying No.</th>
<th>Manufacturer’s Drawing No.</th>
<th>MAWP</th>
<th>Shop Hydro PSI</th>
<th>Year Built</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. DESCRIPTION OF PARTS 

(a) Connections other than tubes

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Size and Shape</th>
<th>Material Spec No.</th>
<th>Thickness (in.)</th>
<th>Heads or Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Tubes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. REMARKS:

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors - 1005 Crupper Avenue, Columbus, Ohio 43229-1183
CERTIFICATE OF COMPLIANCE

I, ____________________________, certify that to the best of my knowledge and belief the statements made in this report are correct and that all material, fabrication, construction, and workmanship of the described parts conforms to the National Board Inspection Code and the standards of construction cited.

National Board "W" Certificate of Authorization No. ____________________________ expires on: ____________________________

Date ____________________________ Signed ____________________________

(National Board and Jurisdiction no., including endorsement)

CERTIFICATE OF INSPECTION

I, ____________________________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of ____________________________ and employed by ____________________________ have inspected the part described in this report on ____________________________ and state that to the best of my knowledge and belief the parts comply with the applicable requirements of the National Board Inspection Code.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Date ____________________________ Signed ____________________________

(Inspector) (Commission) (National Board and Jurisdiction no.)
GUIDE FOR COMPLETING NATIONAL BOARD FORM NR-1 REPORT OF REPAIR/REPLACEMENT ACTIVITIES FOR NUCLEAR FACILITIES

Title Block: Check Category of Activity: 1, 2, or 3
Check type of activity, repair, replacement, alteration/modification, and/or re-rating, as applicable.

1) Name and address of the organization, as shown on the National Board “NR” Certificate of Authorization, which performed the activity.
2) Indicate “NR” Form Registration Number.
3) Indicate the purchase order number, job number, etc., as applicable, assigned by the organization that performed the work.
4) Name and address of the owner of the nuclear power plant.
5) Name and address of the nuclear power plant and, if applicable, identification of the unit.
6) Identify the system (e.g., residual heat removal, reactor coolant) with which the repair, replacement, alteration/modification, or rerating activity is associated.
7) ASME Code Section XI or Section III, as applicable to the repairs, alterations/modification, replacement or rerating activity performed.
8) Name of the organization, as shown on the Certificate of Authorization, which performed the design activity including:
   a. Original Design Specification Number and Revision Number.
   b. Original Design Report Number and Revision Number.
   c. Revised Design Specification Number and Revision Number.
   d. Revised Design Report Number and Revision Number.
   e. Design Reconciliation Number and Revision Number.
   f. Applicable Code Edition and Addenda Date(s).
9) Check the type of test conducted (e.g., hydrostatic, pneumatic, system leakage, exempt, or other) and indicated the pressure applied when applicable.
10) Sequential number assigned to each item reported.
11) Indicate the type of component (e.g., vessel, line valve, pump, piping system).
12) Manufacturer’s name of the affected item.
13) Manufacturer’s serial number.
14) National Board number, if applicable, of the affected item.
15) Indicate Jurisdictional number, if applicable, of the affected item.
16) Indicate plant tag or identification number, if applicable, of the affected item.
17) Year the affected item was manufactured.
18) Identify the name, section, and division of the original construction code for the affected item.
19) Identify the edition, addenda, and as applicable, code cases, and class of the original construction code for the affected item.
20) Indicate the activity performed on this item (e.g., repair, alteration or modification).
21) Manufacturer’s name of this replacement item.
22) Manufacturer’s serial number of this replacement item.
23) National Board number, if applicable, of this replacement item.
24) Indicate plant tag or identification number, if applicable, of this replacement item.
25) Year this replacement item was manufactured.
26) Identify the name, section, and division of the original construction code for this replacement item.
27) Identify the edition, addenda, and as applicable, code cases and class of the original construction code for this replacement item.
28) Provide a detailed summary describing the scope of work completed. Information to be considered should include type of work (e.g., welding, brazing, fusing), location, steps taken for removal or acceptance of defects, examinations, testing, heat treat, and other special processes or methods utilized. If necessary, attach additional data, sketch, drawing, Form R-4, etc. If additional data is attached, so state in the “remarks” section.
29) Indicate any additional information pertaining to the work.
30) Type or print name of authorized representative from the certificate holder.
31) Indicate ASME Section III or Section XI as applicable to the repair, replacement, alteration/modification, and/or rerating activity performed.

32) Indicate National Board Certificate of Authorization number.

33) Indicate month, day, and year the certificate expires.

34) Name of the organization that performed the identified work, using the full name as shown on the Certificate of Authorization, or an abbreviation acceptable to the National Board.

35) Indicate month, day and year of signature by the Authorized Representative.

36) Signature of authorized representative from the certificate holder defined in item 30 above.

37) Title of authorized representative as defined in the Quality Program.

38) Name of the organization that performed the identified work, using the full name as shown on the Certificate of Authorization, or an abbreviation acceptable to the National Board.

39) Indicate the Jurisdiction where the activity is performed, when required.

40) Authorized Nuclear Inspector's employer.

41) Indicate address of Authorized Nuclear Inspector's employer (city and state or province).

42) Indicate month, day, and year of inspection by the Authorized Nuclear Inspector.

43) Indicate month, day, and year of signature by the Authorized Nuclear Inspector.

44) Signature of Authorized Nuclear Inspector defined in item 38 above.

National Board Commission number and required endorsements.

This guide is to be used when completing the National Board Form NR-1, Report of Repair/Replacement Activities for Nuclear Facilities. When computer generated, the form shall replicate the content and format of the information depicted on the Form NR-1, Report of Repair/Replacement Activities for Nuclear Facilities.

Title Block: Check type of activity, repair/replacement and/or rerating, as applicable.

Check category of activity, 1, 2, or 3, as described in Part 3, Paragraph 1.8.2.

1. Name and address of the organization, as shown on the National Board "NR" Certificate of Authorization which performed the activity.

2. Indicate NR Form Registration Number.

3. Indicate the original construction code, edition/addenda used for the system or component identified in line 4.

4. NBIC Edition used for performing activities specified on this form.

5. Organization having responsibility for design when there is a change from the original design specification.

6. Identify code edition/addenda used for design, when applicable.

7. Check the type of test conducted (e.g., hydrostatic, pneumatic, system leakage, exempt, or other) and indicate the pressure applied when applicable.

8. Indicate the number of components where work was performed. Each component shall be indicated on page 2 of the form NR-1.

9. Provide a detailed summary describing the scope of work completed. Information to be considered should include type of work (welding, brazing, fusing), location, steps taken for removal or acceptance of defects, examinations, testing, heat treat, and other special processes or methods utilized. If necessary, attach additional data, sketch, drawing, Form R-4, etc. in the remarks section state if additional data is attached.

10. Indicate any additional information pertaining to the work, including manufacturer's data reports.

11. Number in sequence beginning with No. 1 to identify each component work was performed. This number may be used to correspond with the detailed description of work performed.

12. Indicate the type of item, i.e., piping, pump, valve, etc.
18. Identify the manufacturer’s name of component.
19. Identify the manufacturer’s serial no, or other assigned number for traceability.
20. Identify the National Board registration number, if previously assigned.
21. Identify the code class criteria, as assigned for each component.
22. Identify the code section used to perform work.
23. Identify Code section year and/or addenda used to perform work.
24. Identify any code cases used for work performed.
25. Identify any revisions to be made to the design specifications or if any design reconciliations were performed.
26. Type or print name of authorized representative from the certificate holder.
27. Name of the organization that performed the identified work, using the full name as shown on the Certificate of Authorization, or an abbreviation acceptable to the National Board.
28. Indicate code section as applicable to the repair/replacement activity and/or re-rating activity performed.
30. Indicate month, day, and year the certificate expires.
31. Signature of authorized representative from the NR certificate holder.
32. Indicate month, day and year of signature by the Authorized Representative.
33. Title of authorized representative as defined in the Quality Program.
34. Type or print name of Authorized Nuclear Inspector.
35. Indicate the Jurisdiction where the activity is performed, when required.
36. Indicate Authorized Nuclear Inspector’s employer.
37. Indicate month, day, and year of inspection by the Authorized Nuclear Inspector.
38. Signature of Authorized Nuclear Inspector.
39. Indicate month, day, and year of signature by the Authorized Nuclear Inspector.
40. National Board Commission number and required endorsements.

**NB16-0605**

**Part 3, 5.13.6.1**

**GUIDE FOR COMPLETING NATIONAL BOARD FORM NR-1 AND NVR-1 REPORTS OF REPAIR/REPLACEMENT ACTIVITIES FOR NUCLEAR PRESSURE RELIEF DEVICES**

**Title Block:** Check Category of Activity: 1, 2, or 3

Check type of activity, repair, replacement, alteration/ modification, and/or re-rating, as applicable.

1. Name and address of the organization, as shown on the National Board “VR” and “NR” Certificates of Authorization, which performed the activity.
2. Indicate “NVR” Form Registration Number.
3. Indicate the purchase order number, job number, etc., as applicable, assigned by the organization that performed the work.
4. Name and address of the organization for which the work was performed.
5. Name and address of the owner of the nuclear power plant.
6. Name and address of the nuclear power plant and, if applicable, identification of the unit.
7. Describe the type of pressure relief device (e.g., safety valve, safety relief valve, pressure relief valve).
8. Manufacturer’s name of the affected item.
9. Indicate the pressure relief device by the manufacturer’s valve series or catalog number.
10. Manufacturer’s serial number of the affected item.
11. National Board number, if applicable, of the affected item.
12. Indicate the service as steam, liquid, air/gas, etc.
13. Indicate the pressure relief device by inlet size, in inches.
14. Year the affected item was manufactured.
15. Indicate the name, section and division of the original construction code for the affected item.
16. Identify the edition, addenda, and as applicable, code cases, and class of the original construction code for the affected item.
17. Identify the edition, addenda, and as applicable, code cases of the ASME Section XI code for the in-service inspection activity.
18) Identify the edition, addenda, and as applicable, code cases of the ASME Section XI code for the repair/replacement activity.
19) Identify the edition, addenda, and as applicable, code cases of the construction code for the repair/replacement activity.
20) Identify the organization responsible for design or design reconciliation, if applicable.
21) Indicate the set pressure of the valve.
22) Indicate the blowdown, if applicable, as a percentage of set pressure.
23) Indicate repair organization’s name and address.
24) Indicate medium (steam, air, etc.) used for the adjustment of the set pressure and, if applicable, blowdown.
25) Provide a detailed summary describing the scope of work completed. Information to be considered should include type of work (welding, brazing, fusing), location, steps taken for removal or acceptance of defects, examinations, testing, heat treat, and other special processes or methods utilized. If necessary, attach additional data, sketch, drawing, Form R-4, etc. If additional data is attached, so state in the remarks section.
26) Indicate any additional information pertaining to the work.
27) Type or print name of authorized representative from the certificate holder.
28) Indicate ASME Section XI or construction code as applicable to the repair, replacement, and/or rerating activity performed.
29) Indicate National Board Certificate of Authorization number.
30) Indicate month, day, and year the certificate expires.
31) Indicate month, day, and year of signature by the authorized representative.
32) Signature of authorized representative from the certificate holder defined in item 27 above.
33) Title of authorized representative as defined in the Quality Program.
34) Type or print name of Authorized Nuclear Inspector.
35) Indicate the Jurisdiction where the activity is performed, when required.
36) Indicate Authorized Nuclear Inspector’s employer.
37) Indicate address of Authorized Nuclear Inspector’s employer (city and state or province).
38) Indicate month, day, and year of inspection by the Authorized Nuclear Inspector.
39) Indicate month, day, and year of signature by the Authorized Nuclear Inspector.
40) Signature of Authorized Nuclear Inspector identified in item 34 above.

This guide is to be used when completing the National Board Form NVR-1, Report of Repair/Replacement Activities for Nuclear Pressure Relief Devices. When computer generated, the format of the form shall replicate the type and relative location of the information depicted on the Form NVR-1, Report of Repair/Replacement Activities for Nuclear Pressure Relief Devices.

Title Block: Check type of activity, repair/replacement, as applicable.

Check category of activity, 1, 2, or 3, as described in Part 3, Paragraph 1.8.2.

1. Name and address of the organization, as shown on the National Board “VR” and “NR” Certificates of Authorization, which performed the activity.
2. Indicate NVR Form Registration Number.
3. Indicate the repair/replacement plan number, job number, etc., as applicable for traceability, assigned by the organization that performed the work.
4. Name and address of the organization for which the work was performed.
5. Name and address of the owner nuclear facility.
6. Name and address of the nuclear facility and, if applicable, identification of the unit.
7. Identify the edition, addenda, and as applicable, code cases of the code used for the in-service inspection activity.
8. Identify the edition, addenda, and as applicable, code cases of the code used for the repair/replacement activity.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>Identify the NBIC edition used for the repair/replacement activity.</td>
</tr>
<tr>
<td>10.</td>
<td>Identify the organization responsible for design or design reconciliation, if applicable.</td>
</tr>
<tr>
<td>11.</td>
<td>Indicate the set pressure of the valve.</td>
</tr>
<tr>
<td>12.</td>
<td>Indicate the blowdown, if applicable, as a percentage of set pressure.</td>
</tr>
<tr>
<td>13.</td>
<td>Indicate the location of testing.</td>
</tr>
<tr>
<td>14.</td>
<td>Indicate medium (steam, air, etc.) used for the adjustment of the set pressure and, if applicable, blowdown.</td>
</tr>
<tr>
<td>15.</td>
<td>Provide a detailed summary describing the scope of work completed. Information to be considered should include type of work (welding, brazing, fusing), location, steps taken for removal or acceptance of defects, examinations, testing, heat treat, and other special processes or methods utilized. If necessary, attach additional data, sketch, drawing, Form R-4, etc. If additional data is attached, state in the remarks section.</td>
</tr>
<tr>
<td>16.</td>
<td>Indicate any additional information pertaining to the work, such as, additional documentation that is attached to this form to further support item 15.</td>
</tr>
<tr>
<td>17.</td>
<td>Manufacturer's name of the affected item.</td>
</tr>
<tr>
<td>18.</td>
<td>Describe the type of pressure relief device (e.g., safety valve, safety relief valve, pressure relief valve).</td>
</tr>
<tr>
<td>19.</td>
<td>Manufacturer's serial number of the affected item.</td>
</tr>
<tr>
<td>20.</td>
<td>National Board number, if applicable, of the affected item.</td>
</tr>
<tr>
<td>21.</td>
<td>Indicate the service as steam, liquid, air/gas, etc.</td>
</tr>
<tr>
<td>22.</td>
<td>Indicate the pressure relief device by inlet size, in inches.</td>
</tr>
<tr>
<td>23.</td>
<td>Indicate the year the affected item was manufactured.</td>
</tr>
<tr>
<td>24.</td>
<td>Indicate the name, section and division of the original construction code for the affected item.</td>
</tr>
<tr>
<td>25.</td>
<td>Indicate the code class for the affected item as applicable, i.e., Class 1, 2 or 3.</td>
</tr>
<tr>
<td>26.</td>
<td>Indicate the construction code edition for the affected item.</td>
</tr>
<tr>
<td>27.</td>
<td>Indicate the construction code addenda, as applicable, for the affected item.</td>
</tr>
<tr>
<td>28.</td>
<td>Indicate any applicable code cases used for manufacturing of the affected item.</td>
</tr>
<tr>
<td>29.</td>
<td>Name of the replacement part.</td>
</tr>
<tr>
<td>30.</td>
<td>Identifying number of the replacement part.</td>
</tr>
<tr>
<td>31.</td>
<td>Number/quantity of each replacement part used.</td>
</tr>
<tr>
<td>32.</td>
<td>Indicate the Serial number or other traceability used by the manufacturer of the replacement part.</td>
</tr>
<tr>
<td>33.</td>
<td>Type or print name of authorized representative from the certificate holder.</td>
</tr>
<tr>
<td>34.</td>
<td>Indicate code as applicable to the repair/replacement activity performed.</td>
</tr>
<tr>
<td>35.</td>
<td>Indicate National Board Certificate of Authorization number, if applicable for the “VR” Stamp.</td>
</tr>
<tr>
<td>36.</td>
<td>Indicate month, day, and year the certificate expires, if applicable for the “VR” Stamp.</td>
</tr>
<tr>
<td>37.</td>
<td>Indicate National Board Certificate of Authorization number, if applicable for the “NR” Stamp.</td>
</tr>
<tr>
<td>38.</td>
<td>Indicate month, day, and year the certificate expires, if applicable for the “NR” Stamp.</td>
</tr>
<tr>
<td>39.</td>
<td>Signature of authorized representative from the certificate holder defined in item 27 above.</td>
</tr>
<tr>
<td>40.</td>
<td>Indicate month, day, and year of signature by the authorized representative.</td>
</tr>
<tr>
<td>41.</td>
<td>Title of authorized representative as defined in the Quality Program.</td>
</tr>
<tr>
<td>42.</td>
<td>Type or print name of Authorized Nuclear Inspector.</td>
</tr>
<tr>
<td>43.</td>
<td>Indicate the Jurisdiction where the activity is performed, when required.</td>
</tr>
<tr>
<td>44.</td>
<td>Indicate Authorized Nuclear Inspector’s employer.</td>
</tr>
<tr>
<td>45.</td>
<td>Indicate address of Authorized Nuclear Inspector’s employer (city and state or province).</td>
</tr>
<tr>
<td>46.</td>
<td>Indicate month, day, and year of inspection by the Authorized Nuclear Inspector.</td>
</tr>
<tr>
<td>47.</td>
<td>Signature of Authorized Nuclear Inspector defined in item 42 above.</td>
</tr>
<tr>
<td>48.</td>
<td>Indicate month, day, and year of signature by the Authorized Nuclear Inspector.</td>
</tr>
<tr>
<td>49.</td>
<td>National Board Commission number and required endorsements.</td>
</tr>
</tbody>
</table>
**FORM NR-1, REPORT OF REPAIR/REPLACEMENT ACTIVITIES FOR NUCLEAR FACILITIES**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Work Performed by:</td>
</tr>
<tr>
<td>2.</td>
<td>Owner:</td>
</tr>
<tr>
<td>3.</td>
<td>Name, address and identification of nuclear facility:</td>
</tr>
<tr>
<td>4.</td>
<td>System/Component:</td>
</tr>
<tr>
<td>5.</td>
<td>Construction Code, Section &amp; Edition/Addenda and Applicable Code Cases used for the system or component:</td>
</tr>
<tr>
<td>6.</td>
<td>NBIC edition used for performing repairs/replacement or re-rating activity:</td>
</tr>
<tr>
<td>7.</td>
<td>Design responsibility:</td>
</tr>
<tr>
<td>8.</td>
<td>Tests conducted:</td>
</tr>
<tr>
<td>9.</td>
<td>Number of components repaired/replaced and/or re-rated (refer to Page 2):</td>
</tr>
<tr>
<td>10.</td>
<td>Description of work (use of properly identified additional sheet[s] or sketch[es] is acceptable):</td>
</tr>
<tr>
<td>11.</td>
<td>Remarks:</td>
</tr>
</tbody>
</table>
## COMPONENT IDENTIFICATION

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Item</th>
<th>Mfg. Name</th>
<th>Serial No.</th>
<th>Nat'l Board No.</th>
<th>Code Class</th>
<th>Code Section</th>
<th>Year/ Addenda</th>
<th>Code Case</th>
<th>Revised Design Specification No./Rev. or Design Reconciliation No./Rev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CERTIFICATE OF COMPLIANCE

I, _______________________, employed by _______________________, certify that to the best of my knowledge and belief the statements made in this report are correct and the repair/replacement activities or re-rating described above conform to _______________________, and the National Board Inspection Code "NR" rules.

National Board Certificate of Authorization No. ________________________ Expiration date: ________________________

Signed: ________________________ Date: ________________________
(Authorized Representative)

Title: ________________________

CERTIFICATE OF INSPECTION

I, ________________________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of ________________________, and employed by ________________________, have inspected the repair/replacement and/or re-rating activities described in this report on ____________ and state to the best of my knowledge and belief, these activities have been completed in accordance with the Codes specified and the National Board Inspection Code "NR" rules.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Signed: ________________________ Date: ________________________ Commissions: ________________________
(Inspector) (National Board and Endorsement)
**FORM NVR-1, REPORT OF REPAIR/REPLACEMENT ACTIVITIES FOR NUCLEAR PRESSURE RELIEF DEVICES**

<table>
<thead>
<tr>
<th>REPAIR</th>
<th>REPLACEMENT</th>
<th>CATEGORY OF ACTIVITY:</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
</table>

1. Work Performed by: 
   - Name of N/A-authorized organization:  
   - Address:  
   - NVR-Form Registration No.:  
   - RA Plan No., Job No., etc.:  

2. Work performed for: 
   - Name:  
   - Address:  

3. Owner: 
   - Name:  
   - Address:  

4. Name, address and identification of nuclear facility: 
   - Name:  
   - Address/Unit identification:  

5. Code applicable for in-service inspection:  
   - Edition:  
   - Addenda:  
   - Code Case No.:  

6. Code used for repair/replacement activity: 
   - Edition:  
   - Addenda:  
   - Code Case No.:  

7. NBIC used for repair/replacement activity: 
   - Edition:  
   - Addenda:  
   - Code Case No.:  

8. Design responsibility:  

9. **Repaired Pressure Relief Device: See Page 2** 

10. Opening pressure:  
    Blowdown (if applicable):  

11. Set pressure and blowdown adjustment made at:  
    using  

12. Description of work (include name and identifying number of replacement parts):  

13. Remarks:  

---

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1015 Grupper Ave., Columbus, OH 43229

Page 1 of 3  
NB-160, Rev. B
Work Performed by:

<table>
<thead>
<tr>
<th>Name of &quot;NR&quot; certificate holder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address of &quot;NR&quot; certificate holder</td>
</tr>
</tbody>
</table>

NRNI Form Registration No.

Pressure Relief Device:

<table>
<thead>
<tr>
<th>Name of Mfg.</th>
<th>Type</th>
<th>Mfg Serial No.</th>
<th>National Board No.</th>
<th>Service</th>
<th>Size</th>
<th>Year Built</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>23</td>
</tr>
</tbody>
</table>

Construction Code:

<table>
<thead>
<tr>
<th>Section</th>
<th>Class</th>
<th>Edition</th>
<th>Addenda</th>
<th>Code Case(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
</tr>
</tbody>
</table>

Name and Identifying Number of Replacement Parts:

<table>
<thead>
<tr>
<th>No.</th>
<th>Part Name</th>
<th>Part Number</th>
<th>Quantity</th>
<th>Serial Number/Traceability No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part 3, S1.1

SCOPE

This supplement provides requirements and guidelines for repair and alteration applies to all boilers attached to or of steam locomotives operating on track gaged 24 in. (610 mm) or greater or for steam locomotives under the requirements of the Federal Railroad Administration (FRA). These rules shall be
used in conjunction with the applicable rules of the NBIC.

**S1.1.1  FEDERAL RAILROAD ADMINISTRATION (FRA)**

The Federal Railroad Administration (FRA) rules for steam locomotive boilers are published in the Code of Federal Regulations (CFR) 49CFR Part 230, dated November 17, 1999, [which may be obtained on the FRA website](#). All locomotives under FRA jurisdiction are documented on FRA Form 4 as defined in 49CFR Part 230. This document is the formal documentation of the steam locomotive boiler and is required to be completed prior to the boiler being placed in service. This document shall be used as the data report for the boiler, applicable to all repairs and alterations performed. National Board “R” Certificate Holders shall document their repairs and/or alterations on National Board Forms R-1 or R-2. These reports shall be distributed to the owner-user of the boiler, who is required to incorporate them into a FRA Form 19, which becomes an attachment to the FRA Form 4. The design margin for all such repairs or alterations shall not be less than four, based on ultimate tensile strength of the material.

Steam locomotive inspection and maintenance standards, which is now codified at 49 CFR Part 230, [may be obtained at the FRA website](#).

**TABLE S1.1.3.1**

<table>
<thead>
<tr>
<th>Application</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler Tubes &amp; Flues, Arch Tubes</td>
<td>SA-178 Grade A, SA-192, SA-210</td>
</tr>
<tr>
<td>Superheater Units</td>
<td></td>
</tr>
<tr>
<td>Boiler &amp; Firebox Plate, Pressure Retaining Plate</td>
<td>SA-285 Grade C, SA-515, SA-516, SA-203, SA-204</td>
</tr>
<tr>
<td>Welded Staybolts</td>
<td>SA-675, SA-36, SA-31-Grade B</td>
</tr>
<tr>
<td>Threaded Staybolts and Patch Bolts</td>
<td>SA-31 Grade A</td>
</tr>
<tr>
<td></td>
<td>SA-675 with a tensile strength of 47,000 psi to 65,000 psi inclusive</td>
</tr>
<tr>
<td>Staybolt Sleeves and Caps</td>
<td>SA-105 Forging, SA-675, <a href="#">SA-696</a></td>
</tr>
<tr>
<td>Boiler Braces</td>
<td>SA-675, SA-36</td>
</tr>
<tr>
<td>Rivets</td>
<td>SA-675, SA-31</td>
</tr>
<tr>
<td>Forged Parts &amp; Fittings</td>
<td>SA-105, SA-181</td>
</tr>
<tr>
<td>Pressure-Retaining Steel Castings</td>
<td>SA-216, <a href="#">SA-217</a></td>
</tr>
<tr>
<td>Hollow Cylindrical Pressure-</td>
<td>SA-105 Forgings, SA-675 Bar Stock, <a href="#">SA-696</a></td>
</tr>
<tr>
<td>Retaining Parts</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Superheater Unit Bolts &amp; Nuts</td>
<td></td>
</tr>
<tr>
<td>Bolts - SA-193, Nuts - SA-194</td>
<td></td>
</tr>
<tr>
<td>Pipe Flanges</td>
<td></td>
</tr>
<tr>
<td>SA-181, SA-105</td>
<td></td>
</tr>
<tr>
<td>Bolts &amp; Studs</td>
<td></td>
</tr>
<tr>
<td>SA-307 Grades A&amp;B</td>
<td></td>
</tr>
<tr>
<td>Pipe</td>
<td></td>
</tr>
<tr>
<td>SA-106, SA-53 seamless</td>
<td></td>
</tr>
<tr>
<td>Bronze Castings &amp; Washout Plugs</td>
<td></td>
</tr>
<tr>
<td>SB-61, SB-62, SB-148</td>
<td></td>
</tr>
</tbody>
</table>

### S1.1.4  FORMULA AND CALCULATIONS FOR STEAM LOCOMOTIVE BOILERS

**a)** Most steam locomotive boilers were manufactured in the first half of the 20th century or before. The calculations, formula, and shop practices used are now distant history and quite difficult to obtain. The rules for riveted construction were last published by ASME in Section I Code, 1971 Edition.

**b)** This supplement herein, is based in part on the ASME Code, Section III, 1952 Edition, which was the last published edition of the Steam Locomotive Code. The railroad industry has attempted to collect the old formula and some shop practices. These have been published by The Engineering Standards Committee for Steam Locomotives, Inc. (ESC) as Compendium, Volume 1, Compilation of Calculations, which may be obtained from the Strasburg Rail Road, P.O. Box 96, Strasburg, PA 17579 (717) 687-7421.  

---

14 This code is available from the National Board.
15 Copies of *The Engineering Standards Committee for Steam Locomotives, Inc., Compendium, Volume 1, Compilation of Calculations*, may be obtained from the Strasburg Rail Road, P.O. Box 96, Strasburg, PA 17579, 717.687.8421.

---

* Editorial Note: Switch captions for the two diagrams
Repairs to un-threaded fillet welded staybolts shall be performed in accordance with the original code of construction. If the original code of construction is not known, repairs shall be performed as follows in accordance with an appropriate code of construction that allows fillet welded staybolts:

a) The replacement of un-threaded fillet-welded staybolts is permissible.

b) Existing un-threaded fillet-welded staybolts that leak shall be repaired by re-welding after mechanically removing the entire weld. Only the leaking stays are to be re-welded.

c) Minor leakages (sweat pores) may be repaired by gently caulking the fillet weld. However, identifiable cracks shall be repaired by re-welding.
### Editorial Note: Switch captions, move “Patch bolts or rivets” arrow to the figure on the right

#### Editorial Note: Switch captions, move “Patch bolts or rivets” arrow to the figure on the right

16  
16—This code is available from the National Board. |
|---|---|
| NB16-0809B | S2.1 SCOPE  
This supplement is provided as a guide. This supplement provides requirements and guidelines for repair and alteration of historical steam boilers of riveted and/or welded construction not falling under the scope of Supplement 1. These historical steam boilers would include: steam tractors, traction engines, hobby steam boilers, portable steam boilers, and other such boilers that are being preserved, restored and |
**Note:** This supplement is not to be used for steam locomotive boilers falling under the requirements of the Federal Railroad Administration (FRA). FRA rules for steam locomotive boilers are published in 49 CFR 230. Specific rules and special requirements for inspection, repairs, alterations, and storage of steam locomotive boilers are identified in NBIC Parts 2 and 3, Supplement 1.

The rules specified in this supplement shall be used in conjunction with the applicable rules in this Code. References specified or contained in this supplement may provide additional information to assist the user when applying the requirements of this supplement.

<table>
<thead>
<tr>
<th>NB11-0204B</th>
<th>S2.11 NONDESTRUCTIVE EXAMINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, S2.11</strong></td>
<td>The Inspector may require nondestructive examination (RT, PT, MT, UT, and VT) as necessary to ensure satisfactory welded repairs have been accomplished.</td>
</tr>
<tr>
<td><strong>The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction for the pressure-retaining item.</strong> Weld repairs and alterations shall be subjected to the same nondestructive examination requirements as the original welds.</td>
<td></td>
</tr>
<tr>
<td>Where the original code of construction is unknown or the NDE method is not possible or practicable, alternative NDE methods may be used. These methods shall be acceptable to the owner, the Inspector and where required, the Jurisdiction of the pressure-retaining item.</td>
<td></td>
</tr>
<tr>
<td><strong>NDE methods used shall be suitable for providing meaningful results to verify the integrity of the repair and alteration.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Exclusive use of visual examination (VT) for repair inspection is only permitted when following the requirements of Part 3, 4.4.1 e).</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0204B</th>
<th>S2.13 REPAIR METHODS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, S2.13</strong></td>
<td><strong>a)</strong> Before performing any welding activity, consideration shall be given to ensure the weldability of historical boiler materials. Materials used for patches shall be made from material that is at least equal in quality and strength to the original material.</td>
</tr>
<tr>
<td><strong>b)</strong> Before a repair is made to a defect in a welded joint or base metal, care should be taken to investigate its cause and to determine its extent and likelihood of recurrence.</td>
<td></td>
</tr>
<tr>
<td><strong>c)</strong> <strong>Except as provided in NBIC Part 3, 3.3.4.8, Aa</strong> repair of a defect, such as a crack in a welded joint or base material, shall not be made until the defect has been removed. A suitable nondestructive examination method such as magnetic particle (MT) or liquid penetrant (PT) may be necessary to assure complete removal of the defect. If the defect penetrates the full thickness of the material, the repair shall be made with a complete penetration weld such as a double buttweld or a single buttweld with or without backing. Where circumstances indicate that the defect is likely to recur, consideration should be given to removing the defective area and installing a flush patch or taking other acceptable, corrective measures acceptable to the Inspector, and when required, the Jurisdiction. A repair of a bulge or blister shall be made if a bulge or blister will affect the pressure-retaining capability of the plate or tube or when evidence of leakage is noted. Defects such as cracks, grooving, and wastage may be repaired by weld buildup, welded repair, a welded flush patch, or a riveted patch as appropriate.</td>
<td></td>
</tr>
<tr>
<td><strong>d)</strong> Welded repairs at or near riveted seams requiring preheating or postweld heat treatment shall be carefully made to prevent loosening in the riveted seams, especially when localized heating is used. Where necessary to control expansion or to gain access for welding, rivets at the defective section and...</td>
<td></td>
</tr>
</tbody>
</table>
Table of Contents:

<table>
<thead>
<tr>
<th>NB16-0501 Part 3, S2.13.2</th>
<th>S2.13.2 INSTALLATION OF THREADED STAYBOLTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Threaded staybolts shall have either 11 or 12 thread pitch. Staybolt threads shall have a close fit in sheets. Changing the staybolt thread pitch from 11 to 12 or the reverse shall be considered a repair.</td>
<td></td>
</tr>
<tr>
<td>b) When staybolts 8 in. (200 mm) or less in length are replaced, they shall be replaced with staybolts that have a telltale hole 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter their entire length or with ones that have a 3/16 in. (5 mm) to 7/32 in. (5.5 mm) diameter hole in each end, drilled a minimum of 1-1/4 in. (31 mm) deep. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. (See NBIC Part 3, Figure S2.13.2).</td>
<td></td>
</tr>
<tr>
<td>b) Replacement of staybolts 8 in. (200 mm) and less in length shall have telltale holes when required by the original code of construction or when replacing staybolts with telltale holes. Telltale hole diameter shall be 3/16 in. (5.0 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred. (see Figure S2.13.2)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB16-0501 Part 3, S2.13.4</th>
<th>S2.13.4 INSTALLATION OF WELDED STAYBOLTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The installation of unthreaded staybolts using full penetration welds is permissible. (See NBIC Part 3, Figure S2.13.4).</td>
<td></td>
</tr>
<tr>
<td>b) Threaded stays may be replaced by welded-in stays provided that, in the judgement of the Inspector, the material adjacent to the staybolt has not been materially weakened by deterioration or wasting away. If staybolt hole is threaded, the threads shall be removed prior to welding.</td>
<td></td>
</tr>
<tr>
<td>c) Replacement of staybolts 8 in. (200mm) and less in length shall have telltale holes when required by the original Code of construction or when replacing staybolts with telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred. (See Figure S2.13.4)</td>
<td></td>
</tr>
<tr>
<td>c) Staybolts shorter than 8 in. (200 mm) in length shall have telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred.</td>
<td></td>
</tr>
<tr>
<td>d) Reuse of welded staybolts is prohibited.</td>
<td></td>
</tr>
<tr>
<td>e) Installation of different diameter staybolts shall be considered a repair.</td>
<td></td>
</tr>
</tbody>
</table>

Editorial

Part 3, Figures S2.13.14.3-a and -b

FIGURE S2.13.14.3-a
FUSIBLE PLUG REPAIR USING FLUSH PATCH/HALF COUPLING
S2.13.9.2 WELDED REPAIR OF CRACKS IN UNSTAYED AREAS

a) Prior to repairing cracks, the plate shall be NDE examined for other defects. All affected sections shall be repaired.

b) Cracks in unstayed areas may be repaired by welding. Before cracks are repaired, however, the inner surface of the plate should be examined for possible excessive corrosion or grooving.

c) Cracks in unstayed areas may be repaired by welding, providing the cracks do not extend between rivet holes in a longitudinal seam or parallel to a longitudinal seam within 2 in. (50 mm) from the center line of the outer most row of rivets. Minimum 175°F (79°C) preheat shall be used. The completed repair must be radiographed have volumetric NDE performed and stress relieved. Alternative
methods in lieu of postweld heat treatment identified in NBIC Part 3, 2.5.3 may be used. (See NBIC Part 3, Figure S2.13.9.2).

d) Cracks radiating from a common point (star cracking) shall not be repaired; installation of a flush patch is required. Cracks radiating from a rivet hole in a circumferential seam may be repaired if the plate is not seriously damaged. (See NBIC Part 3, Figure S2.13.9.2).

e) Prior to welding, the rivets into which cracks extend and the rivets on each side of them shall be removed.

f) In riveted joints, tack bolts should be placed in alternating holes to hold the plate laps firmly.

g) Rivets holes should be reamed after welding.

h) Welding shall not cover rivet heads.

### S2.13.9.3 WELDED FLUSH PATCHES IN UNSTAYED AREAS

<table>
<thead>
<tr>
<th>Part 3, S2.13.9.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Welded repairs to boiler unstayed areas shall be radiographically examined or have volumetric NDE performed in accordance with the approved code of construction or ASME Section I, when the size of the repaired area is greater than 3 in. (75 mm) in diameter. The completed repair must be stress relieved. Alternative Methods without Postweld Heat Treatment identified in NBIC Part 3, 2.5.3 may be used.</td>
</tr>
</tbody>
</table>

b) The weld around a flush patch shall be a full penetration weld and the accessible surfaces shall be ground flush. Examples of flush welded patches are shown in Figure NBIC Part 3, S2.13.9.3.

c) Before installing a flush patch, the defective material should be removed until sound material is reached.

d) The patch should be rolled or pressed to the proper shape or curvature. The edges of the patch should align with original material without overlap. Patches shall fit flush on the waterside of the sheet. If the patch includes an existing riveted seam, the patch shall be riveted at that seam. Changing a riveted seam to a welded seam is considered an alteration. Patches may be of any shape or size. If the patch is square or rectangular, an adequate radius, of at least three times the material thickness should be provided at the corners. Square corners shall be avoided.

e) Material thickness of patches shall be at least equal to, but not greater than, 1/8 in. (3 mm) thicker than original construction thickness.

### S2.13.10.2 WELDED REPAIR OF CRACKS IN STAYED AREAS

<table>
<thead>
<tr>
<th>Part 3, S2.13.10.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements specified in NBIC Part 3, S2.13.9.2 shall apply with the following additional requirements identified below:</td>
</tr>
</tbody>
</table>

a) If the crack extends into a staybolt hole, the staybolt shall be removed prior to making the repair.

b) Threaded staybolts shall be retapped after welding.

b) If the load on repair area is carried by other forms of construction, such as staybolts, rivets, or tubes, volumetric NDE of the welds is not required.

### S2.13.10.3 WELDED FLUSH PATCHES IN STAYED AREAS

<table>
<thead>
<tr>
<th>Part 3, S2.13.10.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The requirements identified in NBIC Part 3, S2.13.9.3 shall apply with the additional requirements specified below:</td>
</tr>
</tbody>
</table>

a) Patches may be any shape provided they are adequately supported by staybolts, rivets, tubes, or other forms of construction. Patches on stayed surfaces should be designed so weld seams pass between staybolt rows. (See NBIC Part 3, Figure S2.13.10.3-a);

b) Patches are to be flush type, using full penetration welds. If the load on the patch is carried by other forms of construction, such as staybolts, rivets, or tubes, radiographic examination then volumetric NDE of the welds is not required;
c) Staybolts and rivets should be installed after welding of patch is completed. Reuse of staybolts and rivets is prohibited; and

d) Weld seams parallel to a knuckle shall be located no closer to the knuckle than the point of tangency of the knuckle unless the weld is radiographically examined. Weld seams not located in the knuckle are preferred. (See NBIC Part 3, Figure S2.13.10.3-b). For welded flush patches in stayed areas that include a knuckle area, see S2.13.11.3, Welded Flush Patches in Firebox and Tubesheet Knuckles.

<table>
<thead>
<tr>
<th>NB11-0204B</th>
<th>S2.13.10.3-b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, Figure S2.13.10.3-b</td>
<td>KNUCKLE POINT OF TANGENCY</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0204B</th>
<th>S2.13.11.2 WELDED REPAIR OF CRACKS IN FIREBOX AND TUBESHEET KNUCKLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S2.13.11.2</td>
<td>a) Prior to repairing cracks, the plate shall be NDE examined for other defects. All affected sections shall be repaired.</td>
</tr>
<tr>
<td></td>
<td>b) Welds within the points of tangency of a knuckle are permitted. Welds with angles of less than 45 degrees to the longitudinal axis of the knuckle shall be radiographically examined. (See NBIC Part 3, Figure S2.13.11.2). Welded repair of cracks within the points of tangency of a knuckle are permitted. All welds within the points of tangency of the knuckle shall have volumetric NDE performed.</td>
</tr>
<tr>
<td></td>
<td>c) Cracks radiating from a common point (star cracking) shall not be repaired; installation of a flush patch is required.</td>
</tr>
</tbody>
</table>
S2.13.11.3 WELDED FLUSH PATCHES IN FIREBOX AND TUBESHEET KNUCKLES

a) Any patch not supported by means other than the weld, such as rivets, staybolts, tubes, or other forms of construction, shall have all weld seams radiographically examined. (See NBIC Part 3, Figure S2.13.11.3). All other requirements specified in NBIC Part 3, S2.13.9.3 shall be followed. Volumetric NDE performed on the weld seams. (See NBIC Part 3, Figure S2.13.11.3-b)
b) Weld seams parallel to a knuckle shall be located no closer to the knuckle than the knuckle point of tangency. (See NBIC Part 3, Figure S2.13.11.3-a)

c) All other requirements specified in NBIC Part 3, S2.13.9.3, S2.13.10.3, and S2.13.12.3 shall be followed.
FIGURE S2.13.11.3-a
KNUCKLE FLUSH PATCH

Weld Seams Parallel To Knuckle are Not Allowed In This Area

Knuckle Point of Tangency

Parallel Weld Seams Shall Be Outside The Knuckle Point of Tangency

FIGURE S2.13.11.3-b
KNUCKLE FLUSH PATCH

Stayed Patch Applied to Riveted Ogee Knuckle Seam

New rivets applied between patch and existing material

Weld seams can be located before or between tube or rivet rows.
Weld shall not be located in knuckle radius.
See Figure S2.13.11.3-a

Stayed Patch Applied to Butt welded Seam

Weld seams can be located before or between tube or stay rows.
Weld shall not be located in knuckle radius.
See Figure S2.13.11.3-a

Stayed Patch Applied to Riveted Seam
### S2.13.12.3 WELDED FLUSH PATCHES IN TUBESHEETS

**a)** The method of repair shall follow the same requirements identified in S2.13.10.3 with the following requirement as noted below:

1. Tubes, staybolts, and rivets should be installed after welding of the patch is completed. (See NBIC Part 3, Figure S2.13.12.3).

2. A flush patch repair can be welded through tube holes or around tube holes. (See NBIC Part 3, Figure S2.13.12.3).

3. If the Flush Patch repair extends through the tube sheet radius either the sheet should be flanged to match the original tube sheet flange or a welded alternative may be used as shown in NBIC Part 3, Figure S2.13.12.3.A
S2.13.13.3 ASSEMBLY OF RIVETED JOINTS

After drilling or reaming rivet holes, the plates shall be separated, the burrs and chips removed, and the plates reassembled. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used.

S3.1 SCOPE

a) This supplement provides requirements and guidelines for repairs to graphite pressure equipment require the use of certified impregnated graphite and cement. The determining factor in establishing the desired material properties is the resin impregnation cycle. If the resin impregnation cycle is not controlled, it is not possible to meet the minimum design values.

a) The letter "G" shall be included on the "R" Certificate of Authorization for those organizations authorized to perform repairs/alterations of graphite pressure equipment.

S3.2 REPAIRS

a) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction as required by the original code of
FINISHING THE REPAIR

a) The parts should be held in place to prevent movement while curing the cemented joint to achieve a proper repair. The repair firm should take care to ensure that the cement joint thickness is within the range recommended by the cement manufacturer. Care spent in precisely aligning the parts while clamping will avoid many finishing and machining operations later. Particular attention should be given to gasket and other bearing surfaces.

c) A minimum of two (2) graphite plugs, each with a minimum length of 1 in. (25 mm), shall be used to plug each end of the tube(s) in question. This represents a minimum total of four (4) plugs per tube. Each plug shall have a minimum length of 1 in. (25 mm). Multiple plugs may be used.

REIMPREGNATION OF GRAPHITE PARTS (TUBESHEETS, HEADS, AND BLOCKS)

a) As a function of time, temperature, and chemical exposure, the resin used to impregnate graphite may shrink and/or degrade. As such, it is possible for voids to develop in impregnated graphite that has been in chemical service for a period of time. The resin loss can vary from slight to almost complete loss of impregnation. There is no practical way to determine the amount of resin remaining in the pores. However a pressure test will determine if the graphite has continuous porosity.

b) Reimpregnation of a graphite component may be used to reduce porosity in an existing graphite component, which in turn will improve the performance and expected life of the existing graphite components. A written re-impregnation procedure acceptable to the Inspector is required. The reimpregnation procedure shall include as a minimum:

1) Decontamination and drying of the graphite component
2) Subjecting the component to a vacuum
3) Introducing resin under pressure
4) Curing the resin at a specified temperature and time
5) Leak test

CONTROL OF IMPREGNATION MATERIAL

a) Impregnation material shall be the same as that specified in the Reimpregnation Procedure. Each impregnation material shall be traceable by the name of its manufacturer and the trade name or number of that manufacturer.

b) The impregnation material manufacturer shall supply the Certificate Holder with a Certificate of Analysis for each material. It shall include the following:

1) Impregnation material identification
2) Batch number(s)
3) Date of manufacture
4) Shelf life
5) Viscosity per ASTM D 2393
6) Specific gravity
c) Prior to reimpregnation, and at subsequent intervals not to exceed 14 days, the Certificate Holder shall test each batch of impregnation material to assure that the characteristics of the material have not changed from values specified in the Reimpregnation Procedure. The values obtained for viscosity and specific gravity for the impregnation material shall be within the limits specified by the manufacturer and as listed in the Reimpregnation Procedure. The test values shall be made available to the Inspector.

<table>
<thead>
<tr>
<th>NB16-0809B</th>
<th>S4.1 SCOPE</th>
</tr>
</thead>
</table>
| Part 3, S4.1 | a) This supplement provides general requirements and guidelines that apply to repairs and alterations to fiber-reinforced pressure-retaining items.  
 | b) The letters “RP” shall be included on the “R” Certificate of Authorization for those organizations authorized to perform repairs/alterations of fiber-reinforced plastic pressure equipment. |

<table>
<thead>
<tr>
<th>NB16-0809B</th>
<th>S5.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S5.1</td>
<td>This supplement provides additional requirements and guidelines for repairs and alterations to Yankee dryer pressure-retaining components and shall be used in conjunction with inspection requirements identified in NBIC Part 2, Inspection Supplement 5.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB16-0809B</th>
<th>S6.1 SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S6.1</td>
<td>This supplement provides general requirements and guidelines that apply to the for repairs, alterations, or modifications to DOT Transport Tanks used for the transportation of dangerous goods via highway, rail, air, or water.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-1202</th>
<th>S6.2 DEFINITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S6.2</td>
<td>The definitions specified in NBIC Part 3, Section 9, Glossary, shall be used in conjunction with those specified in NBIC Part 2, S6.17. Where conflicts between definitions exist, those identified in NBIC Part 2, S6.17 shall take precedence.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-1202</th>
<th>S6.3 CONSTRUCTION STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S6.3</td>
<td>When the standard governing the original construction is the ASME Code or other regulations of the Competent Authority, repairs, alterations, or modifications shall conform, insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practical, it is permissible to use other codes, standards or specifications, including the ASME Code provided the “TR” Certificate Holder has the concurrence of the Inspector and, if required, or the Competent Authority.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-1202</th>
<th>S6.4 ACCREDITATION AND REGISTRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S6.4</td>
<td>Organizations performing repairs, alterations, or modifications shall be accredited as in accordance with the National Board “TR” Accreditation Program. In addition repair organizations performing repairs, alterations, or modifications to transport tanks shall be registered with DOT as required by 49 CFR Part 180.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB15-1202</th>
<th>S6.5 MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 3, S6.5</td>
<td>The materials used in making repairs, alterations, or modifications shall conform to the original code of construction including the material specification requirements. Carbon or alloy steel having a carbon content of more than 0.35% (0.30% for ton tanks) shall not be welded unless permitted by the original code</td>
</tr>
</tbody>
</table>
of construction. The “TR” Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the material to be installed. Additional material requirements are provided in NBIC Part 3, Section 3.

<table>
<thead>
<tr>
<th><strong>NB15-1202</strong></th>
<th><strong>S6.65</strong> REPLACEMENT PARTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, S6.6</strong></td>
<td>a) Replacement parts that will be subject to internal or external pressure that consist of new material which may be formed to the required shape by spinning, forging, die forming, and on which no fabrication welding is performed shall be supplied as material. Such parts shall be marked with the material and part identification and the name or trademark of the parts manufactured. In lieu of full identification marking on the material or part, the part manufacturer may use a coded marking system traceable to the original marking. Such markings shall be considered as the part manufacturer’s certification that the part complies with the original code of construction. Examples include seamless or welded tube or pipe, forged nozzles, heads or subassemblies attached mechanically.</td>
</tr>
<tr>
<td></td>
<td>b) Replacement parts that will be subject to internal or external pressure, that are preassembled by attachment welds, shall have the welding performed in accordance with the original code of construction. This certificate shall be supplied in the form of a bill of material or drawings with statement of certification.</td>
</tr>
<tr>
<td></td>
<td>c) Replacement parts subject to internal or external pressure fabricated by welding that require shop inspection by an Authorized Inspector shall be fabricated by an organization having an appropriate ASME Certificate of Authorization. The item shall be inspected and stamped as required by the applicable section of the ASME Code and DOT specification requirements. A completed ASME Manufacturer’s Partial Data Report shall be supplied by the manufacturer.</td>
</tr>
<tr>
<td></td>
<td>d) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure fabricated by welding shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to as required by the original code of construction as required by the original code of construction or equivalent shall be supplied with the item. When this is not possible or practicable the organization fabricating the part may have a National Board Certificate of Authorization. Replacement parts fabricated by an “R” stamp holder shall be documented on Form TR-1R-3 and the “TR” Stamp applied as described in NBIC Part 3, S6.4415.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>NB15-1202</strong></th>
<th><strong>S6.76</strong> AUTHORIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, S6.7</strong></td>
<td>The Inspector’s written authorization to perform a repair, alteration, or modification shall be obtained prior to initiation of the repair or modification work to be performed on to a transport tank. Additional requirements are specified in NBIC Part 3, 1.3.1 and 1.3.2.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>NB15-1202</strong></th>
<th><strong>S6.87</strong> INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 3, S6.8</strong></td>
<td>Inspection and certification shall be made by an Inspector holding an appropriate National Board Commission employed by one of the following:</td>
</tr>
<tr>
<td></td>
<td>a) An organization authorized and recognized by the Competent Authority.</td>
</tr>
<tr>
<td></td>
<td>The Authorized Inspection Agency of the “TR” Certificate Holder making the repair or modification as required by NBIC Part 3, 1.3 and shall be a Registered Inspector meeting the requirements of the Competent Authority.</td>
</tr>
</tbody>
</table>
S6.87.1 INSPECTOR DUTIES FOR REPAIRS, ALTERATIONS, AND MODIFICATIONS

a) Repair Organizations that possess the National Board “TR” Certificate of Authorization and DOT’s Cargo Tank Registration (CTR) number when applicable shall use inspection services of a Registered Inspector while performing repairs, or Modifications of Transport Tanks. The Registered Inspector must have satisfied the following requirements:

1) Has satisfied DOT requirements as a Registered Inspector.
2) Has successfully completed the National Board’s Web-based training program for Registered Inspectors and has been issued a National Board Certificate of Completion.
3) Has received authorization from DOT as a Registered Inspector.
4) Has been registered by DOT for the Classification(s) of Transport Tanks to be inspected.

b) a) Inspectors performing repair, alteration, or modification inspections under the requirements of this supplement shall satisfy the requirements of S6.78.1 to be authorized to sign the Form TR-1, Repairs or Modifications and Form TR-2, Alterations Supplemental Form.

c) b) For repairs, alterations, and modifications of transport tanks, the duties of the Registered Inspector performing inspections are detailed in Part 2, S6.10 through S6.15, as required by the Competent Authority.

d) c) In addition, the duties of the Registered Inspector are summarized below. Registered Inspector shall meet the rules of NB-263, RCI-1, Rules for Commissioned Inspectors. Additional duties are summarized below:

1) Verify the organization performing the repair, alteration or modification activity is properly accredited and in possession of a current valid Certificate of Authorization to apply the “TR” Stamp issued by the National Board and is working to an approved accepted Quality Control System;
2) Verify that the design, if required, for the modification of the vessel is approved by a Design Certifying Engineer, or Designated Approval Agency or other applicable individual;
3) Verify the materials to be used to make the repair, alteration, or modification are approved for use and comply with applicable code requirements;
4) Verify the welding procedures and welders or welding operators are properly qualified;
5) Verify that all heat treatments, if required, including PWHT have been performed in accordance with the applicable standards and that the results are acceptable;
6) Verify that all NDE, impact tests, and other tests have been performed when required, and that the results are acceptable;
7) Make a visual inspection of the work performed to confirm there are no visible defects or deviations from code requirements;
8) Perform external and internal visual inspections, if the vessel is equipped with a manway, and witness the hydrostatic or pneumatic pressure test and/or leak tightness test when they are required;
9) Verify the correct nameplate is properly attached to the vessel and that the current test and inspection markings are properly attached and displayed on the proper vessel;
10) Sign the Form TR-1 and, as appropriate, form TR-2 when work is completed.
### S6.9 WELDING

a) Welding shall be performed in accordance with the requirements of the original code of construction used for the fabrication of the pressure vessel. For hydrogen control when low alloy steel filler metals are used, the filler metal classification shall include an H4 supplemental diffusible hydrogen designator (maximum 4 ml [H2]/100 g deposited metal) for each of the following welding processes:

1) electrodes for shielded metal arc welding (SMAW) conforming to SFA-5.5;
2) electrodes and fluxes for submerged arc welding (SAW) conforming to SFA-5.26;
3) electrodes and rods for gas shielded metal arc welding (GMAW) conforming to SFA-5.28;
4) electrodes for flux-cored arc welding (FCAW) conforming to SFA 5.29.

b) Practices used for controlling storage and exposure of filler metals shall be those developed by the “TR” Certificate Holder or those recommended by the filler metal manufacturer.

### S6.10 NONDESTRUCTIVE EXAMINATION

a) The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction used for the pressure vessel, and repairs, alterations, and modifications shall be subjected to the same nondestructive examination requirements as the original welds. Where this is not possible or practicable, alternative NDE methods acceptable to the Inspector and the Competent Authority may be used on a case-by-case basis.

b) NDE personnel shall be qualified and certified in accordance with the requirements of the original code of construction. When this is not possible or practicable, NDE personnel may be qualified and certified in accordance with their employer’s written practice. ASNT SNT-TC-1A, Recommended Practice for Nondestructive Testing Personnel Qualification and Certification (2006 Edition), or ANSI/ASNT CP-189, Standard for Qualification and Certification of Nondestructive Testing Personnel (2006 Edition), shall be used as a guideline for employers to establish their written practice. The ASNT Central Certification Program (ACCP) may be used to fulfill the examination and demonstration requirements of SNT-TC-1A and the employer’s written practice. Provisions for training, experience, qualification and certification of NDE personnel shall be described in the “TR” Certificate Holder’s written quality system.

### S6.13 MEASUREMENT, EXAMINATION, AND TEST EQUIPMENT

There shall be a system for The calibration of pressure gages, measurement, examination, and test equipment, and documentation of calibration shall be performed, as required, by the applicable standard used for construction. This system shall be documented.

### S6.15 SPECIFIC “TR” STAMPING AND NAMEPLATE REQUIREMENTS

The holder of a “TR” Certificate of Authorization is required to affix a stamping or nameplate on the Transport Tank that indicates, the repair, alteration, or modification has been performed in accordance with the requirements of NBIC Part 3, Supplement 6 and the additional requirements of the code of construction. All repairs, alterations, and modifications, after acceptance by the Registered Inspector, shall have the “TR” Symbol affixed to the stamping or the nameplate. The stamping or nameplate information shall satisfy the requirements of a) thru g) below:

a) The required data shall be in characters at least 4 mm (5/32 in.) high;
b) The markings may be produced by casting, etching, embossing, debossing, stamping, or engraving;
c) The selected method shall not result in any harmful contamination or sharp discontinuities to the pressure-retaining boundary of the Transport Tank;
d) Stamping directly on the Transport Tank, when used, shall be done with blunt-nose continuous or blunt-nose interrupted dot die stamps. If direct stamping would be detrimental to the item, required markings and the embossed Code Symbol stamping may appear on a nameplate affixed to the Transport Tank;
e) The “TR” Certificate Holder shall use its full name as shown on the Certificate of Authorization or use an approved abbreviation acceptable to the National Board;
f) The non-embossed Code Symbol stamping, when directly applied on the item or when a nameplate is used shall be applied adjacent to the original manufacturer’s stamping or nameplate. A single repair, alteration, or modification stamping or nameplate may be used for more than one repair to a Transport Tank additional activities performed, provided the repair, alteration, or modification activity is carried out by the same certificate holder; "R" Certificate Holder;
g) The date of each repair, alteration, or modification corresponding with the date on the applicable “R” form Form TR-1 shall be stamped on the nameplate applied to the exiting stamping or nameplate.

### NB15-1202 Part 3, S6.15.2

#### S6.154.2 REMOVAL OF ORIGINAL STAMPING OR NAMEPLATE

If it becomes necessary to remove the original stamping, the Inspector shall, subject to the approval of the Competent Authority, witness the making of a facsimile of the stamping, the obliteration of the old stamping, and the transfer of the stamping. When the stamping is on a nameplate, the Inspector shall witness the transfer of the nameplate to the new location. Any relocation shall be described on the applicable NBIC “TR” Form. The restamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

### NB15-1202 Part 3, S6.16.1

#### S6.165.1 DOCUMENTATION

Repairs, alterations, or modifications that have been performed in accordance with the NBIC shall be documented on Form TR-1, Report of Repair or Form R-2, Report of Alteration—Alteration or Modification, as shown in NBIC Part 3, Section 5. Form TR-24, Report Supplementary Sheet, shall be used to record additional data when space is insufficient on Form TR-1 or R-2.

### NB15-1202 Part 3, S6.16.2

#### S6.1615.2 PREPARATION OF “TR” FORMS

Preparation of “TR” Forms shall be the responsibility of the “TR” Certificate Holder performing the repairs, alterations, or modifications. An Inspector shall indicate acceptance by signing the appropriate “TR” form.

### NB15-1202 Part 3, S6.16.3

#### S6.165.3 DISTRIBUTION

a) Legible copies of the completed Form TR-1 “R” forms together with attachments shall be distributed to the owner or user, the Inspector, and the Competent Authority, as required, and the Authorized Inspection Agency responsible for the inspection, and the National Board for registration.
b) Distribution of the Form TR-1 “R” forms and attachments shall be the responsibility of the organization “R” Certificate Holder performing the repairwork.

### NB15-1202 Part 3, S6.16.4

#### S6.165.4 REGISTRATION OF FORM TR-1 AND FORM TR-2

a) Organizations performing repairs, alterations, or modifications under the “TR” program required by this supplement must—shall register such repairs, alterations, or modifications with the National Board.
b) The repair organization shall maintain a sequential Form “TR” Log that shall identify the following:
1) Form number assigned for Form TR-1;
2) Identify if the activity was a repair, alteration, or modification;
3) When the repair, alteration, or modification was completed, and
4) Date sent to the National Board.

**NB15-1202**
Part 3, S6.17.3

**S6.176.3 MODIFICATIONS**
All modifications to the pressure-retaining item shall meet the requirements of NBIC Part 3, Section 6 for alterations.

**NB15-1202**
Part 3, S6.17.5

**S6.176.5 AUTHORIZATION**
Repairs, alterations, or modifications to a pressure-retaining item shall not be initiated without the authorization of the Inspector, who shall determine that the repair methods are acceptable and subject to acceptance of the Competent Authority.

**NB15-1202**
Part 3, S6.18

**S6.187 EXAMINATION AND TEST**
The following requirements shall apply to all repairs, alterations, or modifications to DOT Transport Tank pressure-retaining items:

a) The integrity of repairs and replacement parts used in repairs, alterations, or modifications shall be verified by examination and test;

b) The “TR” Certificate Holder is responsible for all activities relating to examination and test of repair, alterations, or modifications;

c) Examination and tests to be used shall be subject to acceptance of the Inspector and the Competent Authority when required.

**NB15-1202**
Part 3, S6.18.1

**S6.187.1 METHODS**
a) One, or a combination of the following examination methods, shall be applied to DOT Transport Tank pressure-retaining items with the concurrence of the Inspector and the Competent Authority when required.

b) Liquid Pressure Test

1) Pressure testing of repairs shall meet the following requirements:

2) Pressure tests shall be conducted using water or other suitable liquid. The test pressure shall be the minimum required to verify the leak tightness integrity of the repair, but not more than 150% of the maximum allowable working pressure (MAWP) stamped on the pressure-retaining item, as adjusted for temperature. When original test pressure included consideration of corrosion allowance, the test pressure may be further adjusted based on the remaining corrosion allowance;

3) During a pressure test where the test pressure will exceed 90% of the set pressure of the pressure relief device, the device shall be removed whenever possible. If not possible, a test gag should be used using the valve manufacturer’s instructions and recommendations; and

4) Hold time for the pressure test shall be a minimum of 10 minutes prior to examination by the Inspector. Where the test pressure exceeds the MAWP of the item, the test pressure shall be reduced to the MAWP for close examination by the Inspector. Hold time for close examination shall be as necessary for the Inspector to conduct the examination.
c) **Pneumatic Test**
   1) A pneumatic test may be conducted. Concurrence of the owner shall be obtained in addition to that of the Inspector and the Competent Authority where required. The test pressure shall be the minimum required to verify leak tightness integrity of the repair, but shall not exceed the maximum pneumatic test pressure of the original code of construction. Precautionary requirements of the original code of construction shall be followed.

d) **Nondestructive Examination**
   1) Nondestructive examination (NDE) may be conducted. NDE methods shall be suitable for providing meaningful results to verify the integrity of the repair.

---

**NB15-1202**

**REPAIRS, ALTERATIONS, OR MODIFICATION REPORTS**

*a) 
When repairs, alterations, or modifications are performed on a transport tank, i.e., cargo tank, portable tank, or ton tank, the owner or User shall have the activity performed by a Repair Organization that has a valid “TR” Certificate of Authorization issued by the National Board. “R” forms shall be completed and certified by the “R” Certificate Holder and received and certified by the Inspector.*

b) For the purposes of documentation and stamping, modification shall be considered an alteration.

a) The repair, alteration, or modification shall be recorded on the Form TR-1. If additional space is needed to properly record the repair, alteration, or modification, Form TR-2 shall be used.

b) It is the responsibility of the “TR” Symbol Stamp Holder to prepare, distribute, and maintain the Form TR-1 and, if required, Form TR-2. The Form(s) shall be distributed as follows:

1) Owner or User;
2) Registered Inspector;
3) Competent Authority (DOT); and
4) National Board.

The Form TR-1 shall be signed by a Registered Inspector as defined in NBIC Part 3, S6.7.1.

---

**NB11-0401**

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

**SUPPLEMENT 7**

**REQUIREMENTS FOR REPAIRS TO PRESSURE RELIEF DEVICES**

**S7.1 SCOPE**

This supplement provides general requirements that apply to repairs to pressure relief valves. Repairs may be required because of defects found during periodic inspections because testing has identified that valve performance does not meet the original code of construction requirements, failure during operation, or for routine preventative maintenance.

**S7.2 GENERAL REQUIREMENTS**

a) Repair of a pressure relief valve is considered to include the disassembly, replacement, re-machining, or cleaning of any critical part, lapping of a seat and disc, reassembly, adjustment, testing, or any other operation that may affect the flow passage, capacity, function, or pressure-retaining integrity.

b) Conversions, changes, or adjustments affecting critical parts are also considered repairs. The scope of conversions may include changes in service fluid and changes such as bellows, soft seats, and other changes that may affect Type/Model number provided such changes are recorded on the document as required for a quality system and the repair nameplate. (See NBIC Part 3, S5.12.1).

c) The scope of repair activities shall not include changes in ASME Code status.
When a repair is being performed under the administrative requirements for National Board Accreditation, a repair shall consist of the following operations as a minimum:

1. Complete disassembly, cleaning, and inspection of parts, repair or replacement of parts found to be defective, reassembly, testing as required by NBIC Part 3, 4.5, sealing and application of a repair nameplate. When completed, the valve’s condition and performance shall be equivalent to the standards for new valves.

2. The administrative requirements for National Board Accreditation apply only to valves that are stamped with an ASME “V,” “UV,” or “NV” Code symbol or marked with an ASME “HV” symbol and have been capacity certified on the applicable fluid by the National Board.

S7.3 WELD REPAIRS TO PRESSURE RELIEF VALVE PARTS

a) The Quality System Manual may include controls for the “VR” Certificate Holder to have the pressure relief valve part repaired by a National Board “R” Certificate Holder, per this supplement provided the following documentation is provided to the “R” Certificate Holder:

1) Code of construction, year built;
2) Part identification;
3) Part material specified; and
4) “VR” Certificate Holder’s unique identifier for traceability as required by the Repair Inspection Program.

b) Prior to performing weld repairs to pressure relief valve (PRV) parts, the “R” Certificate Holder shall receive repair information required by NBIC Part 3, S7.3 a) from the “VR” Certificate Holder responsible for the pressure relief valve repair.

1) PRV part weld repairs shall be performed under the “R” Certificate Holder’s quality system; however, the requirements for in-process involvement of the Inspector (see NBIC Part 3, 1.3.2) may be waived. The requirement for stamping is waived.
2) The process of identifying and controlling repairs shall be documented in the “R” Certificate Holder’s quality system.
3) PRV part repairs shall be documented on a Form R-1 with a statement under Remarks “PRV Part Repair.” The owner’s name and location of installation shall be that of the “VR” Certificate Holder. The information received from the “VR” Certificate Holder as required in NBIC Part 3, S7.3 a) shall be noted under “Description of Work.”
4) Upon completion of the repair, the repaired part and completed Form R-1 shall be returned to the “VR” Certificate Holder responsible for completing the PRV repair.

S7.4 MATERIALS FOR PRESSURE RELIEF DEVICES

The materials used in making repairs shall conform to the requirements of the original code of construction. The “VR” Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the materials to be installed.

S7.5 REPLACEMENT PARTS FOR PRESSURE RELIEF DEVICES

a) Critical parts shall be fabricated by the valve manufacturer or to the manufacturer’s specifications. Critical parts are those that may affect the valve flow passage, capacity, function, or pressure-retaining integrity.

b) Critical parts not fabricated by the valve manufacturer shall be supplied with material test certification for the material used to fabricate the part.

c) Replacement critical parts receiving records shall be attached or be traceable to the valve repair document (see NBIC Part 3, S7.3 a). These records shall conform to at least one of the following:
1) Receiving records documenting the shipping origin of the part fabricated by the valve manufacturer (such as packing list) from the valve manufacturer or assembler of the valve type;
2) A document prepared by the “VR” Certificate Holder certifying that the replacement part used in the repair has the manufacturer’s identification on the part or is otherwise labeled or tagged by the manufacturer and meets the manufacturer’s acceptance criteria (e.g., critical dimensions found in maintenance manual);

3) Receiving records for replacement critical parts obtained from a source other than the valve manufacturer or assembler of the valve type shall include a Certificate of Compliance that provides as a minimum:
   a. The part manufacturer and part designation;
   b. A certifying statement that either:
      (1) The part was fabricated by the valve manufacturer and meets the manufacturer’s acceptance criteria (e.g., critical dimensions found in maintenance manual), or
      (2) The part meets the manufacturer’s specifications and was fabricated from material as identified by the attached material test report.
   c. The signature of an authorized individual of the part source;
   d. The name and address of the part source for whom the authorized individual is signing.

d) Material for bolting shall meet the manufacturer’s specification, but does not require material test certification, if marked as required by the material specification.

S7.6 INITIAL ADJUSTMENTS TO PRESSURE RELIEF VALVES

The initial installation testing and adjustments of a new pressure relief valve on a boiler or pressure vessel are not considered a repair if made by the manufacturer or assembler of the valve.

S7.7 FIELD REPAIR

Repair organizations may obtain a “VR” Certificate of Authorization for field repair, either as an extension to their in-shop/plant scope, or as a field-only scope, provided that:

a) Qualified technicians in the employ of the certificate holder perform such repairs;

b) An acceptable quality system covering field repairs, including field audits, is maintained;

c) Functions affecting the quality of the repaired valves are supervised from the address of record where the “VR” certification is issued.

S7.8 AUDIT REQUIREMENTS

Upon issuance of a Certificate of Authorization, provided field repairs are performed, annual audits of the work carried out in the field shall be performed to ensure that the requirements of the certificate holder’s quality system are met. The audit shall include, but not be limited to, performance testing, in accordance with NBIC Part 3, 4.5, of valve(s) that were repaired in the field. The audits shall be documented.

S7.9 USE OF OWNER-USER PERSONNEL

For the repair of pressure relief valves at an owner-user’s facility for the owner-user’s own use, the “VR” Certificate Holder may utilize owner-user personnel to assist certificate holder technician(s) in the performance of repairs provided:

a) The use of such personnel is addressed in the “VR” Certificate Holder’s quality system;

b) The owner-user personnel are trained and qualified in accordance with NBIC Part 3, S7.11;

c) Owner or user personnel work under direct supervision and control of the “VR” Certificate Holder’s technician(s) during any stage of the repair when they are utilized;

d) The “VR” Certificate Holder shall have the authority to assign and remove owner-user personnel at its own discretion; and

e) The names of the owner-user personnel utilized are recorded on the document, as required, for a quality system.
S7.10 GUIDE TO JURISDICTIONS FOR AUTHORIZATION OF OWNER OR USERS TO MAKE
ADJUSTMENTS TO PRESSURE RELIEF VALVES

S7.10.1 GENERAL

The Jurisdiction may authorize properly trained and qualified employees of boiler and pressure vessel
owners or users or their designees to confirm or restore nameplate set pressure and/or performance of
pressure relief valves. All external adjustments shall be resealed with a seal identifying the responsible
organization and a metal tag that identifies the organization and the date the adjustment shall be installed.

S7.10.2 TRAINING

a) The user shall establish a documented in-house training program. This program shall establish training
objectives and provide a method of evaluating the training effectiveness. As a minimum, training
objectives for knowledge level shall include:
1) Applicable ASME Code and NBIC requirements;
2) Responsibilities within the organization’s quality system;
3) Knowledge of the technical aspects and mechanical skills for making set pressure and/or
   blowdown adjustments to pressure relief valves;
4) Knowledge of the technical aspects and mechanical skills for marking of pressure relief valve
   adjustments.

b) If the user established a designee, the designee shall establish a training program and make their
documentation available to the user and the jurisdictional authority.

S7.10.3 DOCUMENTATION

Each user shall document the evaluation and acceptance of an employee’s or designee’s qualifications.

S7.10.4 QUALITY SYSTEM

a) A written quality system shall be established by either the user or the designee with a written
description available to the jurisdictional authority.

b) The written description shall include at a minimum:
   1) Calibration of Test Equipment: This shall describe a system for the calibration of measuring and
test equipment. Documentation of these calibrations shall include the standard used and the
results. Calibration standards shall be calibrated against the equipment having valid relationships
to nationally recognized standards.
   2) Valve Testing, Setting, and Sealing: This system shall include provisions that each valve shall be
tested, set, and all external adjustments sealed according to the requirements of the applicable
ASME Code Section and NBIC Part 3, S7.10.1.
   3) Valve Marking: An effective marking system shall be established to ensure proper marking of the
metal tag required by NBIC Part 3, S7.10.1. The written quality system shall include a description
drawing of the metal tag.

S7.10.5 EXTERNAL ADJUSTMENTS

Only external adjustments to restore the nameplate set pressure and/or performance of a pressure relief
valve shall be made under the provisions of NBIC Part 3, S7.10.1 and NBIC Part 2, 2.5.7.

S7.10.6 REPAIRS

If disassembly, change of set pressure, or additional repairs are necessary, the valve shall be repaired by
an organization that meets the requirements of the NBIC.
S7.11 TRAINING AND QUALIFICATION OF PERSONNEL

S7.11.1 GENERAL

S7.11.2 CONTENTS OF TRAINING PROGRAM

The repair organization shall establish a documented in-house training program. This program shall establish training objectives and provide a method of evaluating training effectiveness. As a minimum, training objectives for knowledge level shall include:

a) Applicable ASME Code and NBIC requirements;
b) Responsibilities within the organization’s quality system; and
c) Knowledge of the technical aspects and mechanical skills for the applicable position held.

S7.11.3 QUALIFICATION OF PERSONNEL

Each repair organization shall establish minimum qualification requirements for those positions within the organization as they directly relate to pressure relief valve repair. Each repair organization shall document the evaluation and acceptance of an individual’s qualification for the applicable position.

S7.11.4 ANNUAL REVIEW OF QUALIFICATION

The repair organization shall annually review the qualifications of repair personnel to verify proficiency as well as compliance with the certificate holder’s quality system. This review shall include training records, documented evidence of work performed, and when necessary, monitoring job performance. The review shall be documented.

S7.12 WELDING FOR PRESSURE RELIEF VALVES

a) Welding shall be performed in accordance with the requirements of the original code of construction used for the pressure relief valve.
b) Cast iron and carbon or alloy steel having a carbon content of more than 0.35% shall not be welded.
c) Defects in pressure relief valve parts such as cracks, pits, or corrosion that will be repaired by welding shall be completely removed before the weld repair of the part is performed. Removal of the defect shall be verified by suitable NDE as required.
d) Consideration shall be given to the condition of the existing material, especially in the weld preparation area.

S7.12.1 WELDING PROCEDURE SPECIFICATIONS

Welding shall be performed in accordance with Welding Procedure Specifications (WPS) qualified in accordance with the original code of construction. When this is not possible or practicable, the WPS may be qualified in accordance with ASME Section IX.

S7.12.2 STANDARD WELDING PROCEDURE SPECIFICATIONS

A “VR” Certificate Holder may use one or more applicable Standard Welding Procedure Specifications shown in NBIC Part 3, 2.3.

S7.12.3 PERFORMANCE QUALIFICATION

Welders or welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction or ASME Section IX.

S7.12.4 WELDING RECORDS
The “VR” Certificate Holder shall maintain a record of the results obtained in welding procedure qualifications, except for those qualifications for which the provisions of NBIC Part 3, S7.12.2 are used, and of the results obtained in welding performance qualifications. These records shall be certified by the “VR” Certificate Holder and shall be available to the National Board.

S7.12.5—WELDERS’ IDENTIFICATION

The “VR” Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The “VR” Certificate Holder shall also establish a written procedure whereby welded joints can be identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and shall be described in the quality control system written description. The welder’s or welding operator’s identification mark may be stamped (low stress stamp) adjacent to welded joints made by the individual, or the “VR” Certificate Holder may keep a documented record of welded joints and the welders or welding operators used in making the joints.

S7.12.6—WELDERS’ CONTINUITY

The performance qualification of a welder or welding operator shall be affected when one of the following conditions occur:

a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire.

b) When there is specific reason to question their ability to make welds that meet the specification, the qualification that supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.

S7.13—HEAT TREATMENT

S7.13.1—PREHEATING

Preheating may be employed during welding to assist in completion of the welded joint (NBIC Part 3, 2.5.1). The need for and the temperature of preheat are dependent on a number of factors, such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties. The welding procedure specification for the material being welded shall specify the preheat temperature requirements.

S7.13.2—POSTWELD HEAT TREATMENT

Postweld heat treatment shall be performed as required by the original code of construction in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment.

S7.14—RECOMMENDED PROCEDURES FOR REPAIRING PRESSURE RELIEF VALVES

S7.14.1—INTRODUCTION

a) It is essential that the repair organization establish basic, specific procedures for the repair of pressure relief valves. The purpose of these recommended procedures is to provide the repair organization with guidelines for this important aspect of valve repair. It is realized that there are many types of valves and conditions under which they are repaired and, for this reason, the specific items in these recommended procedures may not apply, or they may be inadequate for each of those types or to the detailed repairs that may be required for each valve.

b) NBIC Part 3, S7.14.2 contains recommended procedures for the repair of spring-loaded pressure relief valves, and NBIC Part 3, S7.14.3 contains recommended procedures for the repair of pilot-operated
### S7.14.2 SPRING-LOADED PRESSURE RELIEF VALVES

Prior to removal of a valve from a system for a repair or any disassembly, ensure that all sources of pressure have been removed from the valve.

#### a) Visual Inspection as Received
1. This information is to be recorded:
   a. Record user (customer) identification number;
   b. Complete original PRV nameplate data, plus any important information received from customer;
   c. Check external adjustment seals for warranty repair;
   d. Check bonnet for venting on bellow-type valves; and
   e. Check appearance for any unusual damage, missing, or misapplied parts.
2. If sufficient damage or other unusual conditions are detected that may pose a safety risk during preliminary testing, then proceed directly to NBIC Part 3, S7.14.2 c).
3. Valves that are to be repaired in place proceed to NBIC Part 3, S7.14.2 c), unless preliminary testing has been authorized by the owner.

#### b) Preliminary Test as Received
1. Information from the recommended preliminary performance test and subsequent disassembly and inspections will provide a basis for any repair interval change that should be necessary to ensure that the valve will function as intended.
2. Determine set pressure or Cold Differential Test Pressure (CDTP) in accordance with manufacturer's recommendations and appropriate ASME Code Section. Do not allow test pressure to exceed 116% of set pressure unless otherwise specified by the owner. A minimum of three tests is usually required to obtain consistent results.
3. If results do not correlate with field performance, then steps to duplicate field conditions (fluid and temperature) may be necessary.
4. Record preliminary test results and test bench identification data.

#### c) Disassembly
1. Remove cap and lever assembly, if applicable.
2. Remove release nut assembly, if applicable.
3. Loosen jam nut on adjusting (compression) screw.
4. Record measurement and remove adjusting (compression) screw.
5. Remove bonnet or yoke.
6. Remove spring and washers, and tag (identify) including upper and lower washers, as appropriate.
7. Remove spindle and disk assembly.
8. Remove ring pins.
9. Record measurement and remove adjusting rings, nozzle, and guide, as applicable.

#### d) Cleaning
1. Wire all small parts together and clean. (Caution: do not use a cleaning method that will damage the parts.)
2. Do not clean in a chemical solution except under acceptable circumstances.
3. Protect seating surfaces and nameplates prior to cleaning.

#### e) Inspection
1. Check spring for correct range damage such as erosion, corrosion, cracking, or compression below free height.
2. Check nozzle for cracks (NDE as applicable) or unusual wear.
3. Check disk assembly for cracks (NDE as applicable) or unusual wear.
4. Check spindle for trueness, bearing areas, and thread condition.
5) Check guide for wear and galling.
6) Check adjusting ring(s) for worn threads and wear.
7) Check ring pins for bent or broken pin and thread condition.
8) Check bellows, if provided, for pinholes and corrosion.
9) Check flange gasket facings for wear and cuts.

f) Machining
1) Machine nozzle and disk, as necessary, to the manufacturer’s critical dimension charts.

g) Lapping
1) Machine or hand lap disk and nozzle to be sure of flatness.
2) Lap bevel seats to a grey finish; then re-machine disk or plug to the manufacturer’s critical dimension.

h) Bearing Points

Grind all bearing areas with grinding compound to make sure they are round and true.

i) Assembly
1) Install nozzle.
2) Install lower ring and guide ring to the or to measurement from c) 9) above or to manufacturer’s specifications.
3) Install guide.
4) Install disc and holder.
5) Install spindle.
6) Install spring washers.
7) Install bonnet.
8) Install bonnet bolting.
9) Install adjusting screw and lock nut to the measurement from c) 4) above.
10) Install release nut and lock nut, and cap and lever assembly, and

j) Testing

Test data shall be recorded. Testing will be done in accordance with manufacturer’s recommendations and appropriate ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.

k) Sealing

After final adjusting and acceptance by quality control inspection, all external adjustments will be sealed with a safety seal providing a means of identification of the organization performing the repair.

l) Nameplate

The repairer will place a repair nameplate on each repaired valve. The nameplate shall, as a minimum, meet the requirements of NBIC Part 3, 5.12.1.

m) Packaging, Shipping and Transportation
1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces.
2) Threaded and socket-weld valves up to 2 in. (50 mm) may be securely packaged and cushioned during transport.
3) Valve inlet and outlet connection, drain connections and bonnet vents should be protected during shipment and storage to avoid internal contamination of the valve. Ensure all covers and/or plugs are removed prior to installation.
4) Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped.
Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.

S7.14.3—PILOT OPERATED SAFETY RELIEF VALVES

a) Visual Inspection as Received
   1) This information is to be recorded:
      a. Complete nameplate data, plus any other important information received from the customer;
      b. User identification number, if applicable;
      c. Seals on external adjustment (yes/no);
      d. Identification on seal; and
      e. Obvious damage and external condition including missing or misapplied parts.

b) Disassembly
   1) Remove pilot and disassemble per manufacturer’s maintenance instruction.
   2) Disassemble main valve. Where lift adjustments are provided, do not remove the locking device or change the lift unless it is required as part of conversion.
   3) Remove the nozzle if recommended by the manufacturer’s maintenance instructions and/or when required as part of conversion.

c) Cleaning
   1) Pilot—Components of pilot are small and must be handled carefully to prevent damage or loss. Clean parts and nameplates with solvents that will not affect the parent metal and/or polish with 500 grit paper.
   2) Main Valve—Clean by appropriate means such as abrasive blast. Finishes of machined surfaces must not be affected. (Caution: Do not use a cleaning method that will damage the parts or nameplates.)

d) Inspection
   1) Pilot
      a. Check spring for damage such as corrosion, cracks, out of square ends, etc.
      b. Inspect all parts for damage. Small burrs or scratches may be removed by polishing. Severely damaged parts should be replaced. (Internal components or pilots should not be repaired by machining as the functions of the pilot could easily be impaired.)
      c. Check strainers on inlet and outlet lines.
      d. Replace all soft goods per manufacturer’s recommendation.
   2) Main Valve
      a. Check nozzle seating surface for nicks. These can be removed by machining or lapping as required.
      b. Check the piston and liner (or other moving member) for galling or excessive wear. The piston should move freely in the liner.
      c. Replace soft goods or re-lap disk as required.
      d. Where lift adjustments are provided, measure the lift per the manufacturer’s specifications.

e) Testing
   1) Test data shall be recorded. Testing will be done in accordance with the manufacturer’s recommendation and in accordance with the applicable ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.

f) Sealing
   1) After final adjustment and acceptance by quality control, all external adjustments will be sealed by
means assuring positive identification of the organization performing the repair.

g) Nameplate
1) The repairer will place a repair nameplate on each repaired valve. The nameplate, as a minimum, shall meet the requirements of NBIC Part 3, 5.12.1.

h) Packaging, Shipping and Transportation
1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces.
2) Threaded and socket-weld valves up to 2 in. (50 mm) may be securely packaged and cushioned during transport.
3) Valve inlet and outlet connection and drain connections should be protected during shipment and storage to avoid internal contamination of the valve. Ensure all covers and/or plugs are removed prior to installation.
4) Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored.
5) Tubing should be protected during shipment and storage to avoid damage and/or breakage.
6) Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.

* Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4

SUPPLEMENT 8
RECOMMENDED GUIDE FOR THE DESIGN OF A TEST SYSTEM FOR PRESSURE RELIEF DEVICES IN COMRESSIBLE FLUID SERVICE

S8.1 INTRODUCTION

This supplement provides guidance for the design of a test system using compressible fluids (e.g., steam or air/gas) and permits the determination of pressure relief valve set pressure and valve operating characteristics such as blowdown. The size of the test vessel needed depends on the size of the valve, its set pressure, the design of the test system, and whether blowdown must be demonstrated. A repair organization may use the information provided in this supplement to determine the minimum size test vessel needed so that the measured performance is characteristic of the valve and not the test system.

S8.2 GENERAL
a) The National Board administrative rules and procedures for the “VR” Certificate of Authorization and Symbol Stamp require that pressure relief valves, after repair, be tested in accordance with the manufacturer’s recommendations and the applicable ASME Code. The purpose of this testing is to provide reasonable assurance that valves will perform according to design when they are returned to service.

b) It is recognized that a full evaluation of the performance of some pressure relief valve designs requires testing at maximum allowable overpressure. However, it is beyond the scope of this supplement to define test equipment or facilities for such testing.

c) NBIC Part 3, Section 9 provides a glossary, NBIC Part 3, S8.3 describes typical test equipment, and NBIC Part 3, S8.4 provides data for estimating the size of test vessels required.

S8.3 TEST SYSTEM DESCRIPTION
a) An optimum configuration, particularly when the test medium source is of small capacity, is shown in NBIC Part 3, Figure S8.3-a. The test medium flows from the pressure source, usually a compressor or boiler, to an accumulator. It then flows through a pressure-controlling valve into the test vessel, from
which it is discharged, through the pressure relief valve mounted on the test vessel. The pressure-controlling valve is usually a globe valve, although any throttling valve is acceptable. If the pressure-controlling valve is of adequate size and can open quickly, large transient flows can be generated, increasing the pressure above the pressure relief valve set pressure, causing it to lift, and be sustained in its lifted condition.

b) NBIC Part 3, Figure S8.3-b shows a simpler test system in which the test vessel is pressurized directly from the pressure source without the use of an accumulator. In this configuration, flow rates through the pressure relief valve and any consequent over-pressure are dependent on the flow generating capacity of the pressure source.

c) In a test facility, the pressure relief valve is usually mounted on an isolating valve that should be of sufficient size that it will not choke flow to the pressure relief valve. There should be no intervening piping between the two valves to avoid any significant pressure drop between the test vessel and the pressure relief valve.

d) The isolating valve and any adapter flanges or valve test nozzles must be designed to sustain pressure relief valve discharge forces, and so secured that these forces are not transmitted to the test vessel. This is especially important for larger valves set at pressures greater than 100 psig (700 kPa).

e) The vessel should have a length-to-diameter ratio as low as is practical, and should be suitably anchored.

f) Pressure sensing lines should be connected to the test vessel well away from any inlet or outlet connections where pressure distortions due to transient changes in flow velocity during testing could cause erroneous pressure readings. When testing with steam, any water head that develops in the gage line must be taken into consideration.

g) Any intervening piping between the test vessel and the pressure relief valve should be as short and as straight as possible and be of adequate size to minimize inlet pressure drop.

h) In the case of steam, the equipment should be insulated and steam traps should be installed, as appropriate, to ensure that the test steam is dry, saturated steam with a minimum quality of 98%.

i) Safety valves shall be used to protect the test vessel and the accumulator.

**FIGURE S8.3-a**
SCHEMATIC OF TEST EQUIPMENT WITH ACCUMULATOR
FIGURE S8.3-b
SCHEMATIC OF TEST EQUIPMENT WITHOUT ACCUMULATOR
S8.4 TEST VESSEL SIZING DATA

a) Recommended test vessel sizes are given in NBIC Part 3, Figures S8.4-a and S8.4-b for a configuration using one vessel fed directly from the source of the test medium. Figure S8.4-a gives the test vessel size in cu. ft. vs. the valve orifice area in sq. in. for dry, saturated steam. Curves are shown for set pressures up to 500 psig (3.45 MPa) for three different blowdowns: 4%, 7%, and 10%. The source is assumed to be capable of feeding the test vessel at 2,500 lbs/hr. (1,135 kg/hr). Figure S8.4-b gives similar curves for air with a source capable of feeding the test vessel at 200 SCFM (5.66 cu. m./minute).

b) For valves, with effective orifices less than 1.28 sq. in. (826 sq. mm), the size of the test vessel needed becomes less dependent on the flow capacity of the source. For these valves, a 15 cu. ft. (0.42 cu. m.) minimum size test vessel is recommended. This should allow the accurate measurement and setting of blowdown for small valves. This minimum size should also be adequate for determining set pressures of larger valves; however, larger test vessels must be used if blowdown is to be set accurately. It is recognized that there are practical limits on the size and maximum pressure of a test vessel used to demonstrate pressure relief valve operational characteristics. In such cases, determination of valve set pressure remains the only viable production and repair test option. The recommended minimum size test vessel is 15 cu. ft. (0.42 cu. m.).

FIGURE S8.4-a
RECOMMENDED TEST VESSEL SIZE, TEST MEDIUM: STEAM
**FIGURE S8.4-b**

**RECOMMENDED TEST VESSEL SIZE, TEST MEDIUM: AIR OR GAS**

**S9.1 INTRODUCTION**

*S Editorial Note: This section has been removed from NBIC Part 3 and added to NBIC Part 4*

**SUPPLEMENT 9**

PROCEDURES TO EXTEND THE "VR" CERTIFICATE OF AUTHORIZATION AND STAMP TO ASME "NV" STAMPED PRESSURE RELIEF DEVICES

**S9.1 INTRODUCTION**
Approval to extend the scope of the National Board “VR” Certificate of Authorization to the Certificate Holder to use the “VR” Stamp on ASME Code “NV” Class 1, 2, or 3 stamped pressure relief devices, which have been capacity certified by the National Board, may be given subject to the provisions that follow.

S9.2—ADMINISTRATIVE PROCEDURES

The repair organization shall hold a valid “VR” Certificate of Authorization.

The repair organization shall obtain a National Board “NR” Certificate of Authorization and stamp. The requirements for said certificate and stamp include, but are not limited to, the following. The repair organization shall:

Maintain a documented quality assurance program that meets the applicable requirements of NBIC Part 3, 1.8. This program shall also include all the applicable requirements for the use of the “VR” stamp;

Have a contract or agreement with an Inspection Agency to provide inspection of repaired “NV”-stamped pressure relief devices by Inspectors who have been qualified in accordance with the requirements of ASME QAI-1, Qualifications for Authorized Inspection;

Successfully complete a survey of the quality assurance program and its implementation. This survey shall be conducted by representatives of the National Board, the Jurisdiction wherein the applicant’s repair facilities are located, and the applicant’s Authorized Inspection Agency. Further verification of such implementation by the survey team may not be necessary if the applicant holds a valid ASME “NV” certificate and can verify by documentation the capability of implementing the quality assurance program for repair of “NV”-stamped pressure relief devices, covered by the applicant’s ASME “NV” certificate.

The application of the “NR” Certificate of Authorization and stamp shall clearly define the scope of intended activities with respect to the repair of Section III, “NV”-stamped pressure relief devices. Revisions to the quality assurance program shall be acceptable to the Authorized Nuclear Inspector Supervisor and the National Board before being implemented.

The scope of the “VR” Certificate of Authorization shall include repair of “NV”-stamped pressure relief devices.

Verification testing of valves repaired by the applicant shall not be required provided such testing has been successfully completed under the applicant’s “VR” certification program.

A survey of the applicant for the “VR” Certificate of Authorization and endorsement of the repair of “NV”-stamped pressure relief devices may be made concurrently.

S9.3—GENERAL RULES

ASME Code Section III, “NV”-stamped pressure relief devices, which have been repaired in accordance with these rules, shall be stamped with both the “VR” and “NR” stamps.

The “VR” and “NR” stamps shall be applied only to “NV” stamped (Class 1, 2, or 3) National Board capacity certified pressure relief devices that have been disassembled, inspected, and repaired as necessary, such that the valves’ condition and performance are equivalent to the standards for new valves.

All measuring and test equipment used in the repair of pressure relief devices shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

Documentation of the repair of “NV”-stamped pressure relief devices shall be recorded on the National Board Form NVR-1, Report of Repair/Replacement Activities for Nuclear Pressure Relief Devices, in accordance with the requirements of NBIC Part 3, 1.8.

When an ASME “NV”-stamped pressure relief device requires a duplicate nameplate because the original nameplate is illegible or missing, it may be applied using the procedures of NBIC Part 3, 5.12.5 provided concurrence is obtained from the Authorized Nuclear Inspector and Jurisdiction. In this case the nameplate shall be marked “SEC. III” to indicate original ASME Code stamping.
### S10.1 SCOPE

This supplement provides **general and specific requirements and guidelines** that apply to the repairs or alterations to pressure vessels designed for storing Liquid Petroleum Gas (LPG) and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquid and Gases. When the standard governing the original construction is not the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquid and Gases, the requirements of NBIC Part 3, 1.2 b, shall apply. In addition to this supplement, the applicable paragraphs of Part 3 of the NBIC shall be met. Vessels used for anhydrous ammonia service shall not be considered for repair or alteration in accordance with this supplement.

### S10.5 REQUIREMENTS FOR CHANGE OF SERVICE FROM ABOVE GROUND TO UNDERGROUND SERVICE

ASME LPG storage vessels may be altered from above ground (AG) service to underground (UG) service subject to the conditions of NBIC Part 2, S7.10.

### S11.1 SCOPE

The technical information provided in this supplement pertains to weld repair and post repair inspection of creep strength enhanced ferritic steel (CSEF) pressure retaining items. This Supplement provides guidance for full penetration and partial penetration weld repairs not covered under Welding Method 6 (2.5.3.6).

Creep Strength Enhanced Ferritic alloys (CSEF’s) are a collection of ferritic steels whose creep strength is enhanced by the creation of a precise condition of micro-structure, specifically martensite or bainite, which is stabilized during tempering by controlled precipitation of temper-resistant carbides, carbo-nitrides, or other stable and/or meta-stable phases. Careful consideration shall be given to pressure-retaining items that are fabricated from CSEF’s. The behavior of these materials in low temperature (i.e. fracture toughness and/or fatigue) and in high temperature (i.e. creep and/or creep-fatigue) components can be degraded by not adhering to the welding procedures and improper application of post-weld heat treatment (PWHT). Experienced inspection personnel should oversee weld repairs of this nature for strict compliance with all welding procedure and repair requirements.

Post Construction access and in-service operation may not allow the practicable application of PWHT following original construction fabrication requirements and repair weld joint design. This supplement provides guidelines for weld repair options and post repair inspection using a well-engineered approach for CSEF steels. The user is cautioned to seek technical guidance for welding and selection of heat treating requirements.

Prior to using this guideline an engineering evaluation shall be performed to determine the scope of the repair and impact to safety prior to returning the pressure-retaining item to service for a specified period of time, based on acceptance by the Inspector, and when required the Jurisdiction. The organization performing the engineering evaluation shall have demonstrated experience with Grade 91 CSEF steels.

### S11.2 WELD REPAIR OF GRADE 91 STEEL

#### S11.2.1 Weld Repair Options

1. **9Cr-1Mo-VNbN Filler Metal (i.e. matching to Grade 91) + Controlled Fill + Low PWHT (Minimum**
temperature is 1250°F (675°C). Acceptable filler materials are referenced in Table S11.2.1. The minimum time and maximum heat treatment temperature shall be in accordance with the original code of construction. For reference, where the Ni+Mn content of the filler metal is not known, the maximum PWHT temperature shall be 1425°F (775°C). This maximum shall be enforced to avoid over-tempering or exceeding the absolute maximum PWHT temperature. PWHT hold times at temperature shall be as follows:

a. Minimum holding time at PWHT temperature is specified as 1 hour per 1.0 inch (25 mm) of thickness, 30 minute minimum provided the component < 0.5 inches (12.5 mm) in thickness;

b. Minimum holding time at PWHT temperature is specified as 5 hours plus 15 minutes for each additional 1.0 inch (25 mm) over 5.0 inches (125 mm);

(2) 9Cr-1Mo Filler Metal + Controlled Fill and No PWHT. Acceptable filler materials are detailed in Table S11.2.1.

(3) Ni-base Filler Metal + Controlled Fill and No PWHT. Acceptable nickel base consumables include selected ASME F No. 43 filler metals as detailed in Table S11.2.1.

Table S11.2.1 Alternative Weld Repair Methods, Filler Metals and Welding Processes for Grade 91 Steel.

<table>
<thead>
<tr>
<th>Filler Metal</th>
<th>Acceptable Weld Repair Method</th>
<th>Welding Process and Filler Metal AWS Classification</th>
</tr>
</thead>
</table>
| Matching (9Cr-1Mo-VNbN) | Controlled Fill + Low PWHT | SMAW – E9015-B9, E9016-B9, E9018-B9 or E9015-B91**, E9016-B91** or E9018-B91**  
FGA – E91T1-B9 or E91T1-B91**  
GTAW – ER90S-B9 or ER90S-B91** |
| 9Cr-1Mo            | Controlled Fill              | SMAW – E8015-B8, E8016-B8 or E8018-B8  
FGA – E81T1-B8  
GTAW – ER80S-B8 |
| Ni-base            | Controlled Fill              | SMAW – EPRI P87®, ENiCrFe-2, ENiCrFe-3  
FGA – None available  
GTAW – EPRI P87®, ERNiCr-3 |

**--B91 AWS classification is pending for the various Grade 91 filler metal product forms (currently --B9)  
**Incorporated by ASME B&PV Code as Code Case 2734 for classification as an F No. 43 filler material  
**Incorporated by ASME B&PV Code as Code Case 2733 for classification as an F No. 43 filler material

S11.3 Application of Controlled Fill Welding Procedure

a) The minimum preheat for the repair procedure shall be 300 °F (150 °C). The preheat temperature shall be checked to ensure the minimum preheat temperature is maintained during all welding and until welding is completed. The maximum interpass temperature shall be 550 °F (290 °C). At the completion of welding, a post weld hydrogen bake-out is not required nor prohibited.

b) To control heat input the weld repair shall be performed using a "controlled fill" technique. In this technique, the first layer in contact with the repair groove can be identical or smaller in diameter than the fill passes.

c) Figures S11.3-a through S11.3-d illustrate the types of acceptable weld joint details using the controlled fill technique for full or partial penetration weld repairs.

d) The bead-to-bead overlap should be ~50% or greater. The fill passes should be deposited working from the bevel of the machined excavation towards the center of the excavation with a minimum overlap of 25%
and ideally 50%. As a rule of thumb, if the welder aims for the toe of the previously deposited weld bead, an overlap of at least 40% will be achieved.

e) When the SMAW process is specified using ferrous filler metals for an initial fill pass layer as a controlled fill welding technique, the electrode diameter is restricted to a maximum size of 1/8 in. (3.2 mm). The remaining fill passes to complete this excavation using this technique and SMAW process are limited to an electrode diameter of 5/32 in. (4.0 mm). When the SMAW process is specified with ferrous filler metals, the fill passes are restricted to a maximum electrode diameter of 1/8 in. (3.2 mm). When the SMAW process is specified with nickel-base filler metals, the fill passes in immediate contact with the excavation shall not exceed an electrode diameter of 1/8" (3.2 mm), and for the remaining fill passes to restore the excavated material an increase in the electrode diameter to 5/32 in. (4.0 mm) is permitted. When the GTAW process is specified, any limits for filler metal size shall be reflected in the qualified PQR and WPS.

Figure S11.3-a. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for a Partial Penetration Weld Repair.

Note 1 – The excavation shall have rounded corners to prevent lack of fusion defects. In these locations it is recommended to use a smaller diameter electrode (such as 3/32 in., 2.4 mm) to ensure acceptable fusion.
Note 2 – The repair cavity width shall extend at least 0.40 in. (10 mm) beyond the fusion line of the original weld.

Note 3 – Where the excavation may pose challenges with electrode access, it is recommended that the fill passes in immediate contact with the machined excavation be restricted in height as the weld repair is performed.

Figure S11.3-b. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for a Full Penetration Weld Repair Using a Compound Bevel.

Note 1 – Where the excavation may pose challenges with electrode access, it is recommended that the fill passes in immediate contact with the machined excavation be restricted in height as the weld repair is performed.
Figure S11.3-c. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for Full Penetration Weld Repair Using a Land.

Note 1 – The excavation shall have rounded corners to prevent lack of fusion defects. In these locations it is recommended to use a smaller diameter electrode (such as 3/32 in., 2.4 mm) to ensure acceptable fusion.
Figure S11.3-d. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for a Full Penetration Weld repair Using a Step Weld Preparation.

Note 1 – The excavation shall have rounded corners to prevent lack of fusion defects. In these locations it is recommended to use a smaller diameter electrode (such as 3/32 in., 2.4 mm) to ensure acceptable fusion.

Note 2 – The repair cavity width shall extend at least 0.40 in. (10 mm) beyond the fusion line of the
Note 3 – Where the excavation may pose challenges with electrode access, it is recommended that the fill passes in immediate contact with the machined excavation be restricted in height as the weld repair is performed.

S11.4 Qualification of Controlled Fill Welding Procedure

a) The test material for the welding procedure qualification shall be P-No 15E, Group 1, Grade 91.

b) Qualification thickness for the test plates and repair groove depths shall be in accordance with ASME Section IX.

c) The Welding Procedure Specification (WPS) shall be qualified in accordance with requirements of ASME Section IX. If qualifying the WPS with PWHT, the PWHT is to be low temperature PWHT, i.e., a minimum temperature of 1250 deg F (675 deg C) and a maximum temperature of 1445 deg F(785 deg C).

d) For qualification of weld repair procedures using 9Cr-1Mo filler metal and in the as-welded condition, the requirements for the bend test shall be performed using a bend radius which achieves a minimum of 14% elongation in the outer fibers.

S11.5 POST REPAIR INSPECTION

a) After the completion of weld repairs to CSEF steels, post inspection requirements shall be developed and implemented based on acceptance from the Inspector, and if applicable, the Jurisdiction.

b) Post-repair inspection intervals and methods of examination shall be implemented to ensure safe operation and margin to locate and monitor defect growth in the weld repair area. The selected non-destructive examination method shall provide meaningful results and shall follow NBIC Part 3, Section 4.

c) Post repair inspection shall be on-going until the component reaches end of life or is replaced. The Owner/User may revise the re-inspection interval based on inspection results from previous inspections.
<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>1.3 PRESSURE RELIEF DEVICES — DEFINITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Refer to glossary for definitions relating to pressure relief devices.</td>
</tr>
<tr>
<td>NB11-0401</td>
<td>1.3.1 ADDITIONAL DEFINITIONS RELATING TO PRESSURE RELIEF DEVICES</td>
</tr>
<tr>
<td>NB16-0809A</td>
<td>Unless otherwise specified in the NBIC, the definitions relating to pressure relief devices in Section 2 of ASME PTC-25 shall apply.</td>
</tr>
<tr>
<td>Part 4, 1.3</td>
<td>1.4 ACCREDITATION</td>
</tr>
<tr>
<td></td>
<td>a) Organizations performing repairs to pressure relief valves shall be accredited as described in this section, as appropriate for the scope of work to be performed.</td>
</tr>
<tr>
<td></td>
<td>b) Organizations performing repairs to pressure relief valves outside the scope of the NBIC may be accredited and shall meet any additional requirements of the Jurisdiction where the work is performed.</td>
</tr>
<tr>
<td>NB11-0401</td>
<td>1.4.1 ACCREDITATION PROCESS</td>
</tr>
<tr>
<td>NB16-0809A</td>
<td>a) The National Board administers accreditation programs for authorization of organizations performing repairs to pressure relief valves.</td>
</tr>
<tr>
<td>Part 4, 1.4</td>
<td>b) Any organization may apply to the National Board to obtain a Certificate of Authorization for a requested scope of activities. A review shall be conducted to evaluate the organization’s Quality System. The individual assigned to conduct the evaluation shall meet the qualification requirements prescribed by the National Board. Upon completion of the evaluation, any deficiencies within the organization’s Quality System will be documented and a recommendation will be made to the National Board regarding issuance of a Certificate of Authorization.</td>
</tr>
<tr>
<td></td>
<td>c) National Board procedures provide for the confidential review resulting in recommendations to issue or not issue a Certificate of Authorization.</td>
</tr>
<tr>
<td></td>
<td>d) The accreditation program provides requirements for organizations performing repairs to pressure relief valves. Depending upon the expected scope of activities at the time of review, organizations may be authorized to perform repairs either in the shop only, field only, or shop and field. Repair activities shall be limited to the scope of work authorized.</td>
</tr>
<tr>
<td></td>
<td>e) Organizations desiring to renew or obtain a National Board Certificate of Authorization shall apply to the National Board using forms obtained from the National Board. Application for renewal shall be made prior to the expiration date of the Certificate of Authorization.</td>
</tr>
<tr>
<td></td>
<td>f) When an organization has plants or shops in more than one location, the organization shall submit separate applications for each plant or shop. The organization may perform repairs in its plants, shops, or in the field, provided such operations are described in the organization’s Quality System.</td>
</tr>
<tr>
<td>NB11-0401</td>
<td>PART 4, SECTION 2</td>
</tr>
<tr>
<td>NB16-0809A</td>
<td>INSTALLATION OF PRESSURE RELIEF DEVICES</td>
</tr>
<tr>
<td>Part 4, 2.1</td>
<td>2.1 SCOPE</td>
</tr>
<tr>
<td></td>
<td>NBIC Part 4 Section 2 provides requirements for the installation of pressure relief devices on power boilers, steam heating boilers, hot-water heating boilers, hot-water supply boilers, potable water heaters, pressure vessels and piping.</td>
</tr>
</tbody>
</table>
|            | The correct selection of appropriate pressure relief devices (PRDs) and the proper installation of those devices are critical to the safe operation of pressure retaining Items. Following are requirements for the
Installation of pressure relief devices for protection of different types of pressurized equipment. See NBIC Part 1 for general installation requirements.

**2.2 PRESSURE RELIEF VALVES FOR POWER BOILERS**

See NBIC Part 1, par. 2.2 for the boilers covered under this section

**NB11-0401 Part 4, 2.2**

### 2.2.1 GENERAL REQUIREMENTS

- a) Only direct spring loaded pressure valves, direct spring loaded pressure relief valves, or pilot operated pressure relief valves designed to relieve steam shall be used for steam service.
- b) Pressure relief valves are valves designed to relieve either steam or water, depending on the application.
- c) Pressure relief valves shall be manufactured in accordance with a national or international standard.
- d) Deadweight or weighted-lever pressure relief valves shall not be used.
- e) For high temperature water boilers, pressure relief valves shall have a closed bonnet, and valve bodies shall not be constructed of cast iron.
- f) Pressure relief valves with an inlet connection greater than NPS 3 (DN 80) and used for pressure greater than 15 psig (100 kPa), shall have a flanged inlet connection or a welding-end inlet connection. The dimensions of flanges subjected to boiler pressure shall conform to the applicable standards.
- g) When a pressure relief valve is exposed to outdoor elements that may affect operation of the valve, the valve may be shielded with a cover. The cover shall be properly vented and arranged to permit servicing and normal operation of the valve.

**NB11-0401 Part 4, 2.2.2**

### 2.2.2 NUMBER

At least one National Board capacity certified pressure relief valve shall be installed on the boiler. If the boiler has more than 500 sq. ft. (46 sq. m.) of heating surface, or if an electric boiler has a power input of more than 3.76 million BTU/hr (1100 kW), two or more National Board capacity certified pressure relief valves shall be installed.

**NB11-0401 Part 4, 2.2.3**

### 2.2.3 LOCATION

- a) Pressure relief valves shall be placed on, or as close as physically possible, to the boiler proper.
- b) Pressure relief valves shall not be placed on the feedline.
- c) Pressure relief valves shall be connected to the boiler independent of any other connection without any unnecessary intervening pipe or fittings. Such intervening pipe or fittings shall not be longer than the face-to-face dimension of the corresponding tee fitting of the same diameter and pressure rating as listed in the applicable standards.

**NB11-0401 Part 4, 2.2.4**

### 2.2.4 CAPACITY

- a) The pressure relief valve capacity for each boiler shall be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6% above the highest pressure at which any valve is set and in no case to more than 6% above the maximum allowable working pressure of the boiler.
- b) The minimum relieving capacity for other than electric boilers and forced-flow steam generators with no fixed steam line and waterline shall be estimated for the boiler and waterwall heating surfaces as given in Table 2.2.4.1, but in no case shall the minimum relieving capacity be less than the maximum designed
steaming capacity as determined by the manufacturer.

c) The required relieving capacity in lbs/hr of the pressure relief valves on a high temperature water boiler shall be determined by dividing the maximum output in Btu at the boiler nozzle obtained by the firing of any fuel for which the unit is designed by one thousand.

d) The minimum pressure relief valve relieving capacity for electric boilers shall not be less than 3.5 lbs/hr/kW (1.6 kg/hr/kW) input.

e) If the pressure relief valve capacity cannot be computed, or if it is desirable to prove the computations, it should be checked by any one of the following methods: and if found insufficient, additional relieving capacity shall be provided:

1) By performing an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. This method should not be used on a boiler with a superheater or re heater or on a high-temperature water boiler.

2) By measuring the maximum amount of fuel that can be burned and computing the corresponding evaporative capacity upon the basis of the heating value of the fuel.

3) By determining the maximum evaporative capacity by measuring the feedwater. The sum of the pressure relief valve capacities marked on the valves shall be equal to or greater than the maximum evaporative capacity of the boiler. This method should not be used on high-temperature water boilers.

Table 2.2.4.1 MINIMUM POUNDS OF STEAM PER HOUR PER SQUARE FOOT OF HEATING SURFACE

<table>
<thead>
<tr>
<th>lbs steam/hr/ft² (kg/hr/m²)</th>
<th>Firetube Boilers</th>
<th>Watertube Boilers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler heating surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand-fired</td>
<td>5 (24)</td>
<td>6 (29)</td>
</tr>
<tr>
<td>stoker-fired</td>
<td>7 (34)</td>
<td>8 (39)</td>
</tr>
<tr>
<td>oil, gas, or pulverized fuel-fired</td>
<td>8 (39)</td>
<td>10 (49)</td>
</tr>
<tr>
<td>Waterwall heating surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hand-fired</td>
<td>8 (39)</td>
<td>8 (39)</td>
</tr>
<tr>
<td>stoker-fired</td>
<td>10 (49)</td>
<td>12 (59)</td>
</tr>
<tr>
<td>oil, gas, or pulverized fuel-fired</td>
<td>14 (68)</td>
<td>16 (78)</td>
</tr>
<tr>
<td>Copper-finned watertubes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hand-fired</td>
<td>4 (20)</td>
<td></td>
</tr>
<tr>
<td>stoker-fired</td>
<td>5 (24)</td>
<td></td>
</tr>
<tr>
<td>oil, gas, or pulverized fuel-fired</td>
<td>6 (29)</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:

• When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/ft² (7.5MJ/m²), the minimum relieving capacity should be based on the values given for hand-fired boilers above.

• The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tubesheets, and the projected area of headers need to be considered, except that for vertical firetube steam boilers, only that portion of the tube surface up to the middle gage cock is to be computed.

• For firetube boiler units exceeding 8000 Btu/ft² (9085 J/cm²) (total fuel Btu (J) Input divided by total heating surface), the factor from the table will be increased by 1.488 for every 1000 Btu/ft² (1136 J/cm²) above 8000 Btu/ft² (9085 J/cm²). For units less than 7000 Btu/ft² (7950 J/cm²), the factor from the table will
be decreased by 1 (4.88).

• For watertube boiler units exceeding 16000 Btu/ft² (18170 J/cm²)(total fuel BTU input divided by the total heating surface) the factor from the table will be increased by 1 (4.88) for every 1000 Btu/ft² (1136 J/cm²) above 16000 Btu/ft² (18170 J/cm²). For units with less than 15000 Btu/ft² (17034 J/cm²), the factor in the table will be decreased by 1 (4.88) for every 1000 Btu/ft² (1136 J/cm²) below 15000 Btu/ft² (17034 J/cm²).

# 2.2.5 SET PRESSURE

One or more pressure relief valves on the boiler proper shall be set at or below the maximum allowable working pressure. If additional valves are used, the highest pressure setting shall not exceed the maximum allowable working pressure by more than 3%. The complete range of pressure settings of all the pressure relief valves on a boiler shall not exceed 10% of the highest pressure to which any valve is set. Pressure setting of pressure relief valves on high temperature water boilers may exceed this 10% range.

# 2.2.6 FORCED-FLOW STEAM GENERATORS

For a forced-flow steam generator with no fixed steamline and waterline, equipped with automatic controls and protective interlocks responsive to steam pressure, pressure relief valves may be provided in accordance with the above paragraphs identified in 2.2.5 or the following protection against overpressure shall be provided:

a) One or more power-actuated pressure relief valves shall be provided in direct communication with the boiler when the boiler is under pressure and shall receive a control impulse to open when the maximum allowable working pressure at the superheater outlet is exceeded. The total combined relieving capacity of the power actuated pressure relief valves shall be not less than 10% of the maximum design steaming capacity of the boiler under any operating condition as determined by the manufacturer. The valves shall be located in the pressure part system where they will relieve the overpressure. An isolating stop valve of the outside-screw-and-yoke type should be installed between the power actuated pressure relief valve and the boiler to permit repairs provided an alternate power actuated pressure relief valve of the same capacity is so installed as to be in direct communication with the boiler.

b) Pressure relief valves shall be provided having a total combined relieving capacity, including that of the power-actuated pressure relief valve, of not less than 100% of the maximum designed steaming capacity of the boiler, as determined by the manufacturer. In this total, credit in excess of 30% of the total relieving capacity shall not be allowed for the power-actuated pressure relief valves actually installed. Any or all of the pressure relief valves may be set above the maximum allowable working pressure of the parts to which they are connected, but the set pressures shall be such that when all these valves (together with the power-actuated pressure relief valves) are in operation the pressure will not rise more than 20% above the maximum allowable working pressure of any part of the boiler, except for the steam piping between the boiler and the prime mover.

c) When stop valves are installed in the water steam flow path between any two sections of a forced-flow steam generator with no fixed steamline and waterline:

1) The power-actuated pressure relief valve shall also receive a control impulse to open when the maximum allowable working pressure of the component, having the lowest pressure level upstream to the stop valve, is exceeded.

2) The pressure relief valve shall be located to provide overpressure protection for the component having the lowest working pressure.

3) A reliable pressure-recording device shall always be in service and records kept to provide evidence of conformity to the above requirements.

# 2.2.7 SUPERHEATERS

a) Every attached superheater shall have one or more pressure relief valves. The location shall be suitable for the service intended and shall provide the overpressure protection required. The pressure drop upstream of each pressure relief valve shall be considered in determining the set pressure and relieving capacity of that valve. If the superheater outlet header has a full, free steam passage from end to end and is so constructed that steam is supplied to it at practically equal intervals throughout its length so that there is a uniform flow of steam through the superheater tubes and the header, the pressure relief valve or valves
may be located anywhere in the length of header.

b) The pressure-relieving capacity of the pressure relief valve or valves on an attached superheater shall be included in determining the number and size of the pressure relief valves for the boiler provided there are no intervening valves between the superheater pressure relief valve and the boiler and the discharge capacity of the pressure relief valve or valves, on the boiler, as distinct from the superheater, is at least 75% of the aggregate capacity required.

c) Every independently fired superheater that may be shut off from the boiler and permit the superheater to become a fired pressure vessel shall have one or more pressure relief valves having a discharge capacity equal to 6 lbs steam/hr/ft² (29 kg steam/hr/m²) of superheater surface measured on the side exposed to the hot gases.

d) Every pressure relief valve used on a superheater discharging superheated steam at a temperature over 450°F (230°C) shall have a casing, including the base, body, bonnet, and spindle constructed of steel, steel alloy, or equivalent heat-resistant material. The valve shall have a flanged inlet connection or a welding-end inlet connection. The seat and disk shall be constructed of suitable heat-erosive and corrosive-resistant material, and the spring fully exposed outside of the valve casing so that it is protected from contact with the escaping steam.

NB11-0401 Part 4, 2.2.8

2.2.8 ECONOMIZERS

An economizer that may not be isolated from a boiler does not require a pressure relief valve. Economizers that may be isolated from a boiler or other heat transfer device, allowing the economizer to become a fired pressure vessel, shall have a minimum of one pressure relief valve. Discharge capacity, rated in lbs/hr (kg/hr), of the pressure relief valve or valves shall be calculated from the maximum expected heat absorption rate in Btu/hr (kJ/hr) of the economizer, and will be determined from manufacturer data, divided by 1,000 BTU/lb (2,326 kj/kg). The pressure relief valve shall be located as close as possible to the economizer outlet.

NB11-0401 Part 4, 2.2.9

2.2.9 PRESSURE-REDUCING VALVES

a) Where pressure-reducing valves are used, one or more pressure relief valves shall be installed on the low pressure side of the reducing valve in those installations where the piping or equipment on the low pressure side does not meet the requirements for the steam supply piping.

b) The pressure relief valves shall be located as close as possible to the pressure reducing valve.

c) Capacity of the pressure relief valves shall not be less than the total amount of steam that can pass from the high pressure side to the low pressure side and be such that the pressure rating of the lower pressure piping or equipment shall not be exceeded.

d) The use of hand-controlled bypasses around reducing valves is permissible. The bypass around a reducing valve may not be greater in capacity than the reducing valve unless the piping or equipment is adequately protected by pressure relief valves or meets the requirements of the high pressure system.

e) See NBIC Part 4, Supplement 1 for additional information on the calculation of the required capacity of pressure relief valves installed after pressure-reducing valves.

NB11-0401 NB15-0103 Part 4, 2.2.10

2.2.10 INSTALLATION AND DISCHARGE REQUIREMENTS

a) Every boiler shall have outlet connections for the pressure relief valve, or valves, independent of any other outside steam connection, the area of opening shall be at least equal to the aggregate areas of inlet connections of all of the attached pressure relief valves. An internal collecting pipe, splash plate, or pan should be used, provided the total area for inlet of steam thereto is not less than twice the aggregate areas of the inlet connections of the attached pressure relief valves. The holes in such collecting pipes shall be at least 1/4 in. (.6 mm) in diameter, and the least dimension in any other form of opening for inlet of steam shall be 1/4 in. (.6 mm). If pressure relief valves are attached to a separate steam drum or dome, the opening between the boiler proper and the steam drum or dome shall be not less than 10 times the total area of the pressure relief valve inlet.
b) Every pressure relief valve shall be connected so as to stand in an upright position with spindle vertical.

c) The opening or connection between the boiler and the pressure relief valve shall have at least the area of the valve inlet and the inlet pipe to the pressure relief valve shall be as short and straight as possible, no longer than twice the center-to-end (face) dimension of a corresponding tee fitting of the same diameter, pressure class, and connection type. When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet or of the total of the areas of the valve outlets, discharging there into and shall be as short and straight as possible and arranged to avoid undue stresses on the valve or valves.

d) No valve of any description except a changeover valve as defined below shall be placed between the pressure relief valves and the boiler, nor on the discharge pipe between the pressure relief valves and the atmosphere.

A changeover valve, which allows two redundant pressure relief valves to be installed for the purpose of changing from one pressure relief valve to the other while the boiler is operating, may be used provided the changeover valve is in accordance with the original code of construction. It is recommended that the Jurisdiction be contacted to determine the acceptability of the changeover valves on boiler applications. The changeover valve shall be designed such that there is no intermediate position where both pressure relief valves are isolated form the boiler.

e) When two or more pressure relief valves are used on a boiler, they should be mounted either separately or as twin valves made by placing individual valves on Y-bases, or duplex valves having two valves in the same body casing. Twin valves made by placing individual valves on Y-bases or duplex valves having two valves in the same body shall be of equal size.

f) When two valves of different sizes are installed singly, the relieving capacity of the smaller valve shall not be less than 50% of that of the larger valve.

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

h) All pressure relief valves shall be piped to a safe point of discharge so located or piped as to be carried clear from running boards or platforms. Provision for an ample gravity drain shall be made in the discharge pipe at or near each pressure relief valve, and where water or condensation may collect. Each valve shall have an open gravity drain through the casing below the level of the valve seat. For iron- and steel-bodied valves exceeding NPS 2 (DN 50), the drain hole shall be tapped not less than NPS 3/8 (DN 10).

i) Discharge piping from pressure relief valves on high temperature water boilers shall have adequate provisions for water drainage as well as steam venting.

j) If a muffler is used on a pressure relief valve, it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid a possibility of restriction of the steam passages due to deposits. Mufflers shall not be used on high temperature water boiler pressure relief valves.
### 2.3.2 PRESSURE RELIEF DEVICES

Thermal fluid heaters shall be equipped with one or more pressure relief devices unless the option for overpressure protection by system design is utilized (when permitted by the original code of construction). When pressure relief devices are used, the following shall apply:

a) Pressure relief valve(s) shall be of a totally enclosed type and shall not have a lifting lever. A body drain is not required.

b) Rupture disks may be installed upstream or downstream of the pressure relief valve(s) in accordance with the original code of construction.

c) Pressure relief valves and rupture disks shall be in accordance with the code of construction and designed for liquid, vapor, or combination service as required for the specific installation, service fluids, and overpressure conditions.

d) The inlet connection to the valve shall be not less than NPS ½ (DN 15).

### 2.3.3 LOCATION

a) Pressure relief devices shall be connected to the heater in accordance with the original code of construction.

### 2.3.4 CAPACITY

a) The pressure relief device(s) shall have sufficient capacity to prevent the pressure vessel from exceeding the maximum pressure specified in the vessel code of construction.

### 2.3.5 SET PRESSURE

a) When a single relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure.

b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure needs to be set at or below the maximum allowable working pressure. The set pressure of the additional relief devices shall be such that the pressure cannot exceed the maximum pressure permitted by the code of construction.

### 2.3.6 INSTALLATION

a) When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet. The size of the discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity or adversely affect the operation of the attached pressure vessel relief devices. Discharge piping shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

b) The cross-sectional area of the piping between the heater and the relief device shall be sized either to avoid restricting the flow to the pressure relief devices or made at least equal to the inlet area of the pressure relief devices connected to it.

c) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting the flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it.

d) Unless permitted by the code of construction, there shall be no intervening stop valve between the vessel and its pressure relief device(s), or between the pressure relief device and the point of discharge.

e) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location, such as a catchment tank, for the disposal of fluids being relieved.

f) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with low point or valve body drains to prevent liquid from collecting in the discharge side of a pressure relief device.
Drain piping shall discharge to a safe location for the disposal of the fluids being relieved.

g) The pressure relief discharge should be connected to a closed, vented storage tank or blowdown tank with solid piping (no drip pan elbow, or other air gap). When outdoor discharge is used, the following should be considered for discharge piping at the point of discharge:

1) Both thermal and chemical reactions (personnel hazard)

2) Combustible materials (fire hazard)

3) Surface drains (pollution and fire hazard)

4) Loop seal or rain cap on the discharge (keep both air and water out of the system)

5) Drip leg near device (prevent liquid collection)

6) Heat tracing for systems using high freeze point fluids (prevent blockage)

h) A suitable condenser that will condense all the vapors discharged from the pressure relief valve may be used in lieu of piping the vapors to the atmosphere.

i) In order to minimize the loss by leakage of material through the pressure relief valve, a rupture disk may be installed between the pressure relief valve and the vaporizer, provided the following requirements are met:

1) The cross-sectional area of the connection to a vaporizer shall be not less than the required relief area of the rupture disk.

2) The maximum pressure of the range for which the disk is designed to rupture shall not exceed the opening pressure for which the pressure relief valve is set or the maximum allowable working pressure of the vessel.

3) The opening provided through the rupture disk, after breakage, shall be sufficient to permit a flow equal to the capacity of the attached valve, and there is no chance of interference with the proper functioning of the valve, but in no case shall this area be less than the inlet area of the valve.

4) The space between a rupture disk and the valve shall be provided with a pressure gage, try cock, free vent, or a suitable telltale indicator. This arrangement permits the detection of disk rupture or leakage.

j) Pressure relief valve discharge capacity shall be determined from the following equation:

\[ W = CKAP \sqrt{\frac{M}{T}} \]

Where

- \( A \) = discharge area of pressure relief valve
- \( C \) = constant for vapor that is a function of the ratio of Specific Heats \( k = \frac{c_p}{c_v} \).

Note: Where \( k \) is not known, \( k = 1.001 \).

- \( K \) = coefficient of discharge for the valve design
- \( M \) = molecular weight
- \( P \) = (set pressure × 1.03) + Atmosphere Pressure
- \( T \) = absolute temperature at inlet, \( ^\circ F + 460 (^\circ C + 273) \)
- \( W \) = flow of vapor

The required minimum pressure relief valve relieving capacity shall be determined from the following equation:
\[ W = C \times H \times 0.75/h \]

where

- \( C \) = maximum total weight or volume of fuel burned per hour, lb (kg) or ft\(^3\) (m\(^3\))
- \( H \) = heat of combustion of fuel, Btu/lb (J/kg) or Btu/ft\(^3\) (J/m\(^3\))
- \( h \) = latent heat of heat transfer fluid at relieving pressure, Btu/lb (J/kg)
- \( W \) = weight of organic fluid vapor generated per hour

The sum of the pressure relief valve capacities marked on the valves shall be equal to or greater than \( W \).

**NB11-0401 Part 4, 2.4**

**2.4 PRESSURE RELIEF VALVES FOR STEAM HEATING, HOT WATER HEATING, AND HOT WATER SUPPLY BOILERS**

See NBIC Part 1, 3.2 for the scope of pressure retaining items covered by these requirements.

**NB11-0401 Part 4, 2.4.1**

**2.4.1 PRESSURE RELIEF VALVE REQUIREMENTS — GENERAL**

The following general requirements pertain to the installation of pressure relief valves on heating boilers.

**NB11-0401 NB15-2303 Part 4, 2.4.1.1**

**2.4.1.1 INSTALLATION OF PRESSURE RELIEF VALVES FOR HEATING BOILERS**

**2.4.1.1.1 PERMISSIBLE INSTALLATION**

Pressure relief valves shall be located at the top side of the boiler. The top side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the pressure relief valves be located below the normal operating level and in no case shall the pressure relief valve be located below the lowest permissible water level. 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 pressure relief valve located on the steam or hot water outlet end. Pressure relief valves shall be installed with their spindles vertical. The opening or connection between the boiler and any pressure relief valve shall have at least the area of the valve inlet.

**NB11-0401 Part 4, 2.4.1.1.2**

**2.4.1.1.2 REQUIREMENTS FOR COMMON CONNECTIONS FOR TWO OR MORE VALVES**

a) When a boiler is fitted with two or more pressure relief valves on one connection, this connection shall have a cross-sectional area not less than the combined areas of inlet connections of all the pressure relief 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 pressure relief valve larger than NPS 4 (DN 100), 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 installed on a Y-base.

**NB11-0401 Part 4, 2.4.1.2**

**2.4.1.2 THREADED CONNECTIONS**

A threaded connection may be used for attaching a valve.

**NB11-0401 Part 4, 2.4.1.3**

**2.4.1.3 PROHIBITED INSTALLATIONS**

Pressure relief valves shall not be connected to an internal pipe in the boiler.

**NB11-0401 Part 4, 2.4.1.4**

**2.4.1.4 USE OF SHUTOFF VALVES PROHIBITED**

No shutoff valve of any description shall be placed between the pressure relief valve and the boiler or on discharge pipes between such valves and the atmosphere.
### 2.4.1.5 PRESSURE 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 that discharge into the pipe, 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 pressure relief valve discharge pipe, it shall be located close to the valve outlet downstream of the union to minimize reaction moment stress.

b) The discharge from pressure relief valves shall be so arranged that there will be no danger of scalding attendants. The pressure relief valve discharge shall be piped away from the boiler to a safe point of discharge, and there shall be provisions made for properly draining the piping. The size and arrangement of discharge piping 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.

### 2.4.1.6 TEMPERATURE AND PRESSURE RELIEF VALVES

Hot-water heating or supply boilers limited to a water temperature of 210°F (99°C) may have one or more National Board capacity certified temperature and pressure relief valve(s) installed. The requirements of 2.4.1.1 through 2.4.1.5 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 relief valves.

c) When the temperature and pressure relief valve is installed 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.

### 2.4.2 PRESSURE RELIEF VALVE REQUIREMENTS FOR STEAM HEATING BOILERS

a) Pressure relief valves shall be manufactured in accordance with a national or international standard.

b) Each steam boiler shall have one or more National Board capacity certified pressure relief valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 psig (100 kPa).

c) No pressure relief valve for a steam boiler shall be smaller than NPS 1/2 (DN 15). No pressure relief valve shall be larger than NPS 4 (DN 100). The inlet opening shall have an inside diameter equal to, or greater than, the seat diameter.

d) The minimum valve capacity in lbs/hr (kg/hr) shall be the greater of that determined by dividing the maximum Btu/hr (W) output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000 Btu/hr/lb (645 W/kg), or shall be determined on the basis of the lbs steam/hr/\(ft^2\) (kg steam/hr/m\(^2\)) of boiler heating surface as given in Table 2.2.4.1. For cast-iron boilers, 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 2.4.2 e) shall be met.

e) The pressure relief 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 psig (34 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 2.4.2 e). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

### 2.4.3 PRESSURE RELIEF VALVE REQUIREMENTS FOR HOT WATER HEATING OR HOT WATER SUPPLY BOILERS

a) Pressure relief valves shall be manufactured in accordance with a national or international standard.
b) Each hot-water heating or hot-water supply boiler shall have at least one National Board capacity certified pressure relief valve, of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.

c) Hot-water heating or hot-water 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 (b) above, one or more National Board capacity certified temperature and pressure relief valves of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.

d) When more than one pressure relief valve is used on either hot-water heating or hot-water supply boilers, the additional valves shall be National Board capacity certified and may have a set pressure within a range not to exceed 6 psig (40 kPa) above the maximum allowable working pressure of the boiler up to and including 60 psig (414 kPa), and 5% for those having a maximum allowable working pressure exceeding 60 psig (414 kPa).

e) No pressure relief valve shall be smaller than NPS 3/4 (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) should be equipped with a rated pressure relief valve of NPS 1/2 (DN 15).

f) The required relieving capacity, in lbs/hr (kg/hr), of the pressure relief valve(s) on a boiler shall be the greater of that determined by dividing the maximum output in Btu/hr (W) at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000 Btu/hr/1b (645 W/kg), or shall be determined on the basis of lbs steam/hr/ft² (kg steam/hr/m²) as given in Table 2.2.4.1. For cast-iron boilers, 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 2.4.3 h) shall be met.

g) 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 2.4.3 h). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

h) Pressure relief valve capacity for each boiler with a single pressure 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 pressure relief valve is used, the over pressure shall be limited to 10% above the set pressure of the highest set valve allowed by 2.4.3 b).

<table>
<thead>
<tr>
<th>Part 4, 2.4.4</th>
<th>2.4.4 TEMPERATURE AND PRESSURE RELIEF VALVE REQUIREMENTS FOR POTABLE WATER HEATERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB11-0401</td>
<td>NB15-0312</td>
</tr>
<tr>
<td>a) Each water heater shall have at least one National Board capacity certified temperature and pressure relief valve. No temperature and pressure relief valve shall be smaller than NPS 3/4 (DN 20).</td>
<td></td>
</tr>
<tr>
<td>b) The pressure setting shall be less than or equal to the maximum allowable working pressure of the water heater. However, if any of the other components in the hot-water supply system (such as valves, pumps, expansion or storage tanks, or piping) have a lesser working pressure rating than the water heater, the pressure setting for the temperature and pressure relief valve(s) shall be based upon the component with the lowest maximum allowable working pressure rating. If more than one temperature and relief valve is used, the additional valve(s) may be set within a range not to exceed 10% above the set pressure of the first valve.</td>
<td></td>
</tr>
</tbody>
</table>
| c) The required relieving capacity in Btu/hr (W) of the temperature and pressure relief valve shall not be less than the maximum allowable input unless the water heater is marked with the rated burner input capacity of the water heater on the casing in a readily visible location, in which case the rated burner input capacity may be used as a basis for sizing the temperature and pressure relief valves. The relieving capacity for electric water heaters shall be 3500 Btu/hr (1.0 kW) per kW of input. In every case, the following requirements shall be met. Temperature and pressure relief valve capacity for each water heater shall be such that with the fuel burning equipment installed and operating at maximum capacity, the pressure cannot rise more than 10% above the maximum allowable working pressure. Many temperature
and pressure relief valves have a National Board capacity certified rating which was determined according
to ASME Code requirements, and a lower Canadian Standards Association (CSA) rating value. Where the
ASME Code is the only referenced Code of Construction the National Board capacity certified rating may
be used. If the water heater is not an ASME vessel, or the CSA rating is required by another standard
(such as a plumbing or building code) then that rating shall be used.

d) If operating conditions are changed or additional heating surface is installed, the temperature and
pressure relief valve capacity shall be increased, if necessary, to meet the new conditions and shall be in
accordance with the above provisions. In no case shall the increased input capacity exceed the maximum
allowable input capacity. The additional valves required, on account of changed conditions, may be
installed on the outlet piping providing there is no intervening valve.

| NB11-0401  |
| Part 4, 2.4.4.1 |
| **2.4.4.1 INSTALLATION** |
| Temperature and pressure relief valves shall be installed by either the installer or the manufacturer before
a water heater is placed in operation. |

| NB11-0401  |
| Part 4, 2.4.4.2 |
| **2.4.4.2 PERMISSIBLE INSTALLATIONS** |
| Temperature and pressure relief valves shall be connected directly to a tapped or flanged opening in the
top of the water heater, to a fitting connected to the water heater by a short nipple, to a Y-base, or to a
valveless header connecting water outlets on the same heater. Temperature and pressure relief valves
shall be installed with their spindles upright and vertical with no horizontal connecting pipe, except that,
when the temperature and pressure relief valve is installed directly on the water heater vessel 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. The center line of the temperature and pressure relief valve connection shall
be no lower than 4 in. (100 mm) from the top of the shell. No piping or fitting used to install the temperature
and pressure relief valve shall be of nominal pipe size less than that of the valve inlet. |

| NB11-0401  |
| Part 4, 2.4.4.3 |
| **2.4.4.3 REQUIREMENTS FOR COMMON CONNECTION FOR TWO OR MORE VALVES** |
| a) When a potable water heater is fitted with two or more temperature and pressure relief valves on one
connection, this connection shall have a cross sectional area not less than the combined areas of inlet
connections of all the temperature and pressure relief valves with which it connects.

b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas.

c) When the size of the water heater requires a temperature and pressure relief valve larger than NPS 4
(DN 100) two or more valves having the required combined capacity shall be used. When two or more
valves are used on a water heater, they may be single, directly attached, or installed on a Y-base. |

| NB11-0401  |
| Part 4, 2.4.4.4 |
| **2.4.4.4 THREADED CONNECTIONS** |
| A threaded connection may be used for attaching a temperature and pressure relief valve. |

| NB11-0401  |
| Part 4, 2.4.4.5 |
| **2.4.4.5 PROHIBITED INSTALLATIONS** |
| Temperature and pressure relief valves shall not be connected to an internal pipe in the water heater or a
cold water feed line connected to the water heater. |

| NB11-0401  |
| Part 4, 2.4.4.6 |
| **2.4.4.6 USE OF SHUTOFF VALVES PROHIBITED** |
| No shutoff valve of any description shall be placed between the temperature and pressure relief valve and
the water heater or on discharge pipes between such valves and the atmosphere. |

| NB11-0401  |
| Part 4, 2.4.4.7 |
| **2.4.4.7 TEMPERATURE AND PRESSURE RELIEF VALVE DISCHARGE PIPING** |
| a) The discharge from temperature and pressure relief valves shall be so arranged that there will be no
danger of scalding attendants. When the temperature and pressure relief valve discharge is piped away
from the water heater to the point of discharge, there shall be provisions for properly draining the piping
and valve body. The size and arrangement of discharge piping shall be such that any pressure that may
b) When a discharge pipe is used, it shall be not less than the nominal size of the valve outlet and shall be as short and straight as possible and so arranged as to avoid undue stress on the valve. When an elbow is placed on a temperature and pressure relief discharge pipe, it shall be located close to the valve outlet.

c) Where multiple valves relieve into a common discharge pipe, the cross-sectional flow area of the common discharge pipe shall be equal to or greater than the sum of the individual temperature and pressure valve discharge pipe areas.

### 2.4.5 PRESSURE RELIEF VALVES FOR TANKS AND HEAT EXCHANGERS

#### 2.4.5.1 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 Part 1, 3.2, Definitions, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a pressure 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.

#### 2.4.5.2 HIGH TEMPERATURE WATER TO WATER HEAT EXCHANGER

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 Part 1, 3.2, Definitions, the heat exchanger shall be equipped with one or more National Board capacity certified pressure relief valves 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.

#### 2.4.5.3 HIGH TEMPERATURE WATER TO STEAM HEAT EXCHANGER

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 Part 1, 3.2, Definitions, the heat exchanger shall be equipped with one or more National Board capacity certified pressure relief valves set to relieve at a pressure not to exceed 15 psig (100 kPa), and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than 5 psig (34 kPa) above the maximum allowable working pressure of the vessel. For heat exchangers requiring steam pressures greater than 15 psig (100 kPa), refer to NBIC Part 1, Section 2 or Section 4.

### 2.5 PRESSURE VESSEL PRESSURE RELIEF DEVICES

See NBIC Part 1, 4.1 for the scope of pressure vessels covered by these requirements.

Pressure vessels protected by pressure relief devices shall meet the following requirements:

#### 2.5.1 DEVICE REQUIREMENTS

a) Pressure relief devices shall be manufactured in accordance with a national or international standard and be certified for capacity or flow resistance by the National Board.

b) Dead weight or weighted lever pressure relief valves shall not be used.

c) An unfired steam boiler shall be equipped with pressure relief valves as required in NBIC Part 4, 2.2.

d) Pressure relief devices shall be selected (i.e., material, pressure, etc.) and installed such that their proper functioning will not be hindered by the nature of the vessel’s contents.

#### 2.5.2 NUMBER OF DEVICES

At least one device shall be provided for protection of a pressure vessel. Pressure vessels with multiple chambers with different maximum allowable working pressures shall have a pressure relief device to protect each chamber under the most severe coincident conditions.
### 2.5.3 LOCATION

- **a)** The pressure relief device shall be installed directly on the pressure vessel, unless the source of pressure is external to the vessel and is under such positive control that the pressure cannot exceed the maximum overpressure permitted by the original code of construction and the pressure relief device cannot be isolated from the vessel, except as permitted by 2.5.6 e) 2).

- **b)** Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or in the piping system connected to the vapor space.

- **c)** Pressure relief devices intended for use in liquid service shall be connected below the normal liquid line. The liquid level during upset conditions shall be considered.

### 2.5.4 CAPACITY

- **a)** The pressure relief device(s) shall have sufficient capacity to ensure that the pressure vessel is not exposed to pressure greater than that specified in the original code of construction.

- **b)** Pressure vessels that can be exposed to fire or other sources of unexpected external heat may require supplemental pressure relief devices to provide additional relieving capacity.

  1) The combined capacity of all installed pressure relief devices shall be adequate to prevent the pressure from rising more than 21% above maximum allowable working pressure.

  2) The set point of any supplemental pressure relief device(s) shall not exceed 110% of the maximum allowable working pressure. If a single pressure relief device is utilized to protect the vessel during both operational and fire or other unexpected external heating conditions, the set point shall not exceed maximum allowable working pressure.

- **c)** Vessels connected together by a system of piping not containing valves that can isolate any pressure vessel may be considered as one unit when determining capacity requirements.

- **d)** Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid overpressure in case of internal failure.

- **e)** When a non-reclosing device is installed between a pressure relief valve and the pressure vessel, the reduction in capacity due to installation of the non-reclosing device shall be determined in accordance with the code of construction by use of a National Board certified Combination Capacity Factor (CCF). For rupture disks, if a certified combination capacity factor is not available, the capacity of the pressure relief valve shall be multiplied by 0.9 and this value used as the capacity of the combination installation.

- **f)** The owner shall document the basis for selection of the pressure relief devices used, including capacity, and have such calculations available for review by the Jurisdiction.

### 2.5.5 SET PRESSURE

- **a)** When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure.

- **b)** When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure needs to be at the maximum allowable working pressure. The set pressures of the additional pressure relief devices shall be such that the pressure cannot exceed the overpressure permitted by the code of construction.

### 2.5.6 INSTALLATION AND DISCHARGE PIPING REQUIREMENTS

- **a)** The opening through all pipe and fittings between a pressure vessel and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. When a discharge pipe is used, the size shall be such that any pressure that may exist or develop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. It shall be as short and straight as
possible and arranged to avoid undue stress on the pressure relief device.

b) A non-reclosing device installed between a pressure vessel and a pressure relief valve shall meet the requirements of 2.5.6 a).

c) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device.

d) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of 2.5.6 a).

e) There shall be no intervening stop valves between the vessel and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge, except under the following conditions:

1) When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity; or,

2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a pressure vessel and its pressure relief device may be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station.

3) A full area stop valve may also be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked and sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed.

4) A pressure vessel in a system where the pressure originates from an outside source may have a stop valve between the vessel and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of the pressure.

5) Pressure vessels designed for human occupancy (such as decompression or hyperbaric chambers) shall be provided with a quick opening stop valve between the pressure vessel and its pressure relief valve. The stop valve shall be normally sealed open with a frangible seal and be readily accessible to the pressure relief attendant.

f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

h) Pressure relief devices shall be installed so they are readily accessible for inspection, repair, or replacement.

i) Pressure vessel pressure relief devices and discharge piping shall be safely supported. The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and
discharge piping. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal movement), and loadings (including reaction forces during device operation in accordance with jurisdictional requirements, manufacturer’s recommendations, and/or other industry standards, as applicable.

### NB11-0401 Part 4, 2.5.7

**2.5.7 TEMPERATURE AND PRESSURE RELIEF DEVICES FOR HOT WATER STORAGE TANKS**

a) Each hot water storage tank shall be equipped with an ASME/NB certified temperature and pressure relief device set at a pressure not to exceed the maximum allowable working pressure and 210°F.

b) The temperature and pressure relief device shall meet the requirements of 2.5.1 through 2.5.6 above.

### NB11-0401 Part 4, 2.6

**2.6 PIPING SYSTEM PRESSURE RELIEF DEVICES**

See NBIC Part 1, Section 5 for the piping systems associated with this section.

When required by the original code of construction, piping shall be protected by pressure relief devices in accordance with the following requirements.

### NB11-0401 NB15-0303 NB15-0317 Part 4, 2.6.1

**2.6.1 DEVICE REQUIREMENTS**

a) Pressure relief devices shall be manufactured in accordance with a national or international standard and be certified for capacity or flow resistance by the National Board.

1) In certain cases piping codes of construction permit the use of regulators, which may include integral pressure relief valves to limit the pressure in a piping system. In this case, capacity certification of the pressure relief valve is not required.

2) Some piping codes of construction permit the use of pressure relief devices without capacity certification. In this case, capacity certification of the pressure relief device by the National Board is not required.

b) Dead weight or weighted lever pressure relief devices shall not be used.

c) Pressure relief devices shall be selected (i.e., material, pressure, etc.) and installed such that their proper functioning will not be hindered by the nature of the piping system’s contents.

### NB11-0401 NB15-0309 Part 4, 2.6.2

**2.6.2 NUMBER OF DEVICES**

At least one pressure relief device shall be provided for protection of a piping system. A pressure relief device installed on a pressure vessel or other component connected to the piping system may be used to meet this requirement. Portions of piping systems with different maximum allowable working pressures shall have a pressure relief device to protect each portion separately.

### NB11-0401 Part 4, 2.6.3

**2.6.3 LOCATION**

Pressure relief devices, except those covered by NBIC Part 4, Sections 2.1 through 2.2, may be installed at any location in the system provided the pressure in any portion of the system cannot exceed the maximum overpressure permitted by the original code of construction. Pressure drop to the pressure relief device under flowing conditions shall be considered when determining pressure relief device location. The pressure-relief device shall not be isolated from the piping system except as permitted by 2.6.6 e).

### NB11-0401 Part 4, 2.6.4

**2.6.4 CAPACITY**

a) The pressure relief device(s) shall have sufficient capacity to ensure that the piping is not exposed to pressures greater than that specified in the original code of construction.

b) When a non-reclosing device is installed between a pressure relief valve and the pipe, the reduction in capacity due to installation of the non-reclosing device shall be determined in accordance with the code of construction by use of a National Board certified Combination Capacity Factor (CCF). For rupture disks, if a certified combination capacity factor is not available, the capacity of the pressure relief valve shall be multiplied by 0.9 and this value used as the capacity of the combination installation.

c) The owner shall document the basis for selection of the pressure relief devices used, including capacity.
and have such calculations available for review by the Jurisdiction, when required.

**Part 4, 2.6.5 SET PRESSURE**

- **a)** When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure, except when allowed by the original code of construction.

- **b)** When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure need be at or below the maximum allowable working pressure. The set pressures of the additional pressure relief devices shall be such that the pressure cannot exceed the overpressure permitted by the code of construction.

**Part 4, 2.6.6 INLET AND DISCHARGE PIPING REQUIREMENTS**

- **a)** The opening through all pipes and fittings between a piping system and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the operation of the pressure relief device.

- **b)** A non-reclosing device installed between a piping system and a pressure relief valve shall meet the requirements of 2.6.6 a).

- **c)** The opening in the pipe shall be designed to provide unobstructed flow between the pipe and its pressure relief device.

- **d)** When two or more required pressure relief devices are placed on the connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of 2.6.6 a).

- **e)** There shall be no intervening stop valves between the piping system and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge except under the following conditions:

  1) These stop valves shall be so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity.

  2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a piping system and its pressure relief device may be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station.

  3) A full area stop valve may be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed; or

  4) A piping system where the pressure originates from an outside source may have a stop valve between the system and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of pressure.
f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

h) The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping.

i) Pressure relief devices shall be installed so they are accessible for inspection, repair, or replacement.

**PART 4, SECTION 3**

**IN-SERVICE INSPECTION OF PRESSURE RELIEF DEVICES**

**3.1 SCOPE**

This section provides general guidelines and requirements for conducting in-service inspection and testing of pressure relief devices.

The inspection of pressure relief devices is often coordinated with the inspection of the system. See NBIC Part 2 for in-service inspection requirements and procedures for other portions of the equipment not discussed in this section.

**3.2 GENERAL**

a) The most important appurtenances on any pressurized system are the pressure relief devices provided for overpressure protection of that system. These are devices such as pressure relief valves, rupture disks, and other non-reclosing devices that are called upon to operate and reduce an overpressure condition.

b) These devices are not designed or intended to control the pressure in the system during normal operation. Instead, they are intended to function when normal operating controls fail or abnormal system conditions are encountered.

c) Periodic inspection and maintenance of these important safety devices is critical to ensure their continued functioning and to provide assurance that they will be available when called upon to operate. See 3.2.6 for recommended testing frequency for PRDs.

d) Inspection areas of concern include:

1) correct set pressure; (matching of set pressure to MAWP)
2) safety considerations;
3) device data;
4) condition of the device;
5) condition of the installation; and
6) testing and operational inspection.

**3.2.1 PRESSURE RELIEF DEVICE DATA**

a) Nameplate marking or stamping of the device should be compared to stamping on the protected pressure-retaining item. For a single device, the set pressure shall be no higher than the maximum allowable working pressure (MAWP) marked on the protected pressure-retaining item or system.

b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure need be at or below the maximum allowable working pressure. The set pressure of additional devices may exceed the MAWP, as permitted by the original code of construction.
c) Verify nameplate capacity and, if possible, compare to system capacity requirements.

d) Check identification on seals and ensure they match nameplates or other identification (repair or reset nameplate) on the valve or device.

### 3.2.2 INSPECTION REQUIREMENTS FOR DEVICE CONDITION

**a)** The valve or device shall be checked for evidence that it is leaking or not sealing properly. Evidence of leakage through pressure-relief valves may indicate that the system is being operated at a pressure that is too close to the valve’s set pressure. (See Supplement 2 for guidance on the pressure differential between the pressure relief valve set pressure and system operating pressure.)

**b)** Seals for adjustments shall be intact and show no evidence of tampering.

c) Connecting bolting should be tight and all bolts intact.

d) The valve or device should be examined for deposits or material buildup.

e) The valve or device shall be checked for evidence of rust or corrosion.

f) The valve or device shall be checked for damaged or misapplied parts.

g) If a drain hole is visible, the valve or device should be checked to ensure it is not clogged with debris or deposits.

h) The valve or device shall be checked for test gags left in place after pressure testing of the unit.

i) Bellows valves shall be checked to ensure the bonnet vent is open or piped to a safe location. The vent shall not be plugged since this will cause the valve set pressure to be high if the bellows develops a leak. Leakage noted from the vent indicates the bellows is damaged and will no longer protect the valve from the effects of back pressure.

### 3.2.3 INSPECTION REQUIREMENTS FOR INSTALLATION CONDITION

**a)** Inlet piping shall be inspected to ensure it meets the requirements of the original code of construction. For pressure relief valves, the inlet pipe shall be checked to ensure the inlet pipe size is not smaller than the device inlet size.

**b)** Discharge piping shall be inspected to ensure it meets the original code of construction. For pressure relief valves, the discharge pipe shall be checked to ensure the discharge pipe size is not smaller than the device outlet size.

c) The valve drain piping shall be checked to ensure the piping is open.

d) The discharge piping shall be checked to ensure it drains properly.

**e)** The inlet and discharge piping shall be checked to ensure they are not binding or placing excessive stress on the valve body, which can lead to distortion of the valve body and leakage or malfunction.

**f)** The condition and adequacy of the pipe supports shall be inspected. Discharge piping should be supported independent of the device itself.

g) The valve discharge and discharge pipe shall be checked for possible hazards to personnel.

**h)** The installation shall be checked to ensure that there are no intervening isolation valves between the pressure source and the valve inlet or between the valve outlet and its point of discharge. Isolation valves may be permitted in some pressure vessel service. (See 2.5.6 e)), and jurisdictional requirements. Isolation valves shall not be used for power boilers, heating boilers, or water heaters.

**i)** A change-over valve, which is used to install two pressure relief devices on a single vessel location for
the purpose of switching from one device to a spare device, is not considered a block valve if it is arranged such that there is no intermediate position that will isolate both pressure relief devices from the protected system. Change-over valves should be carefully evaluated to ensure they do not have excessive pressure drop that could affect the pressure relief device operation or capacity. These devices are commonly used in pressure vessel service. They may also be used in some boiler applications. It is recommended that the Jurisdiction be contacted to determine their acceptability on boiler applications.

**NB11-0401**

<table>
<thead>
<tr>
<th>Part 4, 3.2.4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.2.4 ADDITIONAL INSPECTION REQUIREMENTS</strong></td>
</tr>
</tbody>
</table>

The following are additional items that should be considered for the specified types of installations or services.

**NB11-0401**

<table>
<thead>
<tr>
<th>Part 4, 3.2.4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.2.4.1 BOILERS</strong></td>
</tr>
</tbody>
</table>

a) If boilers are piped together with maximum allowable working pressures differing by more than 6%, additional protective devices may be required on the lower pressure units to protect them from overpressure from the higher pressure unit.

b) Hot-Water Heating Boilers and Water Heaters

1) These units generally do not use any water treatment and therefore may be more prone to problems with deposits forming that may impair a safety device’s operation. Particular attention should be paid to signs of leakage through valves or buildups of deposits.

2) Hot-water boilers tend to have buildups of corrosion products since the system is closed with little makeup. These products can foul or block the valve inlet.

3) Water heaters will have cleaner water due to continuous makeup. However, these valves usually have a thermal element that will cause the valve to open slightly when the water is heated and the heat is not removed from the system. When this hot water evaporates in the discharge piping, scale deposits may tend to form in the valve inlet and outlet.

**NB11-0401**

<table>
<thead>
<tr>
<th>Part 4, 3.2.4.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.2.4.2 PRESSURE VESSELS AND PIPING</strong></td>
</tr>
</tbody>
</table>

Standard practice for overpressure protection devices is to not permit any type of isolation valve either before or after the device. However, some pressure vessel standards permit isolation valves under certain controlled conditions when shutting down the vessel to repair a damaged or leaking valve. If isolation block valves are employed, their use should be carefully controlled by written procedures. Block valves should have provisions to be either car-sealed or locked in an open position when not being used. For ASME Section VIII, Div. 1 pressure vessels, see UG-135, Appendix M, and jurisdictional rules for more information.

**NB11-0401**

<table>
<thead>
<tr>
<th>Part 4, 3.2.4.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.2.4.3 RUPTURE DISKS</strong></td>
</tr>
</tbody>
</table>

a) Rupture disks or other non-reclosing devices may be used as sole relieving devices or in combination with pressure relief valves to protect pressure vessels.

b) The selection of the correct rupture disk device for the intended service is critical to obtaining acceptable disk performance. Different disk designs are intended for constant pressure, varying pressure, or pulsating pressure. Some designs include features that make them suitable for back pressure and/or internal vacuum in the pressure vessel.

c) The margin between the operating pressure and the burst pressure is an important factor in obtaining acceptable performance and service life of the disk. Flat and prebulged solid metal disks are typically used with an operating pressure that is no more than 60% to 70% of the burst pressure. Other designs are available that increase the operating pressure to as much as 90% of the burst pressure. Disks that have been exposed to pressures above the normal operating pressure for which they are designed are subject to fatigue or creep and may fail at unexpectedly low pressures. Disks used in cyclic service are also subject to fatigue and may require a greater operating margin or selection of a device suitable for such service.
d) The disk material is also critical to obtaining acceptable service life from the disk. Disks are available in a variety of materials and coatings, and materials that are unaffected by the process fluid should be used. Disks that experience corrosion may fail and open at an unexpectedly low pressure.

e) Disk designs must also be properly selected for the fluid state. Some disk types are not suitable for use in liquid service. Some disks may have a different flow resistance when used in liquid service, which may affect the sizing of the disk.

f) Information from the rupture disk manufacturer, including catalog data and installation instructions, should be consulted when selecting a disk for a particular service.

g) For rupture disks and other non-reclosing devices, the following additional items should be considered during inspections.

1) The rupture disk nameplate information, including stamped burst pressure and coincident temperature, should be checked to ensure it is compatible with the intended service. The coincident temperature on the rupture disk shall be the expected temperature of the disk when the disk is expected to burst and will usually be related to the process temperature, not the temperature on the pressure vessel nameplate.

2) Markings indicating direction of flow should be carefully checked to ensure they are correct. Some rupture disks when installed in the incorrect position may burst well above the stamped pressure.

3) The marked burst pressure for a rupture disk installed at the inlet of a pressure relief valve shall be equal to or less than the pressure relief valve set pressure. A marked burst pressure of 90% to 100% of the pressure relief valve set pressure is recommended. A disk with a non-fragmenting design that cannot affect the pressure relief valve shall be used.

Note: If the pressure relief valve set pressure is less than the vessel MAWP, the marked burst pressure may be higher than the valve set pressure, but no higher than the MAWP.

4) The rupture disk shall be checked that the space between the rupture disk and a pressure relief valve is supplied with a pressure gage, try cock, or telltale indicator to indicate signs of leakage through the rupture disk. The pressure relief valve shall be inspected and the leaking disk shall be replaced if leakage through the disk is observed.

5) If a rupture disk is used on a valve outlet, the valve design shall be of a type not influenced by back pressure due to leakage through the valve. Otherwise, for nontoxic and non-hazardous fluids, the space between the valve and the rupture disk shall be vented or drained to prevent the accumulation of pressure.

6) For rupture disks installed on the valve inlet, the installation should be reviewed to ensure that the combination rules of the original code of construction have been applied. A reduction in the valve capacity up to 10% is expected when used in combination with a non-reclosing device.

7) The frequency of inspection for rupture disks and other non-reclosing devices is greatly dependent on the nature of the contents and operation of the system and only general recommendations can be given. Inspection frequency should be based on previous inspection history. If devices have been found to be leaking, defective, or damaged by system contents during inspection, intervals should be shortened until acceptable inspection results are obtained. With this in mind, the inspection frequency guidelines specified in 3.2.6 are suggested for similar services.

8) Rupture disks are often used to isolate pressure relief valves from services where fouling or plugging of the valve inlet occurs. This tendency should be considered in establishing the inspection frequency.

9) Since rupture disks are non-reclosing devices, a visual inspection is the only inspection that can be performed. A rupture disk that is removed from its holder shall not be reinstalled unless recommended by the manufacturer. A rupture disk contained in an assembly that can be removed from a system without releasing the force maintaining the contact between the disk and holder, such as pre-torqued, welded, soldered, and some threaded assemblies, may be suitable for reinstallation after visual inspection. The manufacturer should be consulted for specific recommendations.
10) It is recommended that all rupture disks be periodically replaced to prevent unintended failure while in service due to deterioration of the device.

Rupture disks should be carefully checked for damage prior to installation and handled by the disk edges, if possible. Any damage to the surface of the ruptured disk can affect the burst pressure.

### NB11-0401

#### Part 4, 3.2.5

**3.2.5 TESTING AND OPERATIONAL INSPECTION OF PRESSURE RELIEF DEVICES**

a) Pressure relief valves shall be tested periodically to ensure that they are free to operate and will operate in accordance with the requirements of the original code of construction. Testing should include device set or opening pressure, reclosing pressure, where applicable, and seat leakage evaluation. Tolerances specified for these operating requirements in the original code of construction shall be used to determine the acceptability of test results.

b) Testing may be accomplished by the owner on the unit where the valve is installed or at a qualified test facility. In many cases, testing on the unit may be impractical, especially if the service fluid is hazardous or toxic. Testing on the unit may involve the bypassing of operating controls and should only be performed by qualified individuals under carefully controlled conditions. It is recommended that a written procedure be available to conduct this testing.

1) The Inspector should ensure that calibrated equipment has been used to perform this test and the results should be documented by the owner.

2) If the testing was performed at a test facility, the record of this test should be reviewed to ensure the valve meets the requirements of the original code of construction. Valves which have been in toxic, flammable, or other hazardous services shall be carefully decontaminated before being tested. In particular, the closed bonnet of valves in these services may contain fluids that are not easily removed or neutralized. If a test cannot be safely performed, the valve shall be disassembled, cleaned, and decontaminated, repaired, and reset.

3) If a valve has been removed for testing, the inlet and outlet connections should be checked for blockage by product buildup or corrosion.

c) Valves may be tested using lift assist devices when testing at full pressure may cause damage to the valve being tested, or it is impractical to test at full pressure due to system design considerations. Lift assist devices apply an auxiliary load to the valve spindle or stem, and using the measured inlet pressure, applied load and other valve data allow the set pressure to be calculated. If a lift assist device is used to determine valve set pressure, the conditions of NBIC Part 4, 4.6.3 shall be met. It should be noted that false set pressure readings may be obtained for valves which are leaking excessively or otherwise damaged.

d) If valves are not tested on the system using the system fluid, the following test mediums shall be used:

1) High pressure boiler pressure relief valves, high temperature hot-water boiler pressure relief valves, low pressure steam heating boilers: steam;

2) Hot-water heating boiler pressure relief valves: steam, air, or water;

3) Hot water heater temperature and pressure relief valves: air or water;

4) Air and gas service process pressure relief valves: air, nitrogen, or other suitable gas;

5) Liquid service process pressure relief valves: water or other suitable fluid;

6) Process steam service pressure relief valves: steam or air with manufacturer’s steam to air correction factor.

**Note:** Valves being tested after a repair must be tested on steam except as permitted by NBIC Part 4, 4.6.2.
e) As an alternative to a pressure test, the valve may be checked by the owner for freedom of operation by activating the test or “try” lever (manual check). For high pressure boiler and process valves, this test should be performed only at a pressure greater than 75% of the stamped set pressure of the valve or the lifting device may be damaged. This test will only indicate that the valve is free to operate and does not provide any information on the actual set pressure. All manual checks should be performed with some pressure under the valve in order to flush out debris from the seat that could cause leakage.

**Note:** The manual check at 75% or higher is based on lift lever design requirements for ASME Section I and VIII valves. Code design requirements for lifting levers for Section IV valves require that the valve be capable of being lifted without pressure.

f) Systems with multiple valves will require the lower set valves to be held closed to permit the higher set valves to be tested. A test clamp or “gag” should be used for this purpose. The spring compression screw shall not be tightened. It is recommended that the test clamps be applied in accordance with the valve manufacturer’s instructions when the valve is at or near the test temperature, and be applied hand tight only to avoid damage to the valve stem or spindle.

g) Upon completion of set pressure testing, all pressure relief valve gags shall be removed.

**NB11-0401**  
Part 4, 3.2.5.1

<table>
<thead>
<tr>
<th>3.2.5.1 CORRECTIVE ACTION</th>
</tr>
</thead>
</table>
| If a valve is found to be stuck closed, the system should immediately be taken out of service until the condition can be corrected, unless special provisions have been made to operate on a temporary basis (such as additional relief capacity provided by another valve.) The owner shall be notified and corrective action such as repairing or replacing the inoperable valve shall be taken.

**NB11-0401**  
Part 4, 3.2.5.2

<table>
<thead>
<tr>
<th>3.2.5.2 VALVE ADJUSTMENTS</th>
</tr>
</thead>
</table>
| a) If a set pressure test indicates the valve does not open within the requirements of the original code of construction, but otherwise is in acceptable condition, minor adjustments (defined as no more than twice the permitted set pressure tolerance) shall be made by a qualified organization accredited by the National Board to reset the valve to the correct opening pressure. All adjustments shall be resealed with a seal identifying the responsible organization and a tag shall be installed identifying the organization and the date of the adjustment. Qualified organizations are considered to be National Board “VR” Certificate Holders, or organizations authorized by the Jurisdiction to make adjustments. See Supplement 3 for more information.

b) If a major adjustment is needed, this may indicate the valve is in need of repair or has damaged or misapplied parts. Its condition should be investigated accordingly.

**NB11-0401**  
**NB15-0312**  
**NB15-0319**  
**NB16-0902**  
Part 4, 3.2.6

<table>
<thead>
<tr>
<th>3.2.6 RECOMMENDED INSPECTION AND TEST FREQUENCIES FOR PRESSURE RELIEF DEVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Power Boilers</td>
</tr>
</tbody>
</table>

1) Pressure less than 400 psig (2.76 MPa): Manual check every 6 months; pressure test annually to verify nameplate set pressure or as determined by operating experience as verified by testing history.

2) Pressure of 400 psig (2.76 MPa) or greater: Set pressure test to verify nameplate set pressure every three years or as determined by operating experience as verified by testing history.

3) Set pressure tests should be performed prior to bringing the boiler down for planned internal inspection so needed repairs or adjustments can be made while the boiler is down.

b) High-Temperature Hot-Water Boilers

Set pressure test annually to verify nameplate set pressure or as determined by operating experience as verified by testing history. For safety reasons, removal and testing on a steam test bench is recommended. Such testing will avoid damaging the pressure relief valve by discharge of a steam water mixture, which could occur if the valve is tested in place.

c) Organic Fluid Vaporizers

Pressure relief valves shall be disconnected from the vaporizer at least once yearly, when they shall be
inspected, tested, repaired if necessary, and then replaced on the vaporizer.

d) Low-Pressure Steam Heating Boilers

Manual check quarterly; set pressure test annually prior to steam heating season to verify nameplate set pressure.

e) Hot-Water Heating Boilers

Manual check quarterly; pressure test annually prior to heating season to verify nameplate set pressure.

**Note**: The frequencies specified for the testing of pressure relief valves on boilers is primarily based on differences between high pressure boilers that are continuously manned, and lower pressure automatically controlled boilers that are not monitored by a boiler operator at all times. When any boiler experiences an overpressure condition such that the pressure relief valves actuate, the valves should be inspected for seat leakage and other damage as soon as possible and any deficiencies corrected.

f) Water Heaters

Manual check every two months, or as determined based upon inspection history and manufacturer recommendations. Every 3 years, remove temperature and pressure relief valve to inspect temperature probe for damage, buildup, or corrosion. The temperature probe shall be checked for the condition of the coating material and freedom of movement without detaching. If the probe pulls out or falls off during inspection, the valve shall be repaired or replaced. Due to the relatively low cost of temperature and pressure relief valves for this service, it is recommended that a defective valve be replaced with a new valve if a repair or resetting is indicated.

g) Pressure Vessels and Piping

Frequency of test and inspection of pressure relief devices for pressure vessel and piping service is greatly dependent on the nature of the contents, external environment, and operation of the system, therefore only general recommendations can be given. Inspection frequency should be based on previous inspection history. If, during inspection, valves are found to be defective or damaged, intervals should be shortened until acceptable inspection results are obtained. Where test records and/or inspection history are not available, the following inspection and test frequencies are suggested:

<table>
<thead>
<tr>
<th>Service</th>
<th>Inspection Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam</td>
<td>Annual</td>
</tr>
<tr>
<td>Air and Clean Dry Gases</td>
<td>Every three years</td>
</tr>
<tr>
<td>Pressure relief valves in combination with rupture disks</td>
<td>Every five years</td>
</tr>
<tr>
<td>Propane, Refrigerant</td>
<td>Every five years</td>
</tr>
<tr>
<td>All Others</td>
<td>Per inspection history</td>
</tr>
</tbody>
</table>

3.2.6.1 ESTABLISHMENT OF INSPECTION AND TEST INTERVALS

Where a recommended test frequency is not listed, the valve user and Inspector must determine and agree on a suitable interval for inspection and test. Some items to be considered in making this determination are:

a) Jurisdictional requirements;

b) Records of test data and inspections from similar processes and similar devices in operation at that facility;

c) Recommendations from the device manufacturer. In particular, when the valve includes non-metallic parts such as a diaphragm or soft seat, periodic replacement of those parts may be specified;

d) Operating history of the system. Systems with frequent upsets where a valve has actuated require more
frequent inspection;

e) Results of visual inspection of the device and installation conditions. Signs of valve leakage, corrosion or damaged parts all indicate more frequent operational inspections;

f) Installation of a valve in a system with a common discharge header. Valves discharging into a common collection pipe may be affected by the discharge of other valves by the corrosion of parts in the outlet portion of the valve or the buildup of products discharged from those valves;

g) Ability to coordinate with planned system shutdowns. The shutdown of a system for other maintenance or inspection activities is an ideal time for the operational inspection and test of a pressure relief valve;

h) Critical nature of the system. Systems that are critical to plant operation or where the effects of the discharge of fluids from the system are particularly detrimental due to fire hazard, environmental damage, or toxicity concerns all call for more frequent inspection intervals to ensure devices are operating properly;

i) Where the effects of corrosion, blockage by system fluid, or ability of the valve to operate under given service conditions are unknown (such as in a new process or installation), a relatively short inspection interval, not to exceed one year or the first planned shutdown, whichever is shorter, shall be established. At that time the device shall be visually inspected and tested. If unacceptable test results are obtained, the inspection interval shall be reduced by 50% until suitable results are obtained.

3.2.6.2 ESTABLISHMENT OF SERVICE INTERVALS

a) The above intervals are guidelines for periodic inspection and testing. Typically if there are no adverse findings, a pressure relief valve would be placed back in service until the next inspection. Any unacceptable conditions that are found by the inspection shall be corrected immediately by repair or replacement of the device. Many users will maintain spare pressure relief devices so the process or system is not affected by excessive downtime.

b) Pressure relief valves are mechanical devices that require periodic preventive maintenance even though external inspection and test results indicate acceptable performance. There may be wear on internal parts, galling between sliding surfaces or internal corrosion, and fouling which will not be evident from an external inspection or test. Periodic re-establishment of seating surfaces and the replacement of soft goods such as o-rings and diaphragms are also well advised preventive maintenance activities that can prevent future problems. If the valve is serviced, a complete disassembly, internal inspection, and repair as necessary, such that the valve’s condition and performance are restored to a like new condition, should be done by an organization accredited by the National Board.

c) Service records with test results and findings should be maintained for all overpressure protection devices. A service interval of no more than three inspection intervals or ten years, whichever is less, is recommended to maintain device condition. Results of the internal inspection and maintenance findings can then be used to establish future service intervals.

PART 4, SECTION 4

REPAIR OF PRESSURE RELIEF VALVES

4.1 SCOPE

This section provides requirements and guidelines that apply to repairs to pressure relief valves.

a) Repairs may be required because of defects found during periodic inspection, testing, operation, or maintenance. Since pressure relief devices are provided for safety and the protection of personnel and property, repairs are often regulated by the jurisdiction where the pressure relief device is installed. The jurisdiction should be contacted for their specific requirements.

b) The National Board administers four specific accreditation programs:
   "R" — Repairs and Alterations to Pressure-Retaining Items
   "VR" — Repairs to Pressure Relief Valves
   "NR" — Repair and Replacement Activities for Nuclear Items
"T/O" – In-service Testing Only of Pressure Relief Valves

c) This section describes some of the administrative requirements for the accreditation of repair organizations. Additional administrative requirements can be found in NB-514, Accreditation of "VR" Repair Organizations. Some jurisdictions may independently administer a program of authorization for organizations to perform repairs within that Jurisdiction.

d) Requirements for the "T/O" are found in NB-528, Accreditation of "T/O" Test Only Organizations.

e) Requirements for repairs and alterations to pressure-retaining items and repair and replacement activities for nuclear items can be found in NBIC Part 3.

NB11-0401 Part 4, 4.2

4.2 GENERAL REQUIREMENTS

a) Repair of a pressure relief valve is considered to include the disassembly, replacement, re-machining, or cleaning of any critical part, lapping of a seat and disc, reassembly, adjustment, testing, or any other operation that may affect the flow passage, capacity, function, or pressure-retaining integrity.

b) Conversions, changes, or adjustments affecting critical parts are also considered repairs. The scope of conversions may include changes in service fluid and changes such as bellows, soft seats, and other changes that may affect Type/Model number provided such changes are recorded on the document as required for a quality system and the repair nameplate. (See 4.7.1).

c) The scope of repair activities shall not include changes in ASME Code status.

NB11-0401 Part 4, 4.2.1

4.2.1 VR REPAIR

a) When a repair is being performed under the administrative requirements for National Board Accreditation, a repair shall consist of the following operations as a minimum:

1) Complete disassembly, cleaning, and inspection of parts, repair or replacement of parts found to be defective, reassembly, testing as required by 4.6, sealing and application of a repair nameplate. When completed, the valve’s condition and performance shall be equivalent to the standards for new valves.

2) The administrative requirements for National Board Accreditation apply only to valves that are stamped with an ASME “V,” “UV,” or “NV” Code symbol or marked with an ASME “HV” symbol and have been capacity certified on the applicable fluid by the National Board.

NB11-0401 Part 4, 4.2.2

4.2.2 CONSTRUCTION STANDARDS FOR PRESSURE RELIEF DEVICES

a) For pressure relief devices, the applicable new construction standard to be used for reference during repairs is the ASME Code. ASME Code Cases shall be used for repairs when they were used in the original construction of the valve. ASME Code Cases may be used when they have been accepted for use by the NBIC Committee and the Jurisdiction where the pressure-retaining item is installed.

1) For pressure relief devices, the Code Case number shall be noted on the repair document and, when required by the code case, stamped on the repair nameplate.

2) The Jurisdiction where the pressure retaining item is installed shall be consulted for any unique requirements it may have established.

NB11-0401 Part 4, 4.2.3

4.2.3 INSTALLATION OF PRESSURE RELIEF DEVICES

Installation of a pressure relief device by mechanical methods is not considered to be a repair, as long as no changes or adjustments are made to the device. Seals installed by the device manufacturer or repair organization shall not be removed when the device is installed.

When a pressure relief device is to be installed by welding on an existing pressure retaining item, the requirements of Part 3 of the NBIC for welded repairs shall be followed.

If a pressure relief valve must be disassembled or its adjustments changed as part of the installation process, the reassembly, resetting, retesting or other such activities shall be done by a qualified
organization which meets the requirements of NBIC Part 4. For a new pressure relief valve, the original valve manufacturer shall perform this activity as required by the original code of construction.

The installation of a non-reclosing pressure relief device or the replaceable element of a non-reclosing pressure relief device such as a rupture disk is not considered to be a repair. The manufacturer’s procedures and instruction shall be followed for the installation of these devices.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>4.2.4 INITIAL ADJUSTMENTS TO PRESSURE RELIEF VALVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 4, 4.2.4</td>
<td>The initial installation testing and adjustments of a new pressure relief valve on a boiler or pressure vessel are not considered a repair if made by the manufacturer or assembler of the valve.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>4.3 MATERIALS FOR PRESSURE RELIEF VALVE REPAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 4, 4.3</td>
<td>The materials used in making repairs shall conform to the requirements of the original code of construction. The &quot;VR&quot; Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the materials to be installed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>4.3.1 REPLACEMENT PARTS FOR PRESSURE RELIEF DEVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB15-0322</td>
<td>Part 4, 4.3.1</td>
</tr>
<tr>
<td>NB15-0323</td>
<td></td>
</tr>
</tbody>
</table>

a) Critical parts shall be fabricated by the valve manufacturer or to the manufacturer's specifications. Critical parts are those that may affect the valve flow passage, capacity, function, or pressure-retaining integrity.

b) Critical parts not fabricated by the valve manufacturer shall be supplied with material test certification for the material used to fabricate the part.

c) Replacement critical parts receiving records shall be attached or be traceable to the valve repair document (see 4.8.5.4 i)). These records shall conform to at least one of the following.

1) Receiving records documenting the shipping origin of the part fabricated by the valve manufacturer (such as packing list) from the valve manufacturer or assembler of the valve type.

2) A document prepared by the "VR" Certificate holder certifying that the replacement part used in the repair has the manufacturer's identification on the part or is otherwise labeled or tagged by the manufacturer and meets the manufacturer’s acceptance criteria (e.g., critical dimensions found in maintenance manual).

3) Receiving records for replacement critical parts obtained from a source other than the valve manufacturer or assembler of the valve type shall include a document that provides as a minimum:

a. The part manufacturer and part designation.

b. A certifying statement that either:

1. The part was fabricated by the valve manufacturer and meets the manufacturer’s acceptance criteria (e.g., critical dimensions found in maintenance manual), or

2. The part meets the manufacturer’s specifications and was fabricated from material as identified by the attached material test report.

c. The signature of an authorized individual of the part source.

d. The name and address of the part source for whom the authorized individual is signing.

d) Material for bolting shall meet the manufacturer’s specification, but does not require material test certification if marked as required by the material specification.
<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4</th>
<th><strong>4.4 WELDING FOR PRESSURE RELIEF VALVES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>When welding is used as a repair technique during a pressure relief valve repair, the following requirements shall apply.</td>
</tr>
<tr>
<td></td>
<td>a) Welding shall be performed in accordance with the requirements of the original code of construction used for the pressure relief valve.</td>
</tr>
<tr>
<td></td>
<td>b) Cast iron and carbon or alloy steel having a carbon content of more than 0.35% shall not be welded.</td>
</tr>
<tr>
<td></td>
<td>c) Defects in pressure relief valve parts such as cracks, pits, or corrosion that will be repaired by welding shall be completely removed before the weld repair of the part is performed. Removal of the defect shall be verified by suitable NDE as required.</td>
</tr>
<tr>
<td></td>
<td>d) Consideration shall be given to the condition of the existing material, especially in the weld preparation area.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4.1</th>
<th><strong>4.4.1 WELDING PROCEDURE SPECIFICATIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welding shall be performed in accordance with Welding Procedure Specifications (WPS) qualified in accordance with the original code of construction. When this is not possible or practicable, the WPS may be qualified in accordance with Section IX of the ASME Code.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4.2</th>
<th><strong>4.4.2 STANDARD WELDING PROCEDURE SPECIFICATIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A “VR” Certificate Holder may use one or more applicable Standard Welding Procedure Specifications shown in NBIC Part 3, 2.3.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4.3</th>
<th><strong>4.4.3 PERFORMANCE QUALIFICATION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welders or welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction or Section IX of the ASME Code.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4.4</th>
<th><strong>4.4.4 WELDING RECORDS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The “VR” Certificate Holder shall maintain a record of the results obtained in welding procedure qualifications, except for those qualifications for which the provisions of 4.4.2 are used, and of the results obtained in welding performance qualifications. These records shall be certified by the “VR” Certificate Holder and shall be available to the National Board.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4.5</th>
<th><strong>4.4.5 WELDERS’ IDENTIFICATION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The “VR” Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The “VR” Certificate Holder shall also establish a written procedure whereby welded joints can be identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and shall be described in the quality control system written description. The welder’s or welding operator’s identification mark may be stamped (low stress stamp) adjacent to welded joints made by the individual, or the “VR” Certificate Holder may keep a documented record of welded joints and the welders or welding operators used in making the joints.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401 Part 4, 4.4.6</th>
<th><strong>4.4.6 WELDERS’ CONTINUITY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The performance qualification of a welder or welding operator shall be affected when one of the following conditions occur:</td>
</tr>
<tr>
<td></td>
<td>a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire.</td>
</tr>
<tr>
<td></td>
<td>b) When there is specific reason to question their ability to make welds that meet the specification, the qualification that supports the welding that is being performed shall be revoked. All other qualifications not</td>
</tr>
</tbody>
</table>
**NB11-0401 Part 4, 4.4.7**

### 4.4.7 WELD REPAIRS TO PRESSURE RELIEF VALVE PARTS BY AN “R” STAMP HOLDER

a) The quality system manual may include controls for the “VR” Certificate Holder to have the pressure relief valve part repaired by a National Board “R” Certificate Holder, per this section provided the following documentation is provided to the “R” Certificate Holder:

1) Code of construction, year built;
2) Part identification;
3) Part material specified; and
4) “VR” Certificate Holder’s unique identifier for traceability as required by the repair inspection program.

b) Prior to performing weld repairs to pressure relief valve (PRV) parts, the “R” Certificate Holder shall receive repair information required by 4.4.7 a) from the “VR” Certificate Holder responsible for the pressure relief valve repair.

1) PRV part weld repairs shall be performed under the “R” Certificate Holder’s quality system; however, the requirements for in-process involvement of the Inspector (see Part 3, 2.2.2) may be waived. The requirement for stamping is waived.

2) The process of identifying and controlling repairs shall be documented in the “R” Certificate Holder’s quality system.

3) PRV part repairs shall be documented on a Form R-1 with a statement under the “Remarks” section “PRV Part Repair.” The owner’s name and location of installation shall be that of the “VR” Certificate Holder. The information received from the “VR” Certificate Holder as required in 4.4.7 a) shall be noted under the “Description of Work” section.

4) Upon completion of the repair, the repaired part and completed Form R-1 shall be returned to the “VR” Certificate Holder responsible for completing the PRV repair.

---

**NB11-0401 Part 4, 4.5.1**

### 4.5 HEAT TREATMENT

#### 4.5.1 PREHEATING

Preheating may be employed during welding to assist in completion of the welded joint in accordance with Part 3, 2.5.1. The need for and the temperature of preheat are dependent on a number of factors, such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties. The welding procedure specification for the material being welded shall specify the preheat temperature requirements.

---

**NB11-0401 Part 4, 4.5.2**

### 4.5.2 POSTWELD HEAT TREATMENT

Postweld heat treatment shall be performed as required by the original code of construction in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment. A time and temperature report or temperature record shall be maintained to document the work performed.

---

**NB11-0401 Part 4, 4.6**

### 4.6 PRESSURE RELIEF VALVE PERFORMANCE TESTING AND TESTING EQUIPMENT

Each pressure relief valve to which the “VR” repair symbol stamp is to be applied shall be subjected to the following tests by the repair Certificate Holder.
4.6.1 TEST MEDIUM AND TESTING EQUIPMENT

Valves marked for steam service, or having special internal parts for steam service, shall be tested on steam. Valves marked for air, gas, or vapor service shall be tested with air or gas. Valves marked for liquid service shall be tested with water or other suitable liquid. ASME Code, Section IV hot-water valves, shall be tested on water, steam, or air.

a) Each valve shall be tested to demonstrate the following:

1) Set pressure (as defined by the valve manufacturer and as listed in NB-18, Pressure Relief Device Certifications);

2) Response to blowdown, when required by the original code of construction;

3) Seat tightness; and

4) For valves designed to discharge to a closed system, the tightness of the secondary pressure zone shall be tested as required by the original code of construction.

b) The equipment used for the performance testing prescribed above shall meet the following requirements:

1) The performance testing equipment shall include a pressure vessel of adequate volume and pressure source capacity to ensure compliance with 4.6.1 a) 1);

2) Prior to use, all performance testing equipment shall be qualified by the Certificate Holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark testing, comparisons to equipment used for verification testing as specified in the quality system, or comparisons to field performance. This qualification shall be documented. Documentation of this qualification shall be retained in accordance with Table 4.8.5.4 s). Documentation of this qualification shall include but not be limited to:

   a. Schematic of the performance test equipment;

   b. Size and pressure ranges of valves to be tested and the test fluid to be used;

   c. Dimensions of test vessels;

   d. Accuracy of pressure measuring equipment;

   e. Size and design type of valves used to control flow; and

   f. Method of qualifying.

3) Prior to the implementation of any addition or modification to the testing equipment that would alter the contents of the document required in 4.6.1 b) 2), the Certificate Holder shall re-qualify the performance test equipment in accordance with 4.6.1 b) 2). If the equipment changed was used to satisfy the requirements of verification testing, the Certificate Holder shall notify the National Board and additional verification testing, in accordance with the quality system, may be required.

4.6.2 OWNER-USER ASME CODE SECTION VIII STEAM TESTING

When ASME Code Section VIII valves are repaired by the owner for the owner's own use, valves for steam service may be tested on air for set pressure and, if possible, blowdown adjustment, provided the valve manufacturer's corrections for differential in set pressure between steam and air are applied to the set pressure.
4.6.3 LIFT ASSIST TESTING

a) A device may be used to apply an auxiliary lifting load on the spring of a repaired valve to establish the set pressure in lieu of the tests required in 4.6.1 a) 1) when such testing at full pressure:

1) may cause damage to the valve being tested; or

2) is impractical when system design considerations preclude testing at full pressure.

b) While actual valve blowdown and valve performance characteristics cannot be verified using this testing technique, valve set pressure may be determined to an acceptable degree of accuracy if, as a minimum:

1) equipment utilized is calibrated as required in the quality system; including, but not limited to:

a. System pressure measurement equipment;

b. Lifting force measurement equipment; and

c. Other measuring elements required by the device manufacturer.

2) the device and test procedures that have proved to give accurate results are used and followed;

3) a static inlet pressure is applied with the test medium specified in 4.6.1; and

4) adjustments are made in accordance with the valve manufacturer’s recommendations to ensure proper lift and blowdown.

c) Prior to use, all lift assist devices shall be qualified by the Certificate Holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation in accordance with Table 4.8.5.4 s). Documentation of this qualification shall include but not be limited to:

1) A description of the lift assist device including model number, serial number and manufacturer;

2) Size and pressure ranges of valves to be tested with the lift assist device and the test fluid to be used;

Note: Maximum set pressure is determined by available lift force and system pressure.

3) Accuracy of pressure measuring equipment; and

4) Method of qualifying.

d) After initial qualification of the device the device shall be re-qualified if:

1) Modifications or repairs to the device are made which would affect test results; or

2) The manufacturer issues a mandatory recall or modification to the device which will affect test results.

4.6.4 PRESSURE TEST OF PARTS

a) Parts used in repaired valves shall be pressure tested and documentation provided according to the following categories:

1) Replacement Parts

The “VR” Certificate Holder is responsible for documentation that the appropriate pressure test has been completed as required by the original code of construction.

2) Parts Repaired by Welding
These parts shall be subjected to a pressure test required by the original code of construction. The “VR” Certificate Holder shall be responsible for documentation of such test.

b) Parts repaired by re-machining within part specifications, lapping, or polishing do not require a pressure test.

**NB11-0401**  
**Part 4, 4.7**

### 4.7 STAMPING REQUIREMENTS FOR PRESSURE RELIEF DEVICES

#### 4.7.1 NAMEPLATES

Proper marking and identification of tested or repaired valves is critical to ensuring acceptance during subsequent inspections, and also provide for traceability and identification of any changes made to the valve. All operations that require the valve’s seals to be replaced shall be identified by a nameplate as described in 4.7.2 or 4.7.4.

#### 4.7.2 REPAIR NAMEPLATE

When a pressure relief valve is repaired, a metal repair nameplate stamped with the information required below shall be securely attached to the valve adjacent to the original manufacturer’s stamping or nameplate. If not installed directly on the valve, the nameplate shall be securely attached so as not to interfere with valve operation and sealed in accordance with the quality system.

a) Prior to attachment of the repair nameplate, the previous repair nameplate, if applicable, shall be removed from the repaired valve.

b) As a minimum, the information on the valve repair nameplate (see Figure 4.7.2-a) shall include:

1) The name of the repair organization preceded by the words “repaired by”;

2) The “VR” repair symbol stamp and the “VR” certificate number;

3) Unique identifier (e.g., repair serial number, shop order number, etc.);

4) Date of repair;

5) Set pressure;

6) Capacity and capacity units (if changed from original nameplate due to set pressure or service fluid change);

7) Type/Model number (if changed from original nameplate by a conversion. See 4.2); and

8) When an adjustment is made to correct for service conditions of superimposed back pressure and/or temperature or the differential between popping pressure between steam and air (see 4.6.2), the information on the valve repair nameplate shall include the:

a. Cold Differential Test Pressure (CDTP); and

b. Superimposed Back Pressure (BP) (only when applicable).

**FIGURE 4.7.2-a**
4.7.3 CHANGES TO ORIGINAL PRESSURE RELIEF VALVE NAMEPLATE INFORMATION

a) If the set pressure is changed, the set pressure, capacity, and blowdown, if applicable, on the original nameplate or stamping shall be marked out but left legible. The new capacity shall be based on that for which the valve was originally certified.

b) If the service fluid is changed, the capacity, including units, on the original nameplate or stamping shall be marked out but left legible. The new capacity shall be based on that for which the valve was originally certified, or if a conversion has been made, as described in 4.2 on the capacity certification for the valve as
c) If the Type/Model number is changed, the Type/Model number on the original nameplate or stamping shall be marked out but left legible.

d) If the blowdown is changed, the blowdown, if shown on the original nameplate or stamping, shall be marked out but left legible. The new blowdown may be based on the current ASME Code requirements.

e) Repair organizations shall verify the Type/Model number, inlet size, set pressure, and capacity on the original nameplate or stamping that is not marked out. Incorrect information on the original manufacturer’s nameplate or stamping shall be marked out but left legible. Corrected information shall be indicated on the repair nameplate and noted on the document as required by the quality system.

**NB11-0401 Part 4, 4.7.4**

### 4.7.4 TEST ONLY NAMEPLATE

a) Where a valve has been tested and adjusted to restore the set pressure shown on the unmodified original nameplate or stamping, or repair nameplate, as permitted by S3.1, but not otherwise repaired, a “Test Only” nameplate shall be applied that contains the following information:

1) Name of responsible organization;
2) Date of test;
3) Set Pressure; and
4) Identification, such as “Test Only.”

b) A “Test Only” nameplate is also recommended when periodic testing has been performed, even when no adjustments have been made, for the purpose of identifying the date the valve was tested.

c) The existing repair nameplates, if applicable, shall not be removed during such testing.

**NB11-0401 Part 4, 4.7.5**

### 4.7.5 REPLACEMENT OF ILLEGIBLE OR MISSING NAMEPLATES

a) Illegible Nameplates

When the information on the original manufacturer’s or assembler’s nameplate or stamping is illegible, but traceability can be confirmed, the nameplate or stamping shall be augmented by a nameplate furnished by the “VR” stamp holder stamped “Duplicate.” It shall contain all information that originally appeared on the nameplate or valve, as required by the applicable section of the ASME Code, except the “V,” “HV,” or “UV” symbol and the National Board mark. The repair organization’s nameplate, with the “VR” stamp and other required data specified in 4.7.2, will make the repairer responsible to the owner and the Jurisdiction that the information on the duplicate nameplate is correct.

b) Missing Nameplates

When the original valve nameplate is missing, the repair organization is not authorized to perform repairs to the valve under the “VR” program, unless positive identification can be made to that specific valve and verification that the valve was originally stamped with an ASME “V” or UV” symbol or marked with an ASME “HV” symbol. Valves that can be positively identified shall be equipped with a duplicate nameplate, as described in this section, in addition to the repairer’s “VR”-stamped nameplate. The repairer’s responsibilities for accurate data, as defined in 4.7.5(a) (Illegible Nameplates), shall apply.

c) Marking of Original Code Stamp

When a duplicate nameplate is affixed to a valve, as required by this section, it shall be marked “Sec. I,” “Sec. IV,” or “Sec. VIII,” as applicable, to indicate the original ASME Code stamping.
4.8 ACCREDITATION OF “VR” REPAIR ORGANIZATIONS

4.8.1 SCOPE

a) This section provides requirements that must be met for an organization to obtain a National Board Certificate of Authorization to use the “VR” Symbol Stamp for repair activities of pressure relief devices constructed in accordance with the requirements of the ASME Code.

b) For administrative requirements to obtain or renew a National Board “VR” Certificate of Authorization and “VR” Symbol Stamp, refer to NB-514, Accreditation of “VR” Repair Organizations.

4.8.2 JURISDICTIONAL PARTICIPATION

The National Board member jurisdiction in which the “VR” organization is located is encouraged to participate in the review and demonstration of the applicant’s quality system. The Jurisdiction may require participation in the review of the repair organization and the demonstration and acceptance of the repair organization’s quality system manual.

4.8.3 ISSUANCE AND RENEWAL OF THE “VR” CERTIFICATE OF AUTHORIZATION

4.8.3.1 GENERAL

Authorization to use the stamp bearing the official National Board “VR” symbol as shown in Figure 4.7.2-a, will be granted by the National Board pursuant to the provisions of the following administrative rules and procedures.

4.8.3.2 ISSUANCE OF CERTIFICATE

Repair organizations, manufacturers, assemblers, or users that make repairs to the ASME Code symbol stamped or marked pressure relief valves and National Board capacity certified pressure relief valves may apply to the National Board for a Certificate of Authorization to use the “VR” symbol.

4.8.4 USE OF THE “VR” AUTHORIZATION

4.8.4.1 TECHNICAL REQUIREMENTS

The administrative requirements of 4.8 for use of the “VR” stamp shall be used in conjunction with the technical requirements for valve repair as described in sections 4.1 through 4.7. Those requirements shall be mandatory when a “VR” repair is performed.

4.8.4.2 STAMP USE

Each “VR” symbol stamp shall be used only by the repair firm within the scope, limitations, and restrictions under which it was issued.

4.8.5 QUALITY SYSTEM

4.8.5.1 GENERAL

Each applicant for a new or renewed “VR” Certificate of Authorization shall have and maintain a quality system which shall establish that all of these rules and administrative procedures and applicable ASME Code requirements, including material control, fabrication, machining, welding, examination, setting, testing, inspection, sealing, and stamping will be met.

4.8.5.2 WRITTEN DESCRIPTION

A written description, in the English language, of the system the applicant will use shall be available for review and shall contain, as a minimum, the features set forth in 4.8.5.4. This description may be brief or voluminous, depending upon the projected scope of work, and shall be treated confidentially. In general,
<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>Part 4, 4.8.5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.8.5.3 MAINTENANCE OF CONTROLLED COPY</strong></td>
<td>Each applicant to whom a “VR” Certificate of Authorization is issued shall maintain thereafter a controlled copy of the accepted quality system manual with the National Board. Except for changes that do not affect the quality system, revisions to the quality system manual shall not be implemented until such revisions are accepted by the National Board.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>NB14-0603</th>
<th>NB15-0316</th>
<th>Part 4, 4.8.5.4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.8.5.4 OUTLINE OF REQUIREMENTS FOR A QUALITY SYSTEM</strong></td>
<td>The following establishes the minimum requirements of the written description of the quality system. It is required that each valve repair organization develop its own quality system that meets the requirements of its organization. For this reason it is not possible to develop one quality system that could apply to more than one organization. The written description shall include, as a minimum, the following features:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>a) Title Page</strong></td>
<td>The title page shall include the name and address of the company to which the National Board Certificate of Authorization is to be issued.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>b) Revision Log</strong></td>
<td>A revision log shall be included to ensure revision control of the quality system manual. The log should contain sufficient space for date, description and section of revision, company approval, and National Board acceptance.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>c) Contents Page</strong></td>
<td>The contents page shall list and reference, by paragraph and page number, the subjects and exhibits contained therein.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>d) Statement of Authority and Responsibility</strong></td>
<td>A statement of authority and responsibility shall be dated and signed by an officer of the company. It shall include:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) A statement that the “VR” stamp shall be applied only to pressure relief valves that meet both of the following conditions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Are stamped with an ASME “V”, “UV”, or “NV” Code symbol or marked with an ASME “HV” symbol and have been capacity certified by the National Board; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Have been disassembled, inspected, and repaired by the Certificate Holder such that the valves’ condition and performance are equivalent to the standards for new valves.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) The title of the individual responsible to ensure that the quality system is followed and who has authority and freedom to effect the responsibility;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3) A statement that if there is a disagreement in the implementation of the written quality system, the matter is to be referred to a higher authority in the company for resolution; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4) The title of the individual authorized to approve revisions to the written quality system and the method by which such revisions are to be submitted to the National Board for acceptance before implementation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>e) Organization Chart</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A chart showing the relationship between management, purchasing, repairing, inspection, and quality control personnel shall be included and shall reflect the actual organization in place.

f) Scope of Work

1) The scope of work section shall indicate the scope and type of valve repairs, including conversions the organization is capable of and intends to perform. The location of repairs (shop, shop and field, or field only), ASME Code Section(s) to which the repairs apply, the test medium (air, gas, liquid, or steam, or combinations thereof), and special processes (machining, welding, postweld heat treatment, or nondestructive examination, or combinations thereof) shall be specifically addressed.

2) The types and sizes of valves to be repaired, pressure ranges and other limitations, such as engineering and test facilities, should also be addressed.

g) Drawings and Specification Control

The drawings and specification control system shall provide procedures assuring that the latest applicable drawings, specifications, and instructions required are used for valve repair, including conversions, inspection, and testing.

h) Material and Part Control

The material and part control section shall describe purchasing, receiving, storage, and issuing of parts.

1) The title of the individual responsible for the purchasing of all material shall be stated.

2) The title of the individual responsible for certification and other records as required shall be stated.

3) All incoming material and parts shall be checked for conformance with the purchase order and, where applicable, the material specifications or drawings. Indicate how material or part is identified and how identity is maintained by the quality system.

i) Repair and Inspection Program

The repair and inspection program section shall include reference to a document (such as a report, traveler, or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure relief valves. Repair procedures shall require verification that the critical parts meet the valve manufacturer's specification. Supplement 4 outlines recommended procedures covering some specific items. This document shall be retained in accordance with Table 4.8.5.4.

1) Each valve or group of valves shall be accompanied by the document referred to above for processing through the plant. Each valve shall have a unique identifier (i.e., repair serial number, shop order number, etc.) appearing on the repair documentation and repair nameplate such that traceability is established.

2) The document referred to above shall describe the original nameplate information, including the ASME Code symbol stamping and the repair nameplate information, if applicable. In addition, it shall include material checks, replacement parts, conversion parts (or both), reference to items such as the welding procedure specifications (WPS), fitup, NDE technique, heat treatment, and pressure test methods to be used. Application of the "VR" stamp to the repair nameplate shall be recorded in this document. Specific conversions performed with the new Type/Model number shall be recorded on the document. There shall be a space for "signoffs" at each operation to verify that each step has been properly performed.

3) The system shall include a method of controlling the repair or replacement of critical valve parts. The method of identifying each spring shall be indicated.

4) The system shall also describe the controls used to ensure that any personnel engaged in the repair of pressure relief valves are trained and qualified in accordance with this section.

j) Welding, NDE, and Heat Treatment (when applicable)
The quality system manual shall indicate the title of the person(s) responsible for and describe the system used in the selection, development, approval, and qualification of welding procedure specifications, and the qualification of welders and welding operators in accordance with the provisions of 4.4.

1) The quality system manual may include controls for the “VR” Certificate Holder to have the pressure relief valve part repaired by a National Board “R” Certificate Holder, per 4.4.7.

2) The completed Form R-1 shall be noted on and attached to the “VR” Certificate Holder’s document required in 4.8.5.4i). Similarly, NDE and heat treatment techniques must be covered in the quality system manual. When outside services are used for NDE and heat treatment, the quality system manual shall describe the system whereby the use of such services meet the requirements of the applicable section of the ASME Code.

k) Valve Testing, Setting, and Sealing

The system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code Section and the National Board. The seal shall identify the “VR” Certificate Holder making the repair. Abbreviations or initials shall be permitted, provided such identification is acceptable to the National Board.

l) Valve Repair Nameplates

An effective valve stamping system shall be established to ensure proper stamping of each valve as required by 4.7.2. The manual shall include a description of the nameplate or a drawing.

m) Calibration

1) The manual shall describe a system for the calibration of examination, measuring, and test equipment used in the performance of repairs. Documentation of these calibrations shall include the standard used and the results. Calibration records shall be retained in accordance with Table 4.8.5.4.i).

2) All calibration standards shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

n) Manual Control

The quality system shall include:

1) Measures to control the issuance of and revisions to the quality system manual;

2) Provisions for a review of the system in order to maintain the manual current with these rules and the applicable sections of the ASME Code;

3) The title(s) of the individual(s) responsible for control, revisions, and review of the manual;

4) Provision of a controlled copy of the written quality system manual to be submitted to the National Board; and

5) Revisions shall be submitted for acceptance by the National Board prior to being implemented.

o) Nonconformities

The system shall establish measures for the identification, documentation, evaluation, segregation, and disposition of nonconformities. A nonconformity is a condition of any material, item, product, or process in which one or more characteristics do not conform to the established requirements. These may include, but are not limited to, data discrepancies, procedural and/or documentation deficiencies, or material defects. Also, the title(s) of the individual(s) involved in this process shall be included.
p) Exhibits

Forms used in the quality system shall be included in the manual with a written description. Forms exhibited should be marked SAMPLE and completed in a manner typical of actual valve repair procedures.

q) Testing Equipment

The system shall include a means to control the development, addition, or modification of testing equipment to ensure the requirements of 4.6.1 b) and 4.6.3 c) are met.

(See Supplement 5 for a guide on the sizing of pressure vessels used as part of pressure relief valve test equipment)

r) Field Repairs

If field repairs are included in the scope of work, the system shall address any differences or additions to the quality system required to properly control this activity, including the following:

1) Provisions for annual audits of field activities shall be included;

2) Provisions for receipt and inspection of replacement parts, including parts received from the owner-user, shall be addressed;

3) If owner-user personnel will assist with repairs, provisions for the use of owner user personnel shall be included; and

4) Provisions for use of owner-user measurement and test equipment, if applicable, shall be addressed.

s) Records Retention

The quality manual shall describe a system for filing, maintaining, and easily retrieving records supporting or substantiating the administration of the Quality System within the scope of the "VR" Certificate of Authorization.

1) Records may represent any information used to further substantiate the statements used to describe the scope of work completed to a pressure-retaining item (PRI), and documented on a Form "R" report.

2) Records include, but are not limited to, those depicting or calculating an acceptable design, material compliance or certifications, NDE-reports, PWHT-charts, a WPS used, a welder, bonder, or cementing technician’s process continuity records, drawings, sketches, or photographs.

3) The record retention schedule described in the Quality System Manual is to follow the instructions identified in NBIC Part 3, Table 1.6.1.

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>NB14-0603</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 4, Table 4.8.5.4 s)</td>
<td>Table 4.8.5.4 s)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reports, Records, or Documents for &quot;VR&quot; Certificate Holders</th>
<th>Instructions</th>
<th>Minimum Retention Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form &quot;R&quot; reports associated with a pressure relief valve that required welding as part of the repair</td>
<td>Record retention shall be in accordance with Part 3, Table 1.6.1</td>
<td>Refer to Part 3, Table 1.6.1</td>
</tr>
<tr>
<td>a) Record of repair or inspection</td>
<td>The repair and inspection program section shall include reference to a document (such as a report, traveler, or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure relief valves.</td>
<td>5 years</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>b) Records related to equipment qualification and instrument calibration</td>
<td>Prior to use, all performance testing equipment shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark testing, comparisons to equipment used for verification testing as specified in the quality system, or comparisons to field performance.</td>
<td>5 years after the subject piece of equipment or instrument is retired.</td>
</tr>
<tr>
<td>c) Record of lift assist device qualification</td>
<td>Prior to use, all lift assist devices shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented.</td>
<td>5 years after the lift assist device is retired.</td>
</tr>
<tr>
<td>d) Records of employee training and qualification</td>
<td>Each repair organization shall establish minimum qualification requirements for those positions within the organization as they directly relate to pressure relief valve repair. Each repair organization shall document the evaluation and acceptance of an individual’s qualification for the applicable position.</td>
<td>5 years after termination of employment.</td>
</tr>
<tr>
<td>Title</td>
<td>Section</td>
<td>Content</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>4.8.6 FIELD REPAIR</strong></td>
<td>4.8.6</td>
<td>Repair organizations may obtain a “VR” Certificate of Authorization for field repair, either as an extension to their in-shop/plant scope, or as a field-only scope, provided that:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) Qualified technicians in the employ of the Certificate Holder perform such repairs;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) An acceptable quality system covering field repairs, including field audits, is maintained;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Functions affecting the quality of the repaired valves are supervised from the address of record where the “VR” certification is issued.</td>
</tr>
<tr>
<td><strong>4.8.6.1 AUDIT REQUIREMENTS</strong></td>
<td>4.8.6.1</td>
<td>Upon issuance of a Certificate of Authorization, provided field repairs are performed, annual audits of the work carried out in the field shall be performed to ensure that the requirements of the Certificate Holder’s quality system are met. The audit shall include, but not be limited to, performance testing, in accordance with 4.6, of valve(s) that were repaired in the field. The audits shall be documented.</td>
</tr>
<tr>
<td><strong>4.8.6.2 USE OF OWNER-USER PERSONNEL</strong></td>
<td>4.8.6.2</td>
<td>For the repair of pressure relief valves at an owner-user’s facility for the owner-user’s own use, the “VR” Certificate Holder may utilize owner-user personnel to assist Certificate Holder technician(s) in the performance of repairs provided:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) The use of such personnel is addressed in the “VR” Certificate Holder’s quality system;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) The owner-user personnel are trained and qualified in accordance with Supplement 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Owner-user personnel work under direct supervision and control of the “VR” Certificate Holder’s technician(s) during any stage of the repair when they are utilized;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) The “VR” Certificate Holder shall have the authority to assign and remove owner-user personnel at its own discretion; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e) The names of the owner-user personnel utilized are recorded on the document as required for a quality system.</td>
</tr>
<tr>
<td><strong>4.9 TRAINING AND QUALIFICATION OF PERSONNEL</strong></td>
<td>4.9.1</td>
<td>The repair organization shall establish a documented in-house training program. This program shall establish training objectives and provide a method of evaluating training effectiveness. As a minimum, training objectives for knowledge level shall include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a) Applicable ASME Code and NBIC requirements;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Responsibilities within the organization’s quality system; and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Knowledge of the technical aspects and mechanical skills for the applicable position held.</td>
</tr>
<tr>
<td><strong>4.9.2 QUALIFICATION OF PERSONNEL</strong></td>
<td>4.9.2</td>
<td>Each repair organization shall establish minimum qualification requirements for those positions within the organization as they directly relate to pressure relief valve repair. Each repair organization shall document the evaluation and acceptance of an individual’s qualification for the applicable position.</td>
</tr>
</tbody>
</table>
4.9.3 ANNUAL REVIEW OF QUALIFICATION

The repair organization shall annually review the qualifications of repair personnel to verify proficiency as well as compliance with the Certificate Holder’s quality system. This review shall include training records, documented evidence of work performed, and when necessary, monitoring job performance. The review shall be documented.

SUPPLEMENT 1

PRESSURE RELIEF VALVES ON THE LOW PRESSURE SIDE OF STEAM PRESSURE-REDUCING VALVES

S1.1 SCOPE

This supplement provides requirements and guidelines for the installation of safety valves on the low-pressure side of steam pressure-reducing valves.

a) The subject of protection of vessels in steam service connected to the low-pressure side of a steam-pressure-reducing valve is of considerable importance to proper operation of auxiliary equipment such as pressure cookers, hot-water heating systems, etc., operating at pressures below that which the primary boiler generating unit is operating.

b) To automatically reduce the primary boiler pressure for such processing equipment, pressure-reducing valves are used. The manufacturers of such equipment have data available listing the volume of flow through reducing valves manufactured by them, but such data are not compiled in a form that the results can be deduced readily. To protect the equipment operating on the low pressure side of a pressure-reducing valve, pressure relief valves of a relieving capacity sufficient to prevent an unsafe pressure rise in case of failure of the pressure-reducing valve, should be installed.

c) The pressure-reducing valve is a throttling device, the design of which is based on certain diaphragm pressures opposed by spring pressure which, in turn, controls the opening through the valve. If the spring, the diaphragm, or any part of the pressure-reducing valve fails, steam will flow directly through the valve and the low pressure equipment will be subjected to the boiler pressure. To protect the equipment operating on the low pressure side of the pressure-reducing valve, pressure relief valve(s) should be installed on the low pressure side of the pressure-reducing valve, which will provide a relieving capacity sufficient to prevent the pressure from rising above the system design pressure.

d) In most cases pressure-reducing valves used for the reduction of steam pressures have the same pipe size on the inlet and outlet. In case of failure of a pressure-reducing valve, the pressure relief valve on the low-pressure side must have a capacity to take care of the volume of steam determined by the high pressure side and the area of the pipe.

S1.2 PRESSURE RELIEF VALVE CAPACITY

a) The capacity of the pressure relief valve(s) on the low-pressure side of the pressure-reducing valve should be based on the capacity of the pressure-reducing valve when wide open or under maximum flow conditions or the flow capacity through the bypass valve.

b) By using the formula in S1.3 below, Inspectors may calculate the required relieving capacities of the pressure relief valve(s) installed on the low-pressure side of the pressure reducing valve.

c) Usually a pressure-reducing valve has a bypass arrangement so that in case of failure of the pressure-reducing valve the boiler pressure may be short circuited into the low-pressure line without passing through the pressure-reducing valve. When determining the required relieving capacity of pressure relief valves for the low-pressure side of the pressure-reducing valve, the steam flow through the bypass must be taken into consideration.
### S1.3 CALCULATION OF PRESSURE RELIEF VALVE RELIEVING CAPACITY

**a)** When a pressure-reducing valve is installed, there are two possibilities of introducing boiler pressure into the low-pressure system:

1) the failure of the pressure-reducing valve so that it remains wide open; and

2) the possibility of the bypass valve being open.

**b)** It is necessary therefore, to determine the flow under both circumstances in paragraph a) above and check that the size of the pressure relief valve under either condition will be adequate. The following formulas should be used:

1) \[ W = \text{steam flow in lbs/hr (kg/hr) through the pressure-reducing valve} \]

\[ W = AKC \]

where,

- \( A \) = internal area in \( \text{in}^2 \) (mm\(^2\)) of the inlet pipe size of the pressure reducing valve (see Table S1.5)
- \( K \) = flow coefficient for the pressure reducing valve (see S1.4)
- \( C \) = flow capacity of saturated steam through a pipe in lbs/hr/in\(^2\) (kg/hr/mm\(^2\)) at various pressure differentials from Tables S1.3-a, S1.3-b, or S1.3-c. (for U.S. Customary units) or Tables S1.3M-a, S1.3M-b, or S1.3M-c (for metric units).

2) \[ W = \text{steam flow in lbs/hr (kg/hr) through the by-pass valve} \]

\[ W = A_1 K_1 C_1 \]

where,

- \( A_1 \) = internal area in \( \text{in}^2 \) (mm\(^2\)) of the pipe size of the bypass around the pressure-reducing valve
- \( K_1 \) = flow coefficient for the bypass valves (see S1.4)
- \( C_1 \) = flow capacity of saturated steam through a pipe in lbs/hr/in\(^2\) (kg/hr/mm\(^2\)) at various pressure differentials from Tables S1.3-a, S1.3-b, or S1.3-c. (for U.S. Customary units) or Tables S1.3M-a, S1.3M-b, or S1.3M-c (for metric units).
### Table S1.3-a
CAPACITY OF SATURATED STEAM, IN lbs/hr, per in.² OF PIPE AREA

<table>
<thead>
<tr>
<th>Outlet pres., psi</th>
<th>Pressure-reducing valve inlet pressure, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
</tr>
<tr>
<td>750</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td></td>
</tr>
</tbody>
</table>

Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

### Table S1.3M-a
CAPACITY OF SATURATED STEAM, IN kg/hr, per mm² OF PIPE AREA

<table>
<thead>
<tr>
<th>Outlet pres., MPa</th>
<th>Pressure-reducing valve inlet pressure, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>1.20</td>
<td></td>
</tr>
<tr>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>1.30</td>
<td></td>
</tr>
</tbody>
</table>

Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.
### Table S1.3-b
CAPACITY OF SATURATED STEAM, IN lbs/hr, per in.² OF PIPE AREA

<table>
<thead>
<tr>
<th>Outlet press., psi</th>
<th>Pressure-reducing valve inlet pressure, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>950</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>900</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>850</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>800</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>750</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>700</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>650</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>600</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>550</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>500</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>450</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>400</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>350</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>300</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>250</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>200</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>175</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>150</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>125</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>100</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>75</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>50</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>30</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>15</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>10</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
<tr>
<td>5</td>
<td>500  400  300  200  100  50  30  20  10</td>
</tr>
</tbody>
</table>

Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

### Table S1.3M-b
CAPACITY OF SATURATED STEAM, IN kg/hr, per mm² OF PIPE AREA

<table>
<thead>
<tr>
<th>Outlet press., MPa</th>
<th>Pressure-reducing valve inlet pressure, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.65</td>
<td>0.50  0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
<tr>
<td>0.50</td>
<td>0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
<tr>
<td>0.35</td>
<td>0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
<tr>
<td>0.25</td>
<td>0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
<tr>
<td>0.15</td>
<td>0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
<tr>
<td>0.10</td>
<td>0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
<tr>
<td>0.05</td>
<td>0.40  0.30  0.20  0.10  0.05  0.03  0.02  0.01</td>
</tr>
</tbody>
</table>

Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.
S1.4 STEAM FLOW WHEN FLOW COEFFICIENTS ARE NOT KNOWN

a) It is possible that the flow coefficients $K$ and $K_1$ may not be known and in such instances for approximating the flow, a factor of 1/3 may be substituted for $K$ and 1/2 for $K_1$.

The formulas in S1.3 then become:

$$W = \frac{1}{3}A^*C$$

for the capacity through the pressure-reducing valve; and

$$W = \frac{1}{2}A_1^*C_2$$

for the capacity through the bypass valve.

b) Caution should be exercised when substituting these factors for the actual coefficients since this method...
S1.5 TWO-STAGE PRESSURE-REDUCING VALVE STATIONS

The pressure relief valve for two-stage pressure-reducing valve stations shall be sized on the basis of the highside pressure and the inlet size of the first pressure-reducing valve in the line. If an intermediate pressure line is taken off between the pressure-reducing valves, then this line and the final low side shall be protected by pressure relief valves sized on the basis of the high-side pressure and the inlet size of the first pressure-reducing valve. See Table S1.5.

Table S1.5
PIPE DATA

<table>
<thead>
<tr>
<th>nominal Pipe size, unit less (ansi b36.10)</th>
<th>nominal Pipe size, unit less (iso 3607)</th>
<th>average outside diamter, in.</th>
<th>average outside diamter, mm</th>
<th>nominal wall thicknness of standard weight Pipe, in.</th>
<th>nominal wall thicknness of standard weight Pipe, mm</th>
<th>approx. Internal area, sq. in.</th>
<th>approx. Internal area, sq. mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS 3/8</td>
<td>DN 10</td>
<td>0.675</td>
<td>17.2</td>
<td>0.091</td>
<td>2.311</td>
<td>40.1</td>
<td>124</td>
</tr>
<tr>
<td>NPS 1/2</td>
<td>DN 15</td>
<td>0.840</td>
<td>21.3</td>
<td>0.109</td>
<td>2.769</td>
<td>51.0</td>
<td>198</td>
</tr>
<tr>
<td>NPS 3/4</td>
<td>DN 20</td>
<td>1.050</td>
<td>26.7</td>
<td>0.113</td>
<td>2.870</td>
<td>61.6</td>
<td>347</td>
</tr>
<tr>
<td>NPS 1</td>
<td>DN 25</td>
<td>1.315</td>
<td>33.3</td>
<td>0.133</td>
<td>3.378</td>
<td>72.0</td>
<td>562</td>
</tr>
<tr>
<td>NPS 1-1/4</td>
<td>DN 32</td>
<td>1.660</td>
<td>42.2</td>
<td>0.140</td>
<td>3.556</td>
<td>80.8</td>
<td>973</td>
</tr>
<tr>
<td>NPS 1-1/2</td>
<td>DN 40</td>
<td>1.900</td>
<td>48.3</td>
<td>0.145</td>
<td>3.683</td>
<td>86.1</td>
<td>1324</td>
</tr>
<tr>
<td>NPS 2</td>
<td>DN 50</td>
<td>2.375</td>
<td>60.2</td>
<td>0.154</td>
<td>3.912</td>
<td>100.0</td>
<td>2182</td>
</tr>
<tr>
<td>NPS 2-1/2</td>
<td>DN 65</td>
<td>2.875</td>
<td>72.2</td>
<td>0.203</td>
<td>5.516</td>
<td>162.5</td>
<td>3113</td>
</tr>
<tr>
<td>NPS 3</td>
<td>DN 80</td>
<td>3.500</td>
<td>88.9</td>
<td>0.216</td>
<td>5.486</td>
<td>170.0</td>
<td>4807</td>
</tr>
<tr>
<td>NPS 3-1/2</td>
<td>DN 90</td>
<td>4.000</td>
<td>101.6</td>
<td>0.226</td>
<td>5.740</td>
<td>194.0</td>
<td>6429</td>
</tr>
<tr>
<td>NPS 4</td>
<td>DN 100</td>
<td>4.500</td>
<td>116.8</td>
<td>0.237</td>
<td>6.020</td>
<td>230.0</td>
<td>8278</td>
</tr>
<tr>
<td>NPS 5</td>
<td>DN 125</td>
<td>5.503</td>
<td>141.3</td>
<td>0.258</td>
<td>6.553</td>
<td>280.1</td>
<td>13009</td>
</tr>
<tr>
<td>NPS 6</td>
<td>DN 150</td>
<td>6.625</td>
<td>168.3</td>
<td>0.280</td>
<td>7.112</td>
<td>339.0</td>
<td>18786</td>
</tr>
<tr>
<td>NPS 8</td>
<td>DN 200</td>
<td>8.625</td>
<td>212.9</td>
<td>0.322</td>
<td>8.179</td>
<td>452.0</td>
<td>32530</td>
</tr>
<tr>
<td>NPS 10</td>
<td>DN 250</td>
<td>10.750</td>
<td>273.1</td>
<td>0.365</td>
<td>9.271</td>
<td>585.0</td>
<td>51275</td>
</tr>
<tr>
<td>NPS 12</td>
<td>DN 300</td>
<td>12.750</td>
<td>328.8</td>
<td>0.375</td>
<td>9.525</td>
<td>673.1</td>
<td>73541</td>
</tr>
</tbody>
</table>

Note: In applying these rules, the area of the pipe is always based upon standard weight pipe and the inlet size of the pressure-reducing valve.

SUPPLEMENT 2

PRESSURE DIFFERENTIAL BETWEEN PRESSURE RELIEF VALVE SETTING AND BOILER OR PRESSURE VESSEL OPERATING PRESSURE

S2.1 SCOPE

If a pressure relief valve is subjected to pressure at or near its set pressure, it will tend to weep or simmer, and deposits may accumulate in the seat and disk area. Eventually, this can cause the valve to freeze closed and thereafter the valve could fail to open at the set pressure. Unless the source of pressure to the boiler or pressure vessel is interrupted, the pressure could exceed the rupture pressure of the vessel. It is important that the pressure differential between the valve set pressure and the boiler or
For hot-water heating boilers, the recommended pressure differential between the pressure relief valve set pressure and the boiler operating pressure should be at least 10 psi (70 kPa), or 25% of the boiler operating pressure, whichever is greater. Two examples follow:

a) If the pressure relief valve of a hot-water heating boiler is set to open at 30 psi (200 kPa), the boiler operating pressure should not exceed 20 psi (140 kPa).

b) If the pressure relief valve of a hot-water heating boiler is set to open at 100 psi (700 kPa), the boiler operating pressure should not exceed 80 psi (550 kPa).

Section IV of the ASME Code does not require that pressure relief valves used on hot water heating boilers have a specified blowdown. Therefore, to help ensure that the pressure relief valve will close tightly after opening and when the boiler pressure is reduced to the normal operating pressure, the pressure at which the valve closes should be well above the operating pressure of the boiler.

For steam heating boilers, the recommended pressure differential between the pressure relief valve set pressure and boiler operating pressure should be at least 5 psi (35 kPa), i.e., the boiler operating pressure should not exceed 10 psi (70 kPa).

Since some absorption-type refrigeration systems use the steam heating boiler for their operation, the boiler operating pressure may exceed 10 psi (70 kPa). If the boiler operating pressure is greater than 10 psi (70 kPa), it should not exceed 15 psi (100 kPa), minus the blowdown pressure of the pressure relief valve.

This recommendation can be verified by increasing the steam pressure in the boiler until the pressure relief valve pops, then slowly reducing the pressure until it closes, to ensure that this closing pressure is above the operating pressure.

For steam power boilers, the recommended pressure differentials between the pressure relief valve set pressure and the boiler operating pressure are as follows:

<table>
<thead>
<tr>
<th>Boiler Design Pressure</th>
<th>Minimum Pressure Differential</th>
</tr>
</thead>
<tbody>
<tr>
<td>over 15 psi to 300 psi (100 KPa to 2.10 MPa):</td>
<td>10% but not less than 7 psi (50 KPa)</td>
</tr>
<tr>
<td>over 300 psi to 1000 psi (2.14 MPa to 6.89 MPa):</td>
<td>7% but not less than 30 psi (200 KPa)</td>
</tr>
<tr>
<td>over 1000 psi to 2000 psi (6.89 MPa to 13.8 MPa):</td>
<td>5% but not less than 70 psi (480 KPa)</td>
</tr>
<tr>
<td>over 2000 psi (13.8 MPa):</td>
<td>per designer’s judgment</td>
</tr>
</tbody>
</table>

Notes:

1. Above 2000 psi (13.8 MPa) the pressure differential between operating pressure and the maximum allowable working pressure is a matter for the designer’s judgment, taking into consideration such factors as satisfactory operating experience and the intended service conditions.

2. Pressure relief valves in hot water service are more susceptible to damage and subsequent leakage, than pressure relief valves relieving steam. It is recommended that the maximum allowable working
pressure of the boiler and pressure relief valve setting for high-temperature hot-water boilers be selected substantially higher than the desired operating pressure, so as to minimize the time the pressure relief valve must lift.

3. For organic fluid vaporizers a pressure differential of 40 psi (280 kPa) is recommended.

**S2.5 PRESSURE VESSELS**

Due to the variety of service conditions and the various designs of pressure relief valves, only general guidelines can be given regarding differentials between the set pressure of the valve and the operating pressure of the vessel. Operating difficulty will be minimized by providing an adequate differential for the application. The following is general advisory information on the characteristics of the intended service and of the pressure relief valves that may bear on the proper pressure differential selection for a given application. These considerations should be reviewed early in the system design since they may dictate the maximum allowable working pressure of the system.

To minimize operational problems it is imperative that the user consider not only normal operating conditions of the fluids (liquids or gases), pressures, and temperatures, but also start-up and shutdown conditions, process upsets, anticipated ambient conditions, instrument response time, and pressure surges due to quick-closing valves, etc. When such conditions are not considered, the pressure relief devices may become, in effect, a pressure controller, a duty for which they were not designed. Additional consideration should be given to the hazard and pollution associated with the release of the fluid. Larger differentials may be appropriate for fluids which are toxic, corrosive, or exceptionally valuable.

The blowdown characteristics and capabilities are the first consideration in selecting a compatible valve and operating margin. After a self-actuated release of pressure, the valve must be capable of reclosing above the normal operating pressure. For example: if the valve is set at 100 psi (700 kPa) with a 7% blowdown, it will close at 93 psi (640 kPa). The operating pressure must be maintained below 93 psi (640 kPa) in order to prevent leakage or flow from a partially open valve. Users should exercise caution regarding the blowdown adjustment of large, spring-loaded valves. Test facilities, whether owned by the manufacturer, repair house, or user, may not have sufficient capacity to accurately verify the blowdown setting. The setting cannot be considered accurate unless made in the field on an actual installation.

Pilot operated valves represent a special case from the standpoint of both blowdown and tightness. The pilot portion of some pilot operated valves can be set at blowdowns as short as 2%. This characteristic is not, however, reflected in the operation of the main valve in all cases. The main valve can vary considerably from the pilot depending on the location of the two components in the system. If the pilot is installed remotely from the main valve, significant time and pressure lags can occur, but reseating of the pilot ensures reseating of the main valve. The pressure drop in connecting piping between the pilot and the main valve must not be excessive, otherwise the operation of the main valve will be adversely affected.

Tightness capability is another factor affecting valve selection, whether spring-loaded or pilot operated. Tightness varies somewhat depending on whether metal or resilient seats are specified and also on such factors as corrosion and temperature. The required tightness and test method should be specified to comply at a pressure not lower than the normal operating pressure of the process. It should be remembered that any degree of tightness obtained should not be considered permanent. Service operation of a valve almost invariably reduces the degree of tightness.

The following minimum pressure differentials are recommended unless the pressure relief valve has been designed or tested in a specific or similar service and a smaller differential has been recommended by the manufacturer:

<table>
<thead>
<tr>
<th>Set Pressure</th>
<th>Recommended pressure differential</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 70 psi (480 kPa)</td>
<td>5 psi (35 kPa)</td>
</tr>
<tr>
<td>70 – 1000 psi (480 kPa – 6.89 MPa)</td>
<td>10% of set pressure</td>
</tr>
<tr>
<td>Above 1000 psi (6.89 MPa)</td>
<td>7% of set pressure</td>
</tr>
</tbody>
</table>
**NB11-0401**

### SUPPLEMENT 3

#### GUIDE TO JURISDICTIONS FOR AUTHORIZATION OF OWNERS- USERS TO MAKE ADJUSTMENTS TO PRESSURE RELIEF VALVES

**S3.1 GENERAL**

The Jurisdiction may authorize properly trained and qualified employees of boiler and pressure vessel owners or users or their designees to confirm or restore set pressure shown on the unmodified original nameplate or stamping, or repair nameplate and/or performance of pressure relief valves. All external adjustments shall be resealed with a seal identifying the responsible organization and a metal tag that identifies the organization and the date the adjustment shall be installed.

---

**NB11-0401**

### Part 4, S3.2

**S3.2 TRAINING**

**a)** The user shall establish a documented in house training program. This program shall establish training objectives and provide a method of evaluating the training effectiveness. As a minimum, training objectives for knowledge level shall include:

1) Applicable ASME Code and NBIC requirements;

2) Responsibilities within the organization’s quality system;

3) Knowledge of the technical aspects and mechanical skills for making set pressure and/or blowdown adjustments to pressure relief valves;

4) Knowledge of the technical aspects and mechanical skills for marking of pressure relief valve adjustments.

**b)** If the user established a designee, the designee shall establish a training program and make their documentation available to the user and the jurisdictional authority.

---

**NB11-0401**

### Part 4, S3.3

**S3.3 DOCUMENTATION**

Each user shall document the evaluation and acceptance of an employee’s or designee’s qualifications.

---

**NB11-0401**

### Part 4, S3.4

**S3.4 QUALITY SYSTEM**

**a)** A written quality system shall be established by either the user or the designee with a written description available to the jurisdictional authority.

**b)** The written description shall include at a minimum:

1) Calibration of Test Equipment: This shall describe a system for the calibration of measuring and test equipment. Documentation of these calibrations shall include the standard used and the results. Calibration standards shall be calibrated against the equipment having valid relationships to nationally recognized standards.

2) Valve Testing, Setting, and Sealing: This system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code section and S3.1.

3) Valve Marking: An effective marking system shall be established to ensure proper marking of the metal tag required by S3.1. The written quality system shall include a description or drawing of the metal tag.

---

**NB11-0401**

### Part 4, S3.5

**S3.5 EXTERNAL ADJUSTMENTS**

Only external adjustments to restore the set pressure shown on the unmodified original nameplate or stamping, or repair nameplate and/or performance of a pressure relief valve shall be made under the provisions of S3.1 and 2.2.5.
### S3.6 REPAIRS

If disassembly, change of set pressure, or additional repairs are necessary, the valve shall be repaired by an organization that meets the requirements of the NBIC.

### SUPPLEMENT 4

**RECOMMENDED PROCEDURES FOR REPAIRING PRESSURE RELIEF VALVES**

#### S4.1 INTRODUCTION

a) It is essential that the repair organization establish basic, specific procedures for the repair of pressure relief valves. The purpose of these recommended procedures is to provide the repair organization with guidelines for this important aspect of valve repair. It is realized that there are many types of valves and conditions under which they are repaired and, for this reason, the specific items in these recommended procedures may not apply, or they may be inadequate for each of those types or to the detailed repairs that may be required for each valve.

b) S4.2 contains recommended procedures for the repair of spring-loaded pressure relief valves, and S4.3 contains recommended procedures for the repair of pilot operated types of pressure relief valves. Information on Packaging, Shipping and Transportation is included as S4.5.

#### S4.2 SPRING-LOADED PRESSURE RELIEF VALVES

Prior to removal of a valve from a system for a repair or any disassembly, ensure that all sources of pressure have been removed from the valve.

a) Visual Inspection as Received

1) This information is to be recorded:

a. Record user (customer) identification number;  

b. Complete original PRV nameplate data, previous repair nameplate data, plus any important information received from customer;  

c. Check external adjustment seals for warranty repair;  

d. Check bonnet for venting on bellows type valves; and  

e. Check appearance for any unusual damage, missing, or misapplied parts.

2) If sufficient damage or other unusual conditions are detected that may pose a safety risk during preliminary testing, then proceed directly to S4.2 c)

3) Valves that are to be repaired in place proceed to S4.2 c) unless preliminary testing has been authorized by the owner.

b) Preliminary Test as Received

1) Information from the recommended preliminary performance test and subsequent disassembly and inspections will provide a basis for any repair interval change that should be necessary to ensure that the valve will function as intended.

2) Determine set pressure or Cold Differential Test Pressure (CDTP) in accordance with manufacturer’s recommendations and appropriate ASME Code Section. Do not allow test pressure to exceed 116% of set pressure unless otherwise specified by the owner. A minimum of three tests is usually required to obtain consistent results.
3) If results do not correlate with field performance, then steps to duplicate field conditions (fluid and temperature) may be necessary.

4) Record preliminary test results and test bench identification data.

c) Disassembly

1) Remove cap and lever assembly, if applicable.

2) Remove release nut assembly, if applicable.

3) Loosen jam nut on adjusting (compression) screw.

4) Record measurement and remove adjusting (compression) screw.

5) Remove bonnet or yoke.

6) Remove spring and washers, and tag (identify) including upper and lower washers, as appropriate.

7) Remove spindle and disk assembly.

8) Remove ring pins.

9) Record measurement and remove adjusting rings, nozzle, and guide, as applicable.

d) Cleaning

1) Wire all small parts together and clean. (Caution: do not use a cleaning method that will damage the parts.)

2) Do not clean in a chemical solution except under acceptable circumstances.

3) Protect seating surfaces and nameplates prior to cleaning.

e) Inspection

1) Check spring for correct range, damage such as erosion, corrosion, cracking, or compression below free height.

2) Check nozzle for cracks (NDE as applicable) or unusual wear.

3) Check disk assembly for cracks (NDE as applicable) or unusual wear.

4) Check spindle for trueness, bearing areas, and thread condition.

5) Check guide for wear and galling.

6) Check adjusting ring(s) for worn threads and wear.

7) Check ring pins for bent or broken pin and thread condition.

8) Check bellows, if provided, for pinholes and corrosion.

9) Check flange gasket facings for wear and cuts.

f) Machining
Machine nozzle and disk as necessary to the manufacturer’s critical dimension charts.

**g) Lapping**
1) Machine or hand lap disk and nozzle to be sure of flatness.
2) Lap bevel seats to a grey finish; then re-machine disk or plug to the manufacturer’s critical dimension.

**h) Bearing Points**
Grind all bearing areas with grinding compound to make sure they are round and true.

**i) Assembly**
1. Install Nozzle
2. Install lower ring and guide ring to the measurement from c) 9) above or to manufacturer’s specifications.
3. Install guide
4. Install disc and holder
5. Install spindle
6. Install spring washers
7. Install bonnet
8. Install bonnet bolting
9. Install adjusting screw and lock nut to the measurement from c) 4) above,
10. Install release nut and lock nut, and cap and lever assembly, and

**j) Testing**
Test data shall be recorded. Testing will be done in accordance with manufacturer’s recommendations and appropriate ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.

**k) Sealing**
After final adjusting and acceptance by quality control inspection, all external adjustments shall be sealed with a safety seal providing a means of identification of the organization performing the repair.

**l) Nameplate**
The repairer will place a repair nameplate on each repaired valve. The nameplate shall, as a minimum, meet the requirements of 4.7.1.

---

**NB11-0401**
**Part 4, S4.3**

**S4.3 PILOT OPERATED PRESSURE RELIEF VALVES**

**a) Visual Inspection as Received**
1) This information is to be recorded:
   a. Complete nameplate data, plus any other important information received from the customer;
   b. User identification number, if applicable;
   c. Seals on external adjustments (ensure seals are intact);
   d. Identification on seal; and
e. Obvious damage and external condition including missing or misapplied parts.

b) Disassembly

1) Remove pilot and disassemble per manufacturer’s maintenance instruction.

2) Disassemble main valve. Where lift adjustments are provided, do not remove the locking device or change the lift unless it is required as part of conversion.

3) Remove the nozzle if recommended by the manufacturer’s maintenance instructions and/or when required as part of conversion.

c) Cleaning

1) Pilot — Components of pilot are small and must be handled carefully to prevent damage or loss. Clean parts and nameplates with solvents that will not affect the parent metal and/or polish with 500 grit paper.

2) Main Valve — Clean by appropriate means such as abrasive blast. Finishes of machined surfaces must not be affected. (Caution: Do not use a cleaning method that will damage the parts or nameplates.)

d) Inspection

1) Pilot

a. Check spring for damage such as corrosion, cracks, out of square ends, etc.

b. Inspect all parts for damage. Small burrs or scratches may be removed by polishing. Severely damaged parts should be replaced. (Internal components or pilots should not be repaired by machining as the functions of the pilot could easily be impaired.)

c. Check strainers and filters on inlet and outlet lines.

d. Replace all soft goods per manufacturer’s recommendation.

2) Main Valve

a. Check nozzle seating surface for nicks. These can be removed by machining or lapping as required.

b. Check the piston and liner (or other moving member) for galling or excessive wear. The piston should move freely in the liner.

c. Replace soft goods or re-lap disk as required.

d. Where lift adjustments are provided, measure the lift per the manufacturer’s specifications.

e) Testing

Test data shall be recorded. Testing will be done in accordance with the manufacturer’s recommendation and in accordance with the applicable ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.

f) Sealing

After final adjustment and acceptance by quality control, all external adjustments shall be sealed by means assuring positive identification of the organization performing the repair.

g) Nameplate
<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>S4.4 PACKAGING, SHIPPING AND TRANSPORTATION OF PRESSURE RELIEF DEVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 4, S4.4</strong></td>
<td>a) The improper packaging, shipment, and transport of pressure relief devices can have detrimental effects on device operation. Pressure relief devices should be treated with the same precautions as instrumentation, with care taken to avoid rough handling or contamination prior to installation.</td>
</tr>
<tr>
<td></td>
<td>b) The following practices are recommended:</td>
</tr>
<tr>
<td></td>
<td>1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces except threaded and socket-weld valves up to NPS 2 (DN 50) may be securely packaged and cushioned during transport.</td>
</tr>
<tr>
<td></td>
<td>2) Valve inlet and outlet connection, drain connections, and bonnet vents should be protected during shipment and storage to avoid internal contamination of the valve. Ensure all covers and/or plugs are removed prior to installation.</td>
</tr>
<tr>
<td></td>
<td>3) The valve should not be picked up or carried using the lifting lever. Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored. These wires shall be removed before the valve is placed in service.</td>
</tr>
<tr>
<td></td>
<td>4) Pilot valve tubing should be protected during shipment and storage to avoid damage and/or breakage.</td>
</tr>
<tr>
<td></td>
<td>5) Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>SUPPLEMENT 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 4, S5.1</strong></td>
<td><strong>RECOMMENDED GUIDE FOR THE DESIGN OF A TEST SYSTEM FOR PRESSURE RELIEF DEVICES IN COMPRESSIBLE FLUID SERVICE</strong></td>
</tr>
<tr>
<td></td>
<td><strong>S5.1 SCOPE</strong></td>
</tr>
<tr>
<td></td>
<td>This supplement provides guidance for the design of a test system using compressible fluids (e.g., steam or air/gas) and permits the determination of pressure relief valve set pressure and valve operating characteristics such as blowdown.</td>
</tr>
<tr>
<td></td>
<td>The size of the test vessel needed depends on the size of the valve, its set pressure, the design of the test system, and whether blowdown must be demonstrated. A repair organization may use the information provided in this supplement to determine the minimum size test vessel needed so that the measured performance is characteristic of the valve and not the test system.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NB11-0401</th>
<th>S5.2 GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 4, S5.2</strong></td>
<td>a) The National Board administrative rules and procedures for the “VR” Certificate of Authorization and symbol stamp require that pressure relief valves, after repair, be tested in accordance with the manufacturer’s recommendations and the applicable ASME Code. The purpose of this testing is to provide reasonable assurance that valves will perform according to design when they are returned to service.</td>
</tr>
<tr>
<td></td>
<td>b) It is recognized that a full evaluation of the performance of some pressure relief valve designs requires testing at maximum allowable overpressure. However, it is beyond the scope of this supplement to define test equipment or facilities for such testing.</td>
</tr>
<tr>
<td></td>
<td>c) Section 6 of this part provides a glossary, S5.3 describes typical test equipment, and S5.4 provides data for estimating the size of test vessels required.</td>
</tr>
</tbody>
</table>
a) An optimum configuration, particularly when the test medium source is of small capacity, is shown in Figure S5.3-a. The test medium flows from the pressure source, usually a compressor or boiler, to an accumulator. It then flows through a pressure-controlling valve into the test vessel, from which it is discharged, through the pressure relief valve installed on the test vessel. The pressure-controlling valve is usually a globe valve, although any throttling valve is acceptable. If the pressure-controlling valve is of adequate size and can open quickly, large transient flows can be generated, increasing the pressure above the pressure relief valve set pressure, causing it to lift, and be sustained in its lifted condition.

b) Figure S5.3-b shows a simpler test system in which the test vessel is pressurized directly from the pressure source without the use of an accumulator. In this configuration, flow-rates through the pressure relief valve and any consequent over-pressure are dependent on the flow generating capacity of the pressure source.

c) In a test facility, the pressure relief valve is usually installed on an isolating valve that should be of sufficient size that it will not choke flow to the pressure relief valve. There should be no intervening piping between the two valves to avoid any significant pressure drop between the test vessel and the pressure relief valve.

d) The isolating valve and any adapter flanges or valve test nozzles must be designed to sustain pressure relief valve discharge forces, and so secured that these forces are not transmitted to the test vessel. This is especially important for larger valves set at pressures greater than 100 psig (700 kPa).

e) The vessel should have a length-to-diameter ratio as low as is practical, and should be suitably anchored.

f) Pressure sensing lines should be connected to the test vessel well away from any inlet or outlet connections where pressure distortions due to transient changes in flow velocity during testing could cause erroneous pressure readings. When testing with steam, any water head that develops in the gage line must be taken into consideration.

g) Any intervening piping between the test vessel and the pressure relief valve should be as short and as straight as possible and be of adequate size to minimize inlet pressure drop.

h) In the case of steam, the equipment should be insulated and steam traps should be installed, as appropriate, to ensure that the test steam is dry, saturated steam with a minimum quality of 98%.

i) Pressure relief valves shall be used to protect the test vessel and the accumulator.
**S5.4 TEST VESSEL SIZING DATA**

a) Recommended test vessel sizes are given in Figures S5.4-a and S5.4-b for a configuration using one vessel fed directly from the source of the test medium. Figure S5.3-a gives the test vessel size in cu. ft. vs. the valve orifice area in sq. in. for dry, saturated steam. Curves are shown for set pressures up to 500 psig (3.45MPa) for three different blowdowns: 4%, 7%, and 10%. The source is assumed to be capable of feeding the test vessel at 2500 lbs/hr. (1135 kg/hr). Figure S5.4-b gives similar curves for air with a source capable of feeding the test vessel at 200 ft.$^3$/min (5.66m$^3$/min).

b) For valves, with effective orifices less than 1.28 in.$^2$ (826 mm$^2$), the size of the test vessel needed becomes less dependent on the flow capacity of the source. For these valves, a 15 ft.$^3$ (.425 m$^3$) minimum size test vessel is recommended. This should allow the accurate measurement and setting of blowdown for small valves. This minimum size should also be adequate for determining set pressures of larger valves; however, larger test vessels must be used if blowdown is to be set accurately. It is recognized that there are practical limits on the size and maximum pressure of a test vessel used to demonstrate pressure relief valve operational characteristics. In such cases, determination of valve set pressure remains the only viable production and repair test option. The recommended minimum size test vessel (15 ft.$^3$ [0.425 m$^3$]) is normally adequate for this purpose.
SUPPLEMENT 6
PROCEDURES FOR REPAIRS TO ASME “NV” STAMPED PRESSURE RELIEF DEVICES

S6.1 INTRODUCTION
ASME Code “NV” Class 1, 2, or 3 stamped pressure relief devices, which have been capacity certified by the National Board, may be repaired provided the following requirements are met.

S6.2 ADMINISTRATIVE PROCEDURES
a) The repair organization shall hold a valid “VR” Certificate of Authorization.

b) The repair organization shall obtain a National Board “NR” Certificate of Authorization and stamp. The requirements for said certificate and stamp include, but are not limited to, the following. The repair organization shall:

1) Maintain a documented quality assurance program that meets the applicable requirements of NBIC Part 3, 1.8. This program shall also include all the applicable requirements for the use of the “VR” stamp;
2) Have a contract or agreement with an Inspection Agency to provide inspection of repaired "NV"-stamped pressure relief devices by inspectors who have been qualified in accordance with the requirements of ASME QAI-1, Qualifications for Authorized Inspection.

3) Successfully complete a survey of the quality assurance program and its implementation. This survey shall be conducted by representatives of the National Board, the Jurisdiction wherein the applicant’s repair facilities are located, and the applicant’s Authorized Inspection Agency. Further verification of such implementation by the survey team may not be necessary if the applicant holds a valid ASME "NV" certificate and can verify by documentation the capability of implementing the quality assurance program for repair of "NV"-stamped pressure relief devices, covered by the applicant’s ASME "NV" certificate.

c) The application of the "NR" Certificate of Authorization and stamp shall clearly define the scope of intended activities with respect to the repair of Section III, "NV"-stamped pressure relief devices.

d) Revisions to the quality assurance program shall be acceptable to the Authorized Nuclear Inspector Supervisor and the National Board before being implemented.

e) The scope of the “VR” Certificate of Authorization shall include repair of “NV”-stamped pressure relief devices.

f) Verification testing of valves repaired by the applicant shall not be required provided such testing has been successfully completed under the applicant’s "VR" certification program for the applicable test fluids.

g) A survey of the applicant for the “VR” Certificate of Authorization and endorsement of the repair of “NV”-stamped pressure relief devices may be made concurrently.

---

**S6.3 GENERAL RULES**

a) ASME Code Section III, “NV”-stamped pressure relief devices, which have been repaired in accordance with these rules, shall be stamped with both the "VR" and "NR" stamps.

b) The "VR" and "NR" stamps shall be applied only to "NV" stamped (Class 1, 2, or 3) National Board capacity certified pressure relief devices that have been disassembled, inspected, and repaired as necessary, such that the valves’ condition and performance are equivalent to the standards for new valves.

c) All measuring and test equipment used in the repair of pressure relief devices shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

d) Documentation of the repair of “NV” stamped pressure relief devices shall be recorded on the National Board Form NVR-1, Report of Repair/Replacement Activities for Nuclear Pressure Relief Devices, in accordance with the requirements of NBIC Part 3, 1.8.

e) When an ASME “NV”-stamped pressure relief device requires a duplicate nameplate because the original nameplate is illegible or missing, it may be applied using the procedures of 4.7.5 provided concurrence is obtained from the Authorized Nuclear Inspector and Jurisdiction. In this case the nameplate shall be marked “SEC. III” to indicate the original ASME Code stamping.

f) Repair activities for pressure relief devices shall not include rerating of the device. Set pressure changes within the range of the valve manufacturer’s capacity certification and the design pressure of the valve (see 4.7.3) are permitted, provided the new set pressure and capacity rating are reconciled with the design of the system where the device will be used. Set pressure changes are not considered to be rerating.

g) Conversions of pressure relief devices as described in 4.2 b) are permitted as part of repair activities.

h) Set pressure changes or conversions of pressure relief devices shall be described in the “Remarks” section of Form NVR-1.
<table>
<thead>
<tr>
<th>Glossary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authorized Nuclear Inspection Agency</strong> – An Authorized Inspection Agency intending to perform nuclear inspection activities and employing nuclear Inspectors / Supervisors.</td>
</tr>
<tr>
<td><strong>CGA</strong> – Compressed Gas Association</td>
</tr>
<tr>
<td><strong>Covered Piping Systems (CPS)</strong> – not to be confused with insulated piping, ASME B31.1 pressure piping systems or other piping systems where safety risks to personnel and equipment may exist during facility operations.</td>
</tr>
<tr>
<td><strong>Cryogenic Liquid</strong> — A refrigerated liquefied gas having a boiling point colder than -90°C (-130°F) at 101.3 kPa (14.7 psia) absolute. – Products stored at or below -238°F (-150°C)</td>
</tr>
<tr>
<td><strong>Existing Material</strong> – The actual material of the pressure retaining item at the location where the repair or alteration is to be performed.</td>
</tr>
<tr>
<td><strong>Jurisdiction</strong> – The National Board member Jurisdiction where the organization is located. Alternatively, where the Jurisdiction elects not to perform the review or where there is no Jurisdiction or where the Jurisdiction is the organization’s Authorized Inspection Agency, The National Board of Boiler and Pressure Vessel Inspectors will represent the Jurisdiction. At the Jurisdiction’s discretion, the Jurisdiction may choose to be a member of the review team if the Jurisdiction chooses not to be the team leader.</td>
</tr>
<tr>
<td><strong>Pilot Operated Pressure Relief Valve</strong> -- A pressure relief valve in which the disk is held closed by system pressure, and the holding pressure is controlled by a pilot valve actuated by system pressure.</td>
</tr>
<tr>
<td><strong>Pressure Relief Device</strong> -- A device designed to prevent pressure or vacuum from exceeding a predetermined value in a pressure vessel by the transfer of fluid during emergency or abnormal conditions.</td>
</tr>
<tr>
<td><strong>Pressure Relief Valve (PRV)</strong> -- A pressure relief device designed to actuate on inlet static pressure and reclose after normal conditions have been restored.</td>
</tr>
<tr>
<td><strong>Pressure roll load</strong> – The terms line load, and nip load are used interchangeably to refer to the interaction between the pressure roll(s) and the Yankee dryer. It is called “nip” load because the pressure roll is rubber-covered and is pressed up against the Yankee with enough force to create a nip (or pinch) that forces the paper into line contact between the rolls and provides some mechanical dewatering. The paper then sticks onto the Yankee surface and follows the Yankee dryer for thermal dewatering by the steam-heated Yankee surface. This “nip load” is called a “line load” because the units are load (force) per length of line contact. The units are pounds per linear inch (PLI) and kilonewtons per meter (kN/m).</td>
</tr>
<tr>
<td><strong>Re-rating</strong> <em>(re-rate)</em> – See alteration. Re-rate does not apply to pressure relief devices.</td>
</tr>
<tr>
<td><strong>Regulatory Authority</strong> – A government agency, such as the United States Nuclear Regulatory Commission, empowered to issue and enforce regulations concerning the design, construction, and operation of nuclear power plants.</td>
</tr>
<tr>
<td><strong>Relief Valve</strong> -- A pressure relief valve characterized by gradual opening that is generally proportional to the increase in pressure. It is normally used for incompressible fluids.</td>
</tr>
<tr>
<td><strong>Safety Relief Valve</strong> -- A pressure relief valve characterized by rapid opening or by gradual opening that is generally proportional to the increase in pressure. It can be used for compressible or incompressible fluids.</td>
</tr>
<tr>
<td><strong>Safety Valve</strong> -- A pressure relief valve characterized by rapid opening and normally used to relieve compressible fluids.</td>
</tr>
<tr>
<td><strong>Volumetric NDE</strong> – A method capable of detecting imperfections that may be located anywhere within the examined volume. Volumetric NDE is limited to radiographic (RT) and ultrasonic (UT) examination methods.</td>
</tr>
</tbody>
</table>