

# **Design, Inspection, Testing and Repair of ASME-Coded Pressure Systems and Safety Relief Valves**

**MSC-RD-19440**

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**Topic: Engineering**

# Design, Inspection, Testing and Repair of ASME-Coded Pressure Systems and Safety Relief Valves

## 1.0 PURPOSE AND SCOPE

This Level 2 Requirements Document specifies requirements for Mission Support Alliance (MSA) and MSA subcontractors performing design, repairs, significant repairs of a routine nature, and alterations to boilers, pressure vessels, pressure piping, and other American Society of Mechanical Engineers (ASME)-coded pressure systems. This document also specifies the requirements for inspecting and testing safety relief valves.

These requirements apply to the design of new boilers, pressure vessels, and piping; to repairs to existing boilers, pressure vessels, and piping; and to inspection and testing of safety relief valves in accordance with the Jurisdictional requirements and the latest editions of the ASME Boiler and Pressure Vessel Code, the ASME Codes for Pressure Piping (B31), and the National Board Inspection Code (NBIC).

A list of typical systems is included below.

- Power boilers (ASME Boiler and Pressure Vessel Code, Section I, "Power Boilers").
- Heating boilers (ASME Boiler and Pressure Vessel Code, Section IV, "Heating Boilers").
- Unfired pressure vessels (ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels").
- Safety relief valves.
- Steam systems with a designed operating pressure above 15 psig.
- Air systems required to control or actuate boilers, regardless of pressure, up to the point where air is regulated or controlled for instrument use.
- Liquid systems (for example, water, oil, chemical solutions) with a designed operating pressure above 30 psig.
- Air or gas systems (argon, carbon dioxide, nitrogen, helium, etc.) with a designed operating pressure above 15 psig.
- Hydraulic distribution systems as defined in ASME Code for Pressure Piping, B31.1, "Power Piping."

**NOTE:** *Components in nuclear related systems that are within the scope of ASME Boiler and Pressure Vessel Code, Sections III and XI, are **excluded** from the scope of this procedure.*

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**NOTE:** *The codes prescribe minimum safety requirements for pressure systems and are not design handbooks. Careful analysis of specific system requirements and competent engineering judgment will still be needed.*

### 2.0 REQUIREMENTS

The requirements presented in this requirements document are arranged as follows. Navigation links are provided.

- [Section 2.1](#).....Pressure Systems Design Requirements
- [Section 2.2](#).....Pressure Vessel Repair Requirements
- [Section 2.3](#).....Pressure Piping Repair Requirements
- [Section 2.4](#).....Pressure Systems Fabrication, Replacement, and Repair
- [Section 2.5](#).....Pressure Systems Inspection
- [Section 2.6](#).....Pressure Systems Welding
- [Section 2.7](#).....Pressure Systems Pressure Testing
- [Section 2.8](#).....Pressure Systems Acceptance
- [Section 2.9](#).....Inspection and Testing of Repairs and Tie-Ins to Existing Systems
- [Section 2.10](#).....Safety Relief Valve Requirements

### 2.1 Pressure Systems Design Requirements

**NOTE:** *For the tables in this section under the requirement "type" column, "V" means verbatim and "I" means interpreted.*

#	Requirement	Type V, I, or S	Source
1.	(a) Contractors must establish safety policies and procedures to ensure that pressure systems are designed, fabricated, tested, inspected, maintained, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles.	V	10 CFR 851 Appendix A Section 4
2.	(b) Contractors must ensure that all pressure vessels, boilers, air receivers, and supporting piping systems conform to: (1) The applicable American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (2004) Sections I through XII including applicable Code Cases (incorporated by reference, see §851.27) (2) The applicable ASME B31 (Code for Pressure Piping Standards as indicated below; or as indicated in paragraph (b)(3) below: (i) B31.1-2001-Power Piping, and B31.1a-2002-Addenda to ASME B31.1-2001 (incorporated by reference, see §851.27); (ii) B31.2-1968-Fuel Gas Piping (incorporated by reference, see §851.27);	V	10 CFR 851 Appendix A Section 4

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	<p>(iii) B31.3-2002-Process Piping (incorporated by reference, see §851.27);</p> <p>(iv) B31.4-2002-Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids (incorporated by reference, see §851.27);</p> <p>(v) B31.5-2001-Refrigeration Piping and Heat Transfer Components, and B31.5a-2004, Addenda to ASME B31.5-2001 (incorporated by reference, see §851.27);</p> <p>(vi) B31.8-2003-Gas Transmission and Distribution Piping Systems (incorporated by reference, see §851.27);</p> <p>(vii) B31.8S-2001-Managing the Integrity of Gas Pipelines (incorporated by reference, see §851.27);</p> <p>(viii) B31.9-1996-Building Services Piping (incorporated by reference, see §851.27);</p> <p>(ix) B31.11-2002-Slurry Transportation Piping Systems (incorporated by reference, see §851.27); and</p> <p>(x) B31G-1991-Manual for Determining the Remaining Strength of Corroded Pipelines (incorporated by reference, see §851.27).</p> <p>(3) The strictest applicable state and local codes.</p>		
3.	<p>(c) When national consensus codes are not applicable (because of pressure range, vessel geometry, use of special materials, etc.), contractors must implement measures to provide equivalent protection and ensure a level of safety greater than or equal to the level of protection afforded by the ASME or applicable state or local code. Measures must include the following:</p> <p>(1) Design drawings, sketches and calculations must be reviewed and approved by a qualified independent design professional (i.e., professional engineer). Documented organizational peer review is acceptable.</p> <p>(2) Qualified personnel must be used to perform examinations and inspections of materials, in-process fabrications, non-destructive tests, and acceptance tests.</p> <p>(3) Documentation, traceability, and accountability must be maintained for each unique pressure vessel or system, including descriptions of design, pressure conditions, testing, inspection, operation, repair, and maintenance.</p>	V	10 CFR 851 Appendix A Section 4

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### 2.2 Pressure Vessel Repair Requirements

#### 1. General Requirements

a.	<p>Boiler and pressure vessel repairs or alterations shall be made only by organizations with an "R" stamp or organizations with an appropriate ASME Certificate of Authorization. The "R" stamp is issued by the National Board. Repairs of a routine nature are subject to approval of the <a href="#">Jurisdictional authority</a>.</p> <p><b>NOTE:</b> <i>Fabrication and inspection of pressure piping in accordance with the ASME Code for Pressure Piping, B31 does not have to be done in a shop certified by ASME, except for portions of boiler piping covered by ASME Boiler and Pressure Vessel Code, Section I, "Power Boilers." Consequently, an Authorized Inspector (AI) has no mandatory code requirements to monitor shop or field construction of the piping.</i></p>	I	NB-23 Part RC-1030
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#### 2. ASME Code-Stamped Boiler and Pressure Vessels

##### a. Repairs and Alterations

1.	<p>All repairs and alterations shall be completed by an appropriate ASME or "R" stamp holder in accordance with the NBIC. The stamp holder performing the work will complete the National Board Form R-1, "Report of Repair," or Form R-2, "Report of Alteration," and attach the "Manufacturers Partial Data Reports" for any parts used in their repair or alteration. The user shall keep these documents on file.</p>	I	NB-23 Part RC-2071
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##### b. Repairs of a Routine Nature

1.	<p>Subject to the administrative procedure of the Jurisdictional authority (see <a href="#">Note 3</a>) and the approval of the AI, nameplates and stamping may not be required for repairs of a routine nature. In all cases, the type and extent of repairs necessary shall be considered before waiving a requirement. The user shall maintain a record of all repairs.</p> <p><b>NOTE 1:</b> <i>No repair of a routine nature shall be initiated to a boiler, pressure vessel, or pressure piping system, within the code jurisdictional limits for piping, without the AI's authorization. The cognizant/project engineer will contact an AI as part of the review when a work package is prepared.</i></p>	I	NB-23 Part RC-2060
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	<p><b>NOTE 2:</b> <i>Subject to the administrative procedures of the jurisdictional authority and the approval of the AI, stamping and repair plates may not be required for repairs of a routine nature.</i></p> <p><b>NOTE 3:</b> <i>The U.S. Department of Energy, Richland Operations Office (DOE-RL) is designated as the “jurisdictional authority.”</i></p>		
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### 2.3 Pressure Piping Repair Requirements

1.	<p>a) Contractors must establish safety policies and procedures to ensure that pressure systems are designed, fabricated, tested, inspected, maintained, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles</p> <p>b) Contractors must ensure that all pressure vessels, boilers, air receivers, and supporting piping systems conform to:</p> <p>(2) The applicable ASME B31 (Code for Pressure Piping Standards as indicated below; or as indicated in paragraph (b)(3) below:</p> <p>(i) B31.1-2001-Power Piping, and B31.1a-2002-Addenda to ASME B31.1-2001 (incorporated by reference, see §851.27);</p> <p>(ii) B31.2-1968-Fuel Gas Piping (incorporated by reference, see §851.27);</p> <p>(iii) B31.3-2002-Process Piping (incorporated by reference, see §851.27);</p> <p>(iv) B31.4-2002-Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids (incorporated by reference, see §851.27);</p> <p>(v) B31.5-2001-Refrigeration Piping and Heat Transfer Components, and B31.5a-2004, Addenda to ASME B31.5-2001 (incorporated by reference, see §851.27);</p> <p>(vi) B31.8-2003-Gas Transmission and Distribution Piping Systems (incorporated by reference, see §851.27);</p> <p>(vii) B31.8S-2001-Managing the Integrity of Gas Pipelines (incorporated by reference, see §851.27);</p> <p>(viii) B31.9-1996-Building Services Piping (incorporated by reference, see §851.27);</p> <p>(ix) B31.11-2002-Slurry Transportation Piping Systems (incorporated by reference, see §851.27); and</p> <p>(x) B31G-1991-Manual for Determining the Remaining Strength of Corroded Pipelines (incorporated by reference, see §851.27).</p> <p>(3) The strictest applicable state and local codes.</p>	V	10 CFR 851 Appendix A Section 4
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### 2.4 Pressure Systems Fabrication, Replacement, and Repair

#### 1. Repairs of a Routine Nature to Boilers and Pressure Vessels

a.	Repairs of a routine nature shall be performed according to the guidance of the NBIC and the approval of the AI.  <b>NOTE:</b> <i>The four categories of routine repairs are summarized below. Refer to NB-23 for details:</i> 1. <i>Welded repair or replacement of tubes or pipes and their attachments.</i> 2. <i>The addition or repair of non-load bearing attachments to pressure parts where postweld heat treatment is not required.</i> 3. <i>Weld buildup of wasted area not exceeding 100 sq. in.</i> 4. <i>Corrosion resistant weld overlay not exceeding 100 sq. in.</i>	I	NB-23 Part RC-2031
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#### 2. Repairs/Alterations of Pressure Piping

a.	Repairs/alterations shall, at a minimum, meet the requirements of the edition of the construction code to which the original component or part was constructed. Replacements for system components originally constructed without code requirements shall, at a minimum, be in accordance with the design, fabrication, and inspection requirements of the latest revision of the applicable ASME Code for Pressure Piping, B31 for the component being replaced.	V	NB-23 Part RC-1020
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### 2.5 Pressure Systems Inspection

1.	Pressure-containing piping, pressure vessels, and boilers shall be inspected at installation and after modifications.  <b>NOTE 1:</b> <i>Step-by-step instructions for performing inspections will be prepared as a part of job planning. This step-by-step plan includes material check, reference to items such as weld procedures, fitup, NDE technique, heat treatment, and pressure test methods to be used.</i>  <b>NOTE 2:</b> <i>The Design Authority (DA) or Quality Assurance (QA) engineer may require signoffs at key steps/operations to verify that each step/operation has been properly performed. The step-by-step instructions also provide for inspection of specific steps/operations the AI may wish to make.</i>	I	ASME B31 Piping Codes/ASME Boiler & Pressure Vessel Code NB-23
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	<p><b>NOTE3:</b> <i>Inspection of threaded or flanged joints for leakage in ASME B31.3 Category D or ASME B31.9 systems may be performed by non-QA staff with the DA's written approval and concurrence of the DA's manager.</i></p> <p><b>NOTE4:</b> <i>Third party inspections of ASME-Coded pressure vessels and boilers are covered by MSC-PRO-489, Third Party Inspections.</i></p>		
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### 2.6 Pressure Systems Welding

1.	Welding operations and welder qualifications shall be conducted according to Hanford Welding manual.	I	NB-23 Part RC-1090
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### 2.7 Pressure Systems Pressure Testing

#### 1. Boiler and Pressure Vessel

a.	<p>A pressure test, when required by the Code, will be performed following the repair of a routine nature. The DA, QA, and the AI shall review and approve the pressure procedure test before each test.</p> <p><b>NOTE:</b> <i>The pressure testing requirements of pressure vessels are detailed by NBIC.</i></p> <p>Instructions and records for the pressure test shall be provided within the work package.</p>	I	NB-23 Part RC-2050
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#### 2. Pressure Piping

a.	<p>A pressure test, when required by the Code, will be performed following repairs and/or alterations to pressure piping. The DA shall review and approve the pressure test procedure before each test. The pressure testing requirements for pressure piping are detailed by the applicable ASME Code for Pressure Piping, B31. Instructions and records for the pressure test will be provided within the work package.</p> <p><b>NOTE:</b> <i>Testing of threaded or flanged joints in ASME B31.3 Category D or ASME B31.9 systems may be performed by non-QA staff with the DA's written approval and concurrence of the DA's manager.</i></p>	I	NB-23 Part RC-2050
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## Design, Inspection, Testing and Repair of ASME-Coded Pressure Systems and Safety Relief Valves

### 2.8 Pressure Systems Acceptance

1.	<p>After repairs and/or alterations the user shall schedule an acceptance inspection. The DA, QA, Safety, and the AI shall inspect boilers, pressure vessels, and some pressure piping systems, and the documentation. The inspection may include checking records kept during fabrication and installation. The acceptance criteria will be defined by the original code of construction for each component.</p> <p><b>NOTE:</b> <i>Acceptance inspection of ASME B31.3 Category D or ASME B31.9 systems may be waived with the DA's written approval and concurrence of the DA's manager.</i></p>	I	NB-23 Part RC-1130
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### 2.9 Inspection and Testing of Repairs and Tie-Ins to Existing Systems

1.	<p>To the extent possible, inspection and testing of repairs and tie-ins to existing piping systems shall meet the requirements of the current edition of the applicable Code.</p> <p><b>NOTE:</b> <i>Where Code-required inspections and tests are not practical due to accessibility, ALARA, or other reasons, the Design Authority may designate alternative inspection and testing requirements with the Director of Engineering's approval. Examples of alternative inspections and tests are PT or MT in lieu of RT or UT, or in-service leak test in lieu of hydrostatic test.</i></p>	I	ASME B31 Piping Codes NB-23
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### 2.10 Safety Relief Valve Requirements

As used herein, the term relief valve or safety relief valve is intended to include all pressure actuated valves used for system pressure relief. These valves are sometimes known as pressure relief, vacuum relief, safety relief, balanced safety relief, internal spring safety relief, pop-off, etc.

Relief valves should be tested for ease of valve lift, correct set pressure, correct blowdown (reset) pressure, and for acceptable leakage after reclose. Any failure to pass these tests will require that the valve be adjusted, repaired, or replaced

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1. General

a.	(a) Contractors must establish safety policies and procedures to ensure that pressure systems are designed, fabricated, tested, inspected, maintained, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles.	V	10 CFR 851 Appendix A Section 4
b.	In service inspection shall be in accordance with Part RB, Section 3500 of the National Board Inspection Code (NB-23).	I	NB-23 Part RB-3550
c.	Pressure relief valves must be periodically tested to ensure that they are free to operate and will operate in accordance with the requirements of the original code of construction.	V	NB-23 Part RB-3550.a
d.	The NBIC permits employees who are trained and qualified in accordance with Section RA-2200 of the NBIC Code to make minor adjustments to the set pressure without an NBIC “VR” certificate. Minor is defined as no more than twice the set pressure tolerance. Repairs can only be made by a current holder of a “VR” certificate.	I	NB-23 Part RB-3550.e

2. Relief Valve Inspection

Inspection as used here includes visual observation and manual check (try-lever test). The manual check verifies that the relief valve will open and close freely, will pass fluid, and will reseal. The following frequencies are *recommendations* only by the National Board Inspection Code. DAs determine the actual inspection frequency and document the rationale for frequencies that are longer than the recommendation.

**NOTE:** *The Design Authority may exempt certain relief valves from inspection on a case-by-case basis if:*

1. *Inspection would result in an uncontained release of radioactive or hazardous chemicals, or*
  2. *Access to the valve requires cell access or the removal of a cover block; provided that failure of the system protected by the relief valve would not cause injury to personnel or an unacceptable financial loss, or*
  3. *The probability and consequences of a failure of the relief valve to operate are low.*
- The Design Authority shall document all exemptions.*

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a.	Relief valves protecting power boilers and hot water boilers with pressures less than 400 psig should be manually checked every 6 months.  <b>NOTE:</b> <i>Manual checks 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.</i>	V	NB-23 Part RB-3560.a
b.	Low-pressure steam heating boilers and hot-water heating boilers should be manually checked quarterly.	V	NB-23 Parts RB-3560. c&d
c.	Relief valves protecting hot water heaters not exceeding 120 gallons, 160 psig, or 210 °F should be manually checked annually. [NB-23 Part RB-3560.e recommends every 2 months.]	I	NB-23 Part RB-3560.e
d.	The manual check frequency for relief valves protecting pressure vessels and piping should be based on previous inspection history, type of service, importance to plant operation, and consequences of failure. The following manual check frequencies are suggested for pressure vessels and piping with the following services: <ul style="list-style-type: none"> <li>• Steam.....Annual.</li> <li>• Air &amp; clean dry gas .....3 years.</li> <li>• Propane or refrigerant .....5 years.</li> </ul>	I	NB-23 Part RB-3560.f
e.	High pressure (> 400 psig) boilers and high temperature hot water heaters need not be manually checked.	I	NB-23 Parts RB-3560. a&b
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).	V	NB-23 Part RB-3550.d

### 3. Relief Valve Testing

Pressure testing as used here means verifying the set point and blow-down pressures. The following frequencies are **recommendations** only by the National Board Inspection Code. DAs determine the actual test frequency and document the rationale for frequencies that are longer than the recommendation.

**NOTE 1:** *In lieu of pressure testing, relief valves may be replaced with new or retested relief valves.*

**NOTE 2:** *New relief valves should be tested for proper set point pressures prior to being placed into service. This testing may be performed and documented by the manufacturer or a qualified*

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*offsite contractor. DAs may choose to skip this test as long as their rationale is documented and approved by the Project Chief Engineer.*

a.	Relief valves protecting power boilers and hot water boilers with pressures less than 400 psig should be tested every year.	V	NB-23 Part RB-3560.a
b.	Low-pressure steam heating boilers and hot-water heating boilers should be tested annually prior to the heating season.	V	NB-23 Parts RB-3560. c&d
c.	High pressure (> 400 psig) boilers should be tested every 3 years.	I	NB-23 Parts RB- 3560.a
d.	High temperature hot water heaters should be tested every year.  <b>NOTE:</b> <i>For safety reasons, removal and testing on a bench is recommended.</i>	I	NB-23 Parts RB- 3560.b
e.	Pressure testing on relief valves protecting pressure vessels and piping should be as specified by the manufacturer initially, then modified by inspection history thereafter.  <b>NOTE:</b> <i>Pressure testing of relief valves, where the frequency is determined by inspection history, shall be performed not less than every 10 years.</i>	I	NB-23 Part RB-3560.f
g.	During pressure testing minor adjustments can be made to correct the set point pressure, providing that the adjustment is not more than twice the permitted set point pressure tolerance.	V	NB-23 Part RB-3550.e
h.	If the as-found set point pressure is greater than twice the permitted set point pressure tolerance, this may indicate that the valve is in need of repair or has damaged or misapplied parts. Its condition should be investigated accordingly.	V	NB-23 Part RB-3550.f
i.	The allowable tolerance shall not exceed 2 psi for set point pressures up to and including 70 psig and 3 % for set point pressures over 70 psig.	V	ASME B&PV Code, Sect. VIII, UG- 134(d)

### 3.0 REFERENCES

#### 3.1 Source References

10 CFR 851, Worker Safety and Health Program, Appendix A to Part 851 Section 4, Pressure Safety

ANSI/NB-23, *National Board Inspection Code*

ASME Boiler and Pressure Vessel Code, Section VIII, *Division 1 Pressure Vessels*

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## 3.2 Working References

ASME Boiler and Pressure Vessel Code

Section I, *Power Boilers*

Section IV, *Heating Boilers*

Section VIII, *Division 1 Pressure Vessels*

Section IX, *Welding and Brazing Qualifications*

ANSI/ASME Code for Pressure Piping,

B31.1, *Power Piping*

B31.2, *Fuel Gas Piping*

B31.3, *Chemical Plant and Petroleum Refinery Piping*

B31.5, *Refrigeration Piping*

B31.9, *Building Services Piping*