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United States Legal Document

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NOTE: Pages ii through xvi are not part of this American National Standard

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The National Board of Boiler and Pressure Vessel Inspectors

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7437 Pingue Drive
Worthington, Ohio 43085-1715
614.888.8320
614.848.3474 Fax

Training & Conference Center
1055 Crupper Avenue
Columbus, Ohio 43229-1183
614.888.8320
614.847.5542 Fax
The National Board of Boiler and Pressure Vessel Inspectors
Board of Trustees

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R.J. Aben Jr.  
First Vice Chairman

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Second Vice Chairman

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Secretary/Treasurer

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Member at Large

D.J. Jenkins  
Member at Large

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Member at Large

M.R. Toth  
Member at Large

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representing welding industries

E.J. Hoveke  
representing National Board certificate holders

L.J. McManamon Jr.  
representing organized labor

G. McRae  
representing pressure vessel manufacturers

B.R. Morelock  
representing boiler and pressure vessel users

C.E. Perry  
representing boiler manufacturers

C.G. Schaber  
representing authorized inspection agencies (insurance companies)
National Board Members

Alabama ................................................................. Ralph P. Pate
Alaska ................................................................. Mark R. Peterson
Arizona .....................................................................
Arkansas .................................................................... Gary R. Myrick
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Colorado ..................................................................... Randall D. Austin
Connecticut ................................................................... Allan E. Platt
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Florida ......................................................................... Mario D. Ramirez
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Kentucky ....................................................................... Rodney Handy
Louisiana ....................................................................... William Owens
Maine .......................................................................... John H. Burpee
Maryland ..................................................................... Karl J. Kraft
Massachusetts .............................................................. Mark Mooney
Michigan ....................................................................... Robert J. Aben Jr.
Minnesota ..................................................................... Joel T. Amato
Mississippi .................................................................... Kenneth L. Watson
Missouri ........................................................................ Gary S. Bubin
Montana ....................................................................... James McGimpsey
Nebraska ....................................................................... Christopher B. Cantrell
Nevada ......................................................................... Gerard F. Mankel
New Hampshire ............................................................ Wayne Brigham
New Jersey .................................................................. Milton Washington
New York ...................................................................... Peter L. Vescio
North Carolina .............................................................. Jack M. Given Jr.
North Dakota ................................................................ Robert Reetz
Ohio ............................................................................. Dean T. Jagger
Oklahoma ...................................................................... Tom Monroe
Oregon .......................................................................... Michael D. Graham
Pennsylvania ................................................................ Jack A. Davenport
Rhode Island ................................................................ Benjamin Anthony
South Dakota ................................................................ Howard D. Pfaif
Tennessee ...................................................................... Martin R. Toth
Texas .............................................................................. Anthony P. Jones
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Virginia ......................................................................... Fred P. Barton
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Wisconsin ....................................................................... Michael J. Verhagen

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New York, NY .............................................................. William McGivney

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Manitoba ..................................................................... Terry W. Rieger
New Brunswick ........................................................... Dale E. Ross
Newfoundland & Labrador ............................................. E. Dennis Eastman
Northwest Territories .................................................... Steve Donovan
Nova Scotia .................................................................... Peter Dodge
Nunavut Territory .......................................................... E. William Bachellier
Ontario .......................................................................... Frantisek Musata
Prince Edward Island .................................................... Kenneth Hynes
Quebec .......................................................................... Madhiha M. Korb
Saskatchewan ................................................................... Brian Krasien
Yukon Territory ................................................................ Daniel C. Price
# National Board Inspection Code Committees

### Main Committee

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<tr>
<th>Name</th>
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<td>T. Parks, Chair</td>
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<td>R. Wielgoszinski, Vice Chair</td>
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### Subgroup for Installation (Part 1)

#### Boilers

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### Subcommittee for Inspection (Part 2)

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## Subgroup for Inspection (Part 2)

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## Subcommittee for Repairs and Alterations (Part 3)

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<th>G. Galanes, Chair</th>
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<tr>
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## Subgroup for Repairs and Alterations (Part 3)

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## Special Subgroups for Installation, Inspection, and Repairs and Alterations (Parts 1, 2, and 3)

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### Special Subgroups for Installation, Inspection, and Repairs and Alterations (Parts 1, 2, and 3)

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<td>Tankinetics, Inc.</td>
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This code was developed under procedures accredited as meeting the criteria for American National Standards. The Consensus Committee that approved the code was balanced to assure that individuals from competent and concerned interests had an opportunity to participate. The proposed code was made available for public review and comment, which provided an opportunity for additional public input from industry, academia, regulatory and jurisdictional agencies, and the public-at-large.

The National Board does not “approve,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

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Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code.

The National Board accepts responsibility for only those interpretations issued in accordance with governing National Board procedures and policies which preclude the issuance of interpretations by individual committee members.

The footnotes in this document are part of this American National Standard.

The above National Board symbols are registered with the US Patent Office.

“National Board” is the abbreviation for The National Board of Boiler and Pressure Vessel Inspectors.

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Foreword

The National Board of Boiler and Pressure Vessel Inspectors is an organization comprised of
Chief Inspectors for the states, cities, and territories of the United States and provinces and
territories of Canada. It is organized for the purpose of promoting greater safety to life and
property by securing concerted action and maintaining uniformity in post-construction
activities of pressure-retaining items, thereby assuring acceptance and interchangeability
among jurisdictional authorities responsible for the administration and enforcement of various
codes and standards.

In keeping with the principles of promoting safety and maintaining uniformity, the National
Board originally published The NBIC in 1946, establishing rules for inspection and repairs to
boilers and pressure vessels. The National Board Inspection Code (NBIC) Committee is charged
with the responsibility for maintaining and revising the NBIC. In the interest of public safety,
the NBIC Committee decided, in 1995, to revise the scope of the NBIC to include rules for
installation, inspection, and repair or alteration to boilers, pressure vessels, piping, and
nonmetallic materials.

In 2007, the NBIC was restructured into three Parts specifically identifying important post-
construction activities involving safety of pressure-retaining items. This restructuring provides for
future expansion, transparency, and uniformity, ultimately improving public safety.

The NBIC Committee’s function is to establish rules of safety governing post-construction activities
for the installation, inspection and repair and alteration of pressure-retaining items, and to interpret
these rules when questions arise regarding their intent. In formulating the rules, the NBIC
Committee considers the needs and concerns of individuals and organizations involved in the
safety of pressure-retaining items. The objective of the rules is to afford reasonably certain
protection of life and property, so as to give a reasonably long, safe period of usefulness.
Advancements in design and material and the evidence of experience are recognized.

The rules established by the NBIC Committee are not to be interpreted as approving,
recommending, or endorsing any proprietary or specific design, or as limiting in any way an
organization’s freedom to choose any method that conforms to the NBIC rules.

The NBIC Committee meets regularly to consider revisions of existing rules, formulation of new
rules, and respond to requests for interpretations. Requests for interpretation must be addressed
to the NBIC Secretary in writing and must give full particulars in order to receive Committee
consideration and a written reply. Proposed revisions to the Code resulting from inquiries will
be presented to the NBIC Committee for appropriate action.

Proposed revisions to the Code approved by the NBIC Committee are submitted to the
American National Standards Institute and published on the National Board Web site to
invite comments from all interested persons. After the allotted time for public review and final
approval, revisions are published annually in Addenda to the NBIC.

Organizations or users of pressure-retaining items are cautioned against making use of
revisions that are less restrictive than former requirements without having assurance that they
have been accepted by the Jurisdiction where the pressure-retaining item is installed.
The general philosophy underlying the NBIC is to parallel those provisions of the original code of construction, as they can be applied to post-construction activities.

The NBIC does not contain rules to cover all details of post-construction activities. Where complete details are not given, it is intended that individuals or organizations, subject to the acceptance of the Inspector and Jurisdiction when applicable, provide details for post-construction activities that will be as safe as otherwise provided by the rules in the original Code of Construction.

Activities not conforming to the rules of the original code of construction or the NBIC must receive specific approval of the Jurisdiction, who may establish requirements for design, construction, inspection, testing, and documentation.

There are instances where the NBIC serves to warn against pitfalls; but the Code is not a handbook, and cannot substitute for education, experience, and sound engineering judgment.

It is intended that this Edition of the NBIC and any subsequent Addenda not be retroactive. Unless the Jurisdiction imposes the use of an earlier edition, the latest effective edition and addenda is the governing document.
Introduction

It is the purpose of the National Board Inspection Code (NBIC) to maintain the integrity of pressure-retaining items by providing rules for installation, and after the items have been placed into service, by providing rules for inspection and repair and alteration, thereby ensuring that these items may continue to be safely used.

The NBIC is intended to provide rules, information and guidance to manufacturers, jurisdictions, inspectors, owner-users, installers, contractors, and other individuals and organizations performing or involved in post-construction activities, thereby encouraging the uniform administration of rules pertaining to pressure-retaining items.

Scope

The NBIC recognizes three important areas of post-construction activities where information, understanding, and following specific requirements will promote public and personal safety. These areas include:

- Installation
- Inspection
- Repairs and Alterations

The NBIC provides rules, information, and guidance for post-construction activities, but does not provide details for all conditions involving pressure-retaining items. Where complete details are not provided in this Code, the Code user is advised to seek guidance from the Jurisdiction and from other technical sources.

The words should, shall, and may are used throughout the NBIC and have the following intent:

- Shall – action that is mandatory and required.
- Should – indicates a preferred but not mandatory means to accomplish the requirement unless specified by others such as the Jurisdiction.
- May – permissive, not required or a means to accomplish the specified task.

Organization

The NBIC is organized into three Parts to coincide with specific post-construction activities involving pressure-retaining items. Each Part provides general and specific rules, information, and guidance within each applicable post-construction activity. Other NBIC Parts or other published standards may contain additional information or requirements needed to meet the rules of the NBIC. Specific references are provided in each Part to direct the user where to find this additional information. NBIC Parts are identified as:

- Part 1, Installation – This Part provides requirements and guidance to assure all types of pressure-retaining items are installed and function properly. Installation includes meeting specific safety criteria for construction, materials, design, supports, safety devices, operation, testing, and maintenance.

- Part 2, Inspection – This Part provides information and guidance needed to perform and document inspections for all types of pressure-retaining items. This Part includes information on personnel safety, non-destructive examination, tests, failure mechanisms, types of pressure equipment, fitness for service, risk-based assessments, and performance based standards.
• Part 3, Repairs and Alterations – This Part provides information and guidance to perform, verify, and document acceptable repairs or alterations to pressure-retaining items regardless of code of construction. Alternative methods for examination, testing, heat treatment, etc. are provided when the original code of construction requirements cannot be met. Specific acceptable and proven repair methods are also provided.

Each NBIC Part is divided into major Sections as outlined in the Table of Contents.

Tables, charts, and figures provide relevant illustrations or supporting information for text passages, and are designated with numbers corresponding to the paragraph they illustrate or support within each Section. Multiple tables, charts, or figures referenced by the same paragraph will have additional letters reflecting the order of reference. Tables, charts, and figures are located in or after each major Section within each NBIC Part.

Text Identification and Numbering
Each page in the text will be designated in the top header with the publication's name, part number, and part title. The numbering sequence for each section begins with the section number followed by a dot to further designate major sections (e.g., 1.1, 1.2, 1.3). Major sections are further subdivided using dots to designate subsections within that major section (e.g., 1.1.1, 1.2.1, 1.3.1). Subsections can further be divided as necessary.

Paragraphs under sections or subsections shall be designated with small letters in parenthesis (e.g., (a), (b), (c)) and further subdivided using numbers in parenthesis (e.g., (1), (2), (3)). Subdivisions of paragraphs beyond this point will be designated using a hierarchical sequence of letters and numbers followed by a dot.

Example: 2.1 Major Section
          2.1.1 Section
          2.1.2 Section
          2.1.2. Subsection
          a) paragraph
          b) paragraph
               1) subparagraph
               2) subparagraph
                  a. subdivisions
                     1. subdivisions
                     2. subdivisions
                  b. subdivisions
                     1. subdivisions
                     2. subdivisions

Tables and figures will be designated with the referencing section or subsection identification. When more than one table or figure is referenced in the same section or subsection, letters or numbers in sequential order will be used following each section or subsection identification.

Supplements
Supplements are contained in each Part of the NBIC to designate information only pertaining to a specific type of pressure-retaining item (e.g., Locomotive Boilers, Historical Boilers, Graphite
Pressure Vessels. Supplements follow the same numbering system used for the main text only preceded by the Letter “S.” Each page of the supplement will identify the supplement number and name in the top heading.

**Addenda**
Addenda, which include revisions and additions to this Code, are published annually. Addenda are permissive on the date issued and become mandatory six months after the date of issue. The addenda will be sent automatically to purchasers of the Code up to the publication of the next edition. Every three years the NBIC is published as a new edition that includes that year's addenda.

**Interpretations**
On request, the NBIC Committee will render an interpretation of any requirement of this Code. Interpretations are provided for each Part and are specific to the Code edition and addenda referenced in the interpretation. Interpretations provide information only and are not part of this Code.

**Jurisdictional Precedence**
Reference is made throughout this Code to the requirements of the “Jurisdiction.” Where any provision herein presents a direct or implied conflict with any jurisdictional regulation, the jurisdictional regulation shall govern.

**Units of Measurement**
Both US Customary units and metric units are used in the NBIC. The value stated in US Customary units or metric units are to be regarded separately as the standard. Within the text, the metric units are shown in parentheses.

US Customary units or metric units may be used with this edition of the NBIC, but one system of units shall be used consistently throughout a repair or alteration of pressure-retaining items. It is the responsibility of National Board accredited repair organizations to ensure the appropriate units are used consistently throughout all phases of work. This includes materials, design, procedures, testing, documentation, and stamping. The NBIC policy for metrciation is outlined in each part of the NBIC.

**Accreditation Programs**
The National Board administers and accredits three specific repair programs\(^1\) as shown below:

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

Part 3, Repairs and Alterations, of the NBIC describes the administrative requirements for the accreditation of these repair organizations.

\(^1\) Caution, some jurisdictions may independently administer a program of authorization for organizations to perform repairs and alterations within that jurisdiction.
The National Board also administers and accredits four specific inspection agency programs as shown below:

**New Construction**
- *Criteria for Acceptance of Authorized Inspection Agencies for New Construction* (NB-360)

**Inservice**
- *Qualifications and Duties for Authorized Inspection Agencies (AIAs) Performing Inservice Inspection Activities and Qualifications for Inspectors of Boilers and Pressure Vessels* (NB-369)

**Owner-User**
- *Accreditation of Owner-User Inspection Organizations (OUIO)* (NB-371) Owners or users may be accredited for both a repair and inspection program provided the requirements for each accreditation program are met.

**Federal Government**
- *Qualifications and Duties for Federal Inspection Agencies Performing Inservice Inspection Activities (FIAs)* (NB-390)

These programs can be viewed on the National Board Web site. For questions or further information regarding these programs contact:

The National Board of Boiler and Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, OH 43229-1183
Phone — 614.888.8320
Fax — 614.847.1828
Web Site — www.nationalboard.org

**Certificates of Authorization for Accreditation Programs**
Any organization seeking an accredited program may apply to the National Board to obtain a *Certificate of Authorization* for the requested scope of activities. A confidential review shall be conducted to evaluate the organization's quality system. Upon completion of the evaluation, a recommendation will be made to the National Board regarding issuance of a *Certificate of Authorization*.

*Certificate of Authorization* scope, issuance, and revisions for National Board accreditation programs are specified in the applicable National Board procedures. When the quality system requirements of the appropriate accreditation program have been met, a *Certificate of Authorization* and appropriate National Board symbol stamp shall be issued.
Part 1 — Installation

All charts, graphs, tables, and other criteria that have been reprinted from the ASME Boiler and Pressure Vessel Code, Sections I, IV, VIII, and X are used with the permission of the American Society of Mechanical Engineers. All Rights Reserved.
## PART 1 — INSTALLATION
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Part 1, Section 1
Installation — General Guidelines
PART 1, SECTION 1
INSTALLATION — GENERAL GUIDELINES

1.1 INTRODUCTION

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. This Part identifies minimum safety requirements for installing pressure-retaining items when this Part is mandated by a Jurisdiction. Otherwise, the requirements specified in this Part 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 manufacturers recommendations. When a Jurisdiction establishes different requirements or where a conflict exists, the rules of the Jurisdiction prevail. Users of this Part are cautioned that other requirements may apply for a particular installation and this Part is not a substitute for sound engineering evaluations.

1.2 PURPOSE

a) The purpose of these rules is to establish minimum requirements, which, if followed, will ensure that pressure-retaining items, when installed, may be safely operated, inspected, and maintained.

b) It should be recognized that many of the requirements included in these rules must be considered in the design of the pressure-retaining item by the manufacturer. However, the owner-user is responsible for ensuring that the installation complies with all the applicable requirements contained herein. Further, the installer is responsible for complying with the applicable sections when performing work on behalf of the owner-user.

1.3 APPLICATION OF THESE RULES

a) As referenced in lower case letters, the terms “owner,” “user,” or “owner-user” means any person, firm, or corporation legally responsible for the safe operation of the boiler, pressure vessel, piping, or other pressure-retaining item. Further, where the term owner is used, it shall mean the owner, or user, or the owner’s or user’s designee.

b) Where the owner is required to perform an activity, it is intended that the owner or the owner’s designee may perform the activity; however, the owner retains responsibility for compliance with these rules.

c) These rules refer to documentation obtained from the Jurisdiction (installation permit, operating permit). It is not intended to require the Jurisdiction to issue such permits but rather a caution to owners and installers that such permits may be required.

1.4 CERTIFICATION, INSPECTION, AND JURISDICTIONAL REQUIREMENTS

1.4.1 RESPONSIBILITY

a) The owner is responsible for satisfying jurisdictional requirements for certification and documentation. When required by jurisdictional rules applicable to the location of installation, the boilers, pressure vessels,
piping, and other pressure-retaining items shall not be operated until the required documentation has been provided by the installer to the owner and the Jurisdiction.

b) The National Board Commissioned Inspector providing inservice inspection for the facility in which the pressure-retaining item is installed has the following responsibilities:

1) verify the Boiler Inspection Report (I-1 Report) has been completed and signed by the installer, when required by the jurisdiction;

2) verify pressure-retaining items comply with the laws and regulations of the jurisdiction governing the specific type of boiler or pressure vessel;

3) verify any repairs or alterations to pressure-retaining items, which are conducted prior to, or during, the initial installation, are in accordance with the NBIC;

4) request or assign jurisdictional identification number, when required by the jurisdiction; and

5) complete and submit the first inservice inspection/certificate report to the jurisdiction when required by the jurisdiction.

Unless otherwise specifically required by the jurisdiction, the duties of the inservice inspector do not include the installation’s compliance to other standards and requirements (environmental, construction, electrical, undefined industry standards, etc.) for which other regulatory agencies have authority and responsibility to oversee.

1.4.2 EQUIPMENT CERTIFICATION

a) All boilers, pressure vessels, piping, and other pressure-retaining items shall have documented certification from the manufacturer indicating that the boiler, pressure vessel, piping, or any other pressure-retaining items complies with the requirements of the code of construction. The certification shall identify the ‘Addenda’ for a code of construction to which the boiler was fabricated.

b) Package boilers having external piping disassembled and shipped with the boiler shall have a method for traceability of the disassembled piping that can be verified at the time of installation and inspection. The manufacturer of the package boiler is responsible for determining a method of traceability.

1.4.3 JURISDICTIONAL REVIEW

a) The owner shall determine jurisdictional requirements (i.e., certificates, permits, licenses, etc.) before installing the equipment. The organization responsible for installation shall obtain all permits required by the Jurisdiction prior to commencing installation.

b) The owner shall determine jurisdictional requirements (i.e., certificates, permits, licenses, etc.) before operating the equipment. The owner shall obtain operating certificates, permits, etc., required by the Jurisdiction prior to commencing operation.
1.4.4 **INSPECTION**

All boilers, pressure vessels, piping, and other pressure-retaining items shall be inspected and tested after installation and prior to commencing operation.

1.4.5 **BOILER INSTALLATION REPORT**

a) Upon completion, inspection, testing and acceptance of the installation, the installer shall complete and certify the *Boiler Installation Report* (I-1) for all power boilers, hot-water heating boilers, steam heating boilers, hot-water supply boilers, and portable water heaters.

b) The *Boiler Installation Report* (I-1) shall be submitted as follows:

1) One copy to the owner; and

2) One copy to the Jurisdiction, if required.
### BOILER INSTALLATION REPORT I-1

**INSTALLATION:**
- [ ] New
- [ ] Reinstalled
- [ ] Second Hand
- Date __/__/__

#### INSTALLER
- Name
- Street
- City, State, ZIP

#### OWNER-USER
- Name
- Street
- City, State, ZIP

#### OBJECT LOCATION
- Name
- Street
- City, State, ZIP

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<th>Stamped MAWP</th>
<th>Heating Surface, Sq. Ft.</th>
<th>Cast Iron/Steel</th>
<th>Manhole</th>
<th>Specific On-Site Location, i.e., Utility Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure Relief Valve Size</th>
<th>Pressure Relief Valve Set Pressure</th>
<th>Pressure Relief Valve Capacity</th>
<th>Low Water Fuel Cutoff Mfg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>24</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

#### PRESSURE/ALTITUDE GAGE
- Dial Graduation
- Valve/Cock Size: MAWP
- Pipe Connection Size
- Sebbon or Equivalent Device: Yes/No

#### WATER LEVEL INDICATORS
- Number of Gauge Glasses
- Number of Remote Indicators
- Size of Conduit Piping

#### STOP VALVES
- Number of Valves
- Valve Size

#### BOTTOM BLOWDOWN CONNECTIONS
- Number of Valves
- Valve Size: MAWP
- Piping Run Full Size: Yes/No

<table>
<thead>
<tr>
<th>Manufacturer’s Certification Attached: Yes/No</th>
<th>Does boiler replace existing one: Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

### VENTILATION AND COMBUSTION AIR
- Unobstructed Opening (sq. in.)
- Power Ventilator Fan (CFM)

### FEED WATER SUPPLY
- Number of Feeding Means
- Pipe Size
- Stop Valve Size: MAWP
- Check Valve Size: MAWP

### EXTERNAL PIPING ASME CODE
- Fuel Train: Yes/No
- CSD-1
- NFPA-85
- Other

### POTABLE WATER HEATER UNIQUE REQUIREMENTS
- Inlet Stop Valve Size: MAWP
- Outlet Stop Valve Size: MAWP
- Drain Valve Size
- Thermometer: Yes

<table>
<thead>
<tr>
<th>Clearance from walls and floors: Side</th>
<th>Bottom</th>
<th>Top</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Additional recommendations and remarks by installer:**

**I HEREBY CERTIFY THAT THE INSTALLATION COMPLIES WITH APPENDIX 1**

Installer Name (PRINT) Registration # Installer Signature

---

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229

NB-365 Rev. 1
1.4.5.1.1 GUIDE FOR COMPLETING NATIONAL BOARD BOILER INSTALLATION REPORT

1. INSTALLATION: Indicate the type and date of installation — new, reinstalled, or second-hand.

2. INSTALLER: Enter the Installer name and physical address.

3. OWNER-USER: Enter the name and mailing address of the owner-user of the boiler.

4. OBJECT LOCATION: Enter the name of the company or business and physical address where the installation was made.

5. JURISDICTION NO.: Enter the number if assigned at the time of installation.

6. NATIONAL BOARD NO.: Enter the assigned National Board number. Note: Cast-iron section boilers do not require National Board registration.

7. MANUFACTURER: Enter the boiler manufacturer’s name.

8. MFG, SERIAL NO.: Enter the assigned boiler manufacturer’s serial number.

9. YEAR BUILT: Enter the year the boiler was manufactured.

10. BOILER TYPE: Enter the type of boiler, i.e., watertube, firetube, cast iron, electric, etc.

11. BOILER USE: Enter the service the boiler will be used for, i.e., heating (steam or water), potable water, etc.

12. FUEL: Enter the type of fuel, i.e., natural gas, diesel, wood, etc. If more than one fuel type, enter the types the boiler is equipped for.

13. METHOD OF FIRING: Enter the method of firing, i.e., automatic, hand, stoker, etc.

14. BTU/KW INPUT: Enter the Btu/hr or kw input of the boiler.

15. BTU/KW OUTPUT: Enter the Btu/hr or kw output of the boiler.

16. OPERATING PSI: Enter the allowed operating pressure.

17. ASME CODE STAMP(S): Check the ASME Code stamp shown on the code nameplate or stamping of other certification mark (specify).

18. STAMPED MAWP: Enter the maximum allowable working pressure shown on the nameplate or stamping.

19. HEATING SURFACE SQ. FT.: Enter the boiler heating surface shown on the stamping or nameplate. Note: This entry is not required for electric boilers.

20. CAST IRON: Enter the total number of sections for cast-iron boilers.

21. MANHOLE: Indicate whether the boiler has a manway.

22. SPECIFIC ON-SITE LOCATION: Enter the on-site location of the boiler in sufficient detail to allow location of that boiler.

23. PRESSURE RELIEF VALVE SIZE: Enter the inlet and outlet size of all installed boiler safety or safety relief valves.

24. PRESSURE RELIEF VALVE SET PRESSURE: Enter the set pressure of all installed boiler safety or safety relief valves.

25. PRESSURE RELIEF VALVE CAPACITY: Enter the capacity in either lbs. of steam per hour or Btu/hr for each installed boiler safety or safety relief valve.

26. MANUFACTURER: Enter the manufacturer of each installed boiler safety and safety relief valve.
27. LOW WATER FUEL CUTOFF: Enter the manufacturer's name, type, number and maximum allowable working pressure of all installed low water fuel cutoff devices.

28. PRESSURE/ALTITUDE GAGE: Enter the dial range of the installed pressure or altitude gage, cutout valve or cock size, a maximum allowable working pressure, and gage pipe connection size. For steam boilers, indicate gage siphon or equivalent device installed.

29. EXPANSION TANK: Indicate code of construction of installed expansion tank, tank maximum allowable working pressure, and tank capacity in gallons.

30. VENTILATION AND COMBUSTION AIR: Indicate total square inches of unobstructed opening or total cubic feet per minute of power ventilator fan(s) available for ventilation and combustion air.

31. WATER LEVEL INDICATORS: Enter the number of gage glasses and/or remote indicators and connecting pipe size.

32. FEED WATER SUPPLY: Enter the total number of feeding means, connecting pipe size, stop and check valve size, and maximum allowable working pressure.

33. STOP VALVE(S): Enter the number of stop valves installed, valve size and maximum allowable working pressure.

34. POTABLE WATER HEATER UNIQUE REQUIREMENTS: Indicate if stop valves installed and if so enter size and maximum allowable working pressure. Enter drain valve size and indicate installation of thermometer at or near boiler outlet.

- Indicate if manufacturer's certificate is attached (mandatory for new installations).
- Indicate clearances and whether the installation replaced an existing boiler.
- Enter any remarks or comments you deem appropriate.
- Print installer name and registration number and sign completed report.
Insert
Section 2
Tab
Here
NBIC

07

Part 1, Section 2
Installation — Power Boilers
PART 1, SECTION 2
POWER BOILERS

2.1 SCOPE

This Section provides requirements for the installation of power boilers as defined in 2.2, Definitions. For installation of items that do not fall within the scope of this Section, refer to the following Sections as applicable:

Section 3 — Steam Heating Boilers, Hot-Water Heating Boilers, Hot-Water Supply Boilers, and Potable Water Heaters
Section 4 — Pressure Vessels
Section 5 — Piping

2.2 DEFINITIONS

A power boiler is a closed vessel in which water or other liquid is heated, steam or vapor generated, steam or vapor is superheated, or any combination thereof, under pressure for use external to itself, by the direct application of energy from the combustion of fuels or from electricity or solar energy. The term boiler includes fired units for heating or vaporizing liquids other than water but does not include fired process heaters and systems. The term boiler also shall include the apparatus used to generate heat and all controls and safety devices associated with such apparatus or the closed vessel.

a) Power Boiler — a boiler in which steam or other vapor is generated at a pressure in excess of 15 psig (100 kPa) for use external to itself.

b) High-Temperature Water Boiler — a boiler in which water is heated and operates at a pressure in excess of 160 psig (1.1 MPa) and/or temperature in excess of 250°F (121°C).

2.3 GENERAL REQUIREMENTS

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.

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.

2.3.3 CLEARANCES

a) Boiler installations shall allow for normal operation, maintenance, and inspections. There shall be at least 36 in. (915 mm) of clearance on each side of the boiler to enable access for maintenance and/or inspection activities. Boilers operated in battery shall not be installed closer than 48 in. (1220 mm) from each other. The front or rear of any boiler shall not be located nearer than 36 in. (915 mm) from any wall or structure.
Note: Alternative clearances in accordance with the manufacturer's recommendations are subject to acceptance by the Jurisdiction.

b) Boilers shall be installed to allow for removal and installation of tubes.

c) Boilers with a top-opening manhole, shall have at least 84 in. (2135 mm) of unobstructed clearance above the manhole to the ceiling of the boiler room.

d) Boilers without top-opening manholes shall have at least 36 in. (915 mm) of clearance from the top of the boiler or as recommended by the manufacturer.

e) Boilers with a bottom opening used for inspection or maintenance shall have at least 12 in. (305 mm) of unobstructed clearance.

2.4 BOILER ROOM REQUIREMENTS

2.4.1 EXIT

Two means of exit shall be provided for boiler 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.

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;

5) equipped with handrails 42 in. (1070 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. (1070 mm) high with an intermediate grid.

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;

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.
2.4.3 DRAINS

At least one floor drain shall be installed in the boiler room.

2.4.4 WATER (CLEANING)

A convenient water supply shall be provided for flushing out the boiler and its appurtenances, adding water to the boiler while it is not under pressure and cleaning the boiler room floor.

2.5 SOURCE REQUIREMENTS

2.5.1 FEEDWATER

2.5.1.1 VOLUME

The source of feedwater shall be capable of supplying a sufficient volume of water as determined by the boiler manufacturer in order to prevent damage to the boiler when all the safety relief valves are discharging at full capacity.

2.5.1.2 CONNECTION

a) To prevent thermal shock, feedwater shall be introduced into a boiler in such a manner that the water will not be discharged directly against surfaces exposed to gases of high temperature or to direct radiation from the flame.

b) For boiler operating pressures of 400 psig (2.8 MPa) or higher, the feedwater inlet through the drum shall be fitted with shields, sleeves, or other suitable means to reduce the effects of temperature differentials in the shell or head.

c) Feedwater other than condensate return shall not be introduced through the blow-off.

d) Boilers having more than 500 sq. ft. (46.5 sq. m) of water heating surface shall have at least two means of supplying feedwater. For boilers that are fired with solid fuel not in suspension, and boilers whose setting or heat source can continue to supply sufficient heat to cause damage to the boiler if the feedwater supply is interrupted, one such means of supplying feedwater shall not be subject to the same interruption as the first method. Boilers fired by gaseous, liquid, or solid fuel in suspension may be equipped with a single means of supplying feedwater provided means are furnished for the immediate removal of heat input if the supply of feedwater is interrupted.

e) For boilers having a water heating surface of not more than 100 sq. ft. (9 sq. m), the feedwater piping and connection to the boiler shall not be smaller than NPS 1/2 (DN 15). For boilers having a water heating surface more than 100 sq. ft. (9 sq. m), the feedwater piping and connection to the boiler shall not be less than NPS 3/4 (DN 20).

f) Electric boiler feedwater connections shall not be smaller than NPS 1/2 (DN 15).

g) High temperature water boilers shall be provided with means of adding water to the boiler or system while under pressure.

2.5.1.3 PUMPS

a) Boiler feedwater pumps shall have discharge pressure in excess of the boiler rated pressure (MAWP) 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 three percent higher than the highest setting of any safety valve on the boiler plus the expected pressure drop across the boiler. The following table
is a guideline for estimating feed pump differential:

Table 2.5.1.3
Guide for Feedpump Differential

<table>
<thead>
<tr>
<th>Boiler Pressure</th>
<th>Boiler Feedwater Pump Discharge Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>psig</td>
<td>(MPa)</td>
</tr>
<tr>
<td>200</td>
<td>(1.4)</td>
</tr>
<tr>
<td>400</td>
<td>(2.8)</td>
</tr>
<tr>
<td>800</td>
<td>(5.5)</td>
</tr>
<tr>
<td>1,200</td>
<td>(8.3)</td>
</tr>
<tr>
<td></td>
<td>psig</td>
</tr>
<tr>
<td>250</td>
<td>(1.7)</td>
</tr>
<tr>
<td>475</td>
<td>(3.3)</td>
</tr>
<tr>
<td>925</td>
<td>(6.4)</td>
</tr>
<tr>
<td>1,350</td>
<td>(9.3)</td>
</tr>
</tbody>
</table>

b) For forced-flow steam generators with no fixed steam or water line, each source of feedwater shall be capable of supplying feedwater to the boiler at a minimum pressure equal to the expected maximum sustained pressure at the boiler inlet corresponding to operation at maximum designed steaming capacity with maximum allowable pressure at the superheater outlet.

c) Control devices may be installed on feedwater piping to protect the pump against overpressure.

2.5.1.4 VALVES

a) The feedwater piping shall be provided with a check valve and a stop valve. The stop valve shall be located between the check valve and the boiler.

b) When two or more boilers are fed from a common source, there shall also be a globe or regulating valve on the branch to each boiler located between the check valve and the feedwater source.

c) When the feedwater piping is divided into branch connections and all such connections are equipped with stop and check valves, the stop and check valve in the common source may be omitted.

d) On single boiler-turbine unit installations, the boiler feedwater stop valve may be located upstream from the boiler feedwater check valve.

e) If a boiler is equipped with duplicate feedwater supply arrangements, each such arrangement shall be equipped as required by these rules.

f) A check valve shall not be a substitute for a stop valve.

g) A combination feedwater stop-and-check valve in which there is only one seat and disk and a valve stem is provided to close the valve when the stem is screwed down shall be considered only as a stop valve, a separate check valve shall be installed.

h) Whenever globe valves are used on feedwater piping, the inlet shall be under the disk of the valve.

i) Stop valves and check valves shall be placed on the inlet of economizers or feedwater-heating devices.

j) The recirculating return line for a high temperature water boiler shall be provided with the stop valve, or valves, required for the main discharge outlet on the boiler.

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.
2.5.3 ELECTRICAL

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

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

c) If the boiler room door is on the building exterior, the shutdown switch shall be located just inside the door. If there is more than one door to the boiler room, there shall be a shutdown 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.

d) Controls and Heat Generating Apparatus

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

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

3) These devices shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

2.5.4 VENTILATION AND COMBUSTION AIR

a) The boiler 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.

b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2000 Btu/hr (586 W) maximum fuel input of the combined burners located in the boiler room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The boiler 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 1000 Btu/hr (293 W) of maximum fuel input for the combined burners of all boilers located in the boiler room. Additional capacity may be required for any other fuel burning equipment in the boiler room.

1 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 boiler room must still be considered.
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 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.

2.5.5 LIGHTING

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

2.5.6 EMERGENCY VALVES AND CONTROLS

All emergency shut-off valves and controls shall be accessible from a floor, platform, walkway, or runway. Accessibility shall mean within a 6 ft. (1.8 m) elevation of the standing space and not more than 12 in. (305 mm) horizontally from the standing space edge.

2.6 DISCHARGE REQUIREMENTS

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.

2.6.2 ASH REMOVAL

Ash removal systems shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

2.6.3 DRAINS

2.6.3.1 CONNECTION

a) Each boiler shall have at least one drain pipe fitted with a stop valve at the lowest point of the boiler. If the connection is not intended for blowoff purposes, a single valve is acceptable if it can be locked in the closed position or a blank flange can be installed downstream of the valve. If the connection is intended for blowoff purposes, requirements of 2.7.5 shall be followed.

b) For high temperature water boilers, the minimum size of the drain pipe shall be NPS 1 (DN 25).

c) Drain pipes, valves, and fittings within the same drain line shall be the same size.

d) The discharge from the drain shall be piped to a safe location.

2.6.3.2 PRESSURE RATING

a) When the maximum allowable working pressure of the boiler is equal to or less than 100 psig (700 kPa), the drain pipe, valve, and fittings shall be rated for at least 100 psig (700 kPa) and 220°F (104°C).

b) When the maximum allowable working pressure of the boiler exceeds 100 psig (700 kPa), the drain pipe, valve, and fittings shall be rated for at least the maximum allowable working pressure and temperature of the boiler.
2.6.3.3 PARTS

a) When parts (economizers, etc.) are installed with a stop valve between the part and the boiler or the part cannot be completely drained through the drain on the boiler, a separate drain shall be installed on each such part. These drains shall meet the additional requirements of 6.3, as applicable.

b) Each water column shall have a drain pipe fitted with a stop valve at the lowest point of the water column. The stop valve shall have the capability of being locked in the closed position while the boiler is under pressure. The minimum size of the drain shall be NPS 3/4 (DN 20) and all other requirements of 6.3, as applicable.

2.7 OPERATING SYSTEMS

2.7.1 BREECHING AND DAMPERS

Breeching and dampers shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

2.7.2 BURNERS AND STOKERS

Burners and stokers shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

2.7.3 STEAM SUPPLY

a) Provisions shall be made for the expansion and contraction of steam mains connected to boiler(s) so that there shall be no undue stress transmitted to the boiler(s). Steam reservoirs shall be installed on steam mains when heavy pulsations of the steam flow causes vibration of the boiler shell plates.

b) Each discharge outlet of the boiler drum or superheater outlet shall be fitted with a stop valve located at an accessible point in the steam-delivery line and as near the boiler nozzle as is convenient and practicable. The valve shall be equipped to indicate from a distance whether it is closed or open, and shall be equipped with a slow-opening mechanism. When such outlets are over NPS 2 (DN 50), the valve or valves used on the connection shall be of the outside screw-and-yoke-rising spindle type, so as to indicate from a distance by the position of its spindle whether it is closed or open, and the wheel should be carried either on the yoke or attached to the spindle. In the case of a single boiler and prime mover installation, the stop valve may be omitted provided the prime mover throttle valve is equipped with an indicator to show whether the valve is open or closed and is designed to withstand the required hydrostatic test pressure of the boiler.

c) Stop valves and fittings shall comply with the appropriate national standard except that austenitic stainless steel is not permitted for water wetted service.

d) Stop valves and fittings shall be rated for the maximum allowable working pressure of the boiler and shall be at least rated for 100 psig (700 kPa) at the expected steam temperature at the valve or fitting, in accordance with the appropriate national standard.

e) The nearest stop valve or valves to the superheater outlet shall have a pressure rating at least equal to the minimum set pressure of any safety valve on the superheater and at the expected superheated steam temperature; or at least equal to 85% of the lowest set pressure of any safety valve on the boiler drum at the expected steam temperature of the superheater outlet, whichever is greater.
f) Ample provision for gravity drain shall be provided when a stop valve is so located that water or condensation may accumulate. The gravity drain(s) shall be located such that the entire steam supply system can be drained.

b) The blowoff piping for each electric boiler pressure vessel having a nominal water content not exceeding 100 gal. (378 l) is required to extend through only one valve.

c) One of the blowoff valves shall be a slow-opening valve. When a second valve is required, the second valve may be a quick-opening or slow-opening valve.

d) Two independent slow-opening valves or a slow-opening valve and quick-opening valve should be combined in one body and should be used provided the combined fitting is the equivalent of two independent slow-opening valves or a slow-opening valve and a quick-opening valve, and provided further that the failure of one to operate cannot affect the operation of the other.

e) Straight-run globe valves or valves where dams or pockets can exist for the collection of sediment shall not be used.

f) The blowoff valve or valves and the pipe and fittings between them and the boiler shall be of the same size. The minimum size of pipe and fittings shall be NPS 1 (DN 25), except boilers with 100 sq. ft (9.3 sq. m) of heating surface or less should be NPS 3/4 (DN 20). The maximum size of pipe and fittings shall not exceed NPS 2-1/2 (DN 65).

g) For electric boilers, the minimum size of blowoff pipes and fittings shall be NPS 1 (DN 25), except for boilers of 200 kW input or less, the minimum size should be NPS 3/4 (DN 20).

2.7.4 CONDENSATE AND RETURN

Each condensate return pump where practicable, shall be provided with an automatic water level control set to maintain an adequate water level in the condensate tank. Condensate tanks not constructed in accordance with an accepted code or standard shall be vented to the atmosphere.

2.7.5 BLOWOFF

a) Except for forced-flow steam generators with no fixed steam or water line, each boiler shall have a blowoff pipe, fitted with a stop valve, in direct connection with the lowest water space practicable. When the maximum allowable working pressure of the boiler exceeds 100 psig (700 kPa), there shall be two valves installed.
h) Fittings and valves shall comply with the appropriate national standard except that austenitic stainless steel and malleable iron are not permitted.

i) When the maximum allowable working pressure exceeds 100 psig (700 kPa), blowoff piping shall be at least Schedule 80 and the required valves and fittings shall be rated for at least 1.25 times the maximum allowable working pressure of the boiler. When the maximum allowable working pressure exceeds 900 psig (6.2 MPa), blowoff piping shall be at least Schedule 80 and the required valves and fittings shall be rated for at least the maximum allowable working pressure of the boiler plus 225 psi (1.6 MPa).

j) All blowoff piping, when exposed to furnace heat, shall be protected by fire brick or other heat resisting material so constructed that the piping may be readily inspected.

k) On a boiler having multiple blowoff pipes, a single master stop valve should be placed on the common blowoff pipe from the boiler and one stop valve on each individual blowoff. Either the master valve or the valves on the individual blowoff lines shall be of the slow-opening type.

l) The discharge of blowoff pipes shall be located so as to prevent injury to personnel.

m) All waterwalls or water screens that do not drain back into the boiler and integral economizers forming part of a boiler shall be equipped with blowoff piping and valves conforming to the requirements of this paragraph.

n) Blowoff piping from a boiler should not discharge directly into a sewer. A blowoff tank, constructed to the provisions of a code of construction acceptable to the jurisdiction, shall be used where conditions do not provide an adequate and safe open discharge.

o) Galvanized pipe shall not be used.

p) Boiler blowoff systems shall be constructed in accordance with the Guide for Blowoff Vessels(NB-27).2

q) Where necessary to install a blowoff tank underground, it shall be enclosed in a concrete or brick pit with a removable cover so that inspection of the entire shell and heads of the tank can be made.

r) Piping connections used primarily for continuous operation, such as deaerators on continuous blowdown systems, are not classed as blowoffs but the pipe connections and all fittings up to and including the first shutoff valve shall be equal at least to the pressure requirements for the lowest set pressure of any safety valve on the boiler drum and with the corresponding saturated-steam temperature. Further, such connections shall not exceed NPS 2-1/2 (DN 65).

2.8 CONTROLS AND GAGES

2.8.1 WATER

a) Each automatically fired steam boiler shall be equipped with at least two low-water fuel cutoffs. The water inlet shall not feed water into the boiler through a float chamber.

b) Each electric steam boiler of the resistance element type shall be equipped with an automatic low-water cutoff so located as to automatically cut off the power supply to the heating elements before the surface of the water falls below the visible part of the glass. No low-water cutoff is required for electrode-type boilers.

c) Designs embodying a float and float bowl shall have a vertical straightaway drainpipe at the lowest point in the water equalizing pipe connections, by which the bowl and the equalizing pipe can be flushed and the device tested.

d) The water column shall be directly connected to the boiler. Outlet connections (except for damper regulator, feedwater regulator, low-water fuel cutoff, drains, steam gages, or such apparatus that does not permit the escape of an appreciable amount of steam or water) should not be placed on the piping that connects the water column to the boiler.

e) Straight-run globe valves of the ordinary type shall not be used on piping that connects the water column to the boiler. Where water columns are 7 ft (2.1 m) or more above the floor level, adequate means for operating gage cocks or blowing out the water glass shall be provided.

f) When automatic shutoff valves are used on piping that connects the water column to the boiler, they shall conform to the requirements of the code of construction for the boiler.

g) When shutoff valves are used on the connections to a water column, they shall be either outside-screw-and-yoke or lever-lifting-type gate valves or stop cocks with levers permanently fastened thereto and marked in line with their passage, or of such other through-flow constructions to prevent stoppage by deposits of sediment and to indicate by the position of the operating mechanism whether they are in open or closed position; and such valves or cocks shall be locked or sealed open.

h) Each steam boiler having a fixed waterline shall have at least one water-gage glass except that boilers operated at pressures over 400 psig (2.8 MPa) shall be provided with two water-gage glasses that may be connected to a single water column or connected directly to the drum. The gage glass connections and pipe connection shall be not less than NPS 1/2 (DN 15). Each water-gage glass shall be equipped with a valved drain.

i) Electric steam boilers shall have at least one water-gage glass. On electrode-type electric boilers, the gage glass shall be located as to indicate the water levels both at startup and maximum steam load conditions, as established by the boiler manufacturer. On resistance element type electric steam boilers, the lowest visible part of the gage glass shall be located at least 1 in. (25 mm) above the lowest permissible water level established by the boiler manufacturer.

j) The lowest visible part of the water-gage glass shall be at least 2 in. (50 mm) above the lowest permissible water level established by the boiler manufacturer.

k) For all installations where the water-gage glass or glasses are not easily viewed by the operator, consideration should be given to install a method of remote transmission of the water level to the operating floor.

l) Boilers of the horizontal firetube type shall be so set that when the water is at the lowest reading in the water gage glass there shall be at least 3 in. (75 mm) of water over the highest point of the tubes, flues, or crown sheet.

m) Each water-gage glass shall be equipped with a top and a bottom shutoff valve of such through-flow construction as to prevent blockage by deposits of sediment and to indicate by the position of the operating mechanism whether they are in the open or closed position. The pressure-temperature rating shall be at least equal to that of the lowest set pressure of any safety valve on the boiler drum and the corresponding saturated steam temperature.
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 or no greater than two times the pressure at which the lowest safety relief valve is set.

2.8.2.1  CONNECTION

a) For a steam boiler the gage or connection shall contain a syphon or equivalent device that will develop and maintain a water seal that will prevent steam from entering the gage tube. A valve or cock shall be placed in the gage connection adjacent to the gage. An additional valve or cock should be located near the boiler providing it is locked or sealed in the open position. No other shut-off valves shall be located between the gage and the boiler.

b) Pressure gage connections shall be suitable for the maximum allowable working pressure and temperature, but if the temperature exceeds 406°F (208°C) brass or copper pipe or tubing shall not be used. The connections to the boiler, except for the syphon, if used, shall not be less than NPS 1/4 (DN 8). Where steel or wrought iron pipe or tubing is used, it shall not be less than 1/2 in. (13 mm) inside diameter. The minimum size of a syphon, if used, shall be 1/4 in. (6 mm) inside diameter.

2.8.3  TEMPERATURE

Each high temperature water boiler shall have a temperature gage or other reporting device located to provide an accurate representation of the temperature at or near the boiler outlet.

2.9  PRESSURE RELIEF VALVES

2.9.1  VALVE REQUIREMENTS — GENERAL

a) Safety valves are designed to relieve steam.

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

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

d) Deadweight or weighted-lever pressure-relieving 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 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 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 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 mil-
lion BTU/hr (1100 kW), two or more National Board capacity certified safety or safety relief valves shall be installed.

2.9.1.2 LOCATION

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

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

c) Safety or safety 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 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 2.9.1.3, 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 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 relief valve relieving capacity for electric boilers is 3.5 lbs/hr/kW (1.6 kg/hr/kW) input.

e) If the safety or safety 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 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 2.9.1.3 - Minimum Pounds of Steam per Hour per Square Foot of Heating Surface 1 lb steam/hr/sq.ft (kg/hr/sq m)

<table>
<thead>
<tr>
<th></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>4 (20)</td>
</tr>
<tr>
<td>stoker-fired</td>
<td>5 (24)</td>
<td>5 (24)</td>
</tr>
<tr>
<td>oil, gas, or pulverized fuel-fired</td>
<td>5 (24)</td>
<td>6 (29)</td>
</tr>
</tbody>
</table>

NOTES:
• When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/cu. ft.(7.5MJ/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.

2.9.1.4 SET PRESSURE

One or more safety or safety 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 relief valves on a boiler shall not exceed 10% of the highest pressure to which any valve is set. Pressure setting of safety relief valves on high temperature water boilers may exceed this 10% range.

2.9.2 FORCED-FLOW STEAM GENERATOR

For a forced-flow steam generator with no fixed steamline and waterline, equipped with automatic controls and protective interlocks responsive to steam pressure, safety valves should be installed in accordance with the following, as an alternative:

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 maxi-
mum 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 valves shall be provided having a total combined relieving capacity, including that of the power-actuated pressure-relieving valve, of not less than one hundred percent 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 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 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.

2.9.3 SUPERHEATERS

a) Every attached superheater shall have one or more safety valves. The location shall be suitable for the service intended and shall provide the overpressure protection required. The pressure drop upstream of each safety 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 valve or valves may be located anywhere in the length of header.

b) The pressure-relieving capacity of the safety valve or valves on an attached superheater shall be included in determining the number and size of the safety valves for the boiler provided there are no intervening valves between the superheater safety valve and the boiler and the discharge capacity of the safety 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 valves having a discharge capacity equal to six 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 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.

2.9.4 ECONOMIZERS

An economizer that may not be isolated from a boiler does not require a safety 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 relief valve. Discharge capacity, rated in lbs/hr (kg/hr), of the safety relief valve or valves shall 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 1000. The safety relief valve shall be located as close as possible to the economizer outlet.

2.9.5 PRESSURE-REDUCING VALVES

a) Where pressure-reducing valves are used, one or more safety or safety 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 relief valves shall be located as close as possible to the pressure-reducing valve.

c) Capacity of the safety or safety 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 safety or safety relief valves or meets the requirements of the high pressure system.

2.9.5.1 MOUNTING AND DISCHARGE REQUIREMENTS

a) Every boiler shall have outlet connections for the safety or safety 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 safety or safety 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 safety or safety 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 safety or safety 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 ten times the total area of the safety valve inlet.
b) Every safety or safety 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 safety or safety relief valve shall have at least the area of the valve inlet. No valve of any description should be placed between the safety or safety relief valves and the boiler, nor on the discharge pipe between the safety or safety relief valves and the atmosphere. 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) When two or more safety 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.

e) 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.

f) When a boiler is fitted with two or more safety 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 safety relief valves with which it connects.

g) All safety or safety 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. Ample provision for gravity drain shall be made in the discharge pipe at or near each safety or safety 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).

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

i) If a muffler is used on a safety or safety 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 relief valves.

2.10 TESTING AND ACCEPTANCE

2.10.1 GENERAL

a) Care shall be exercised during installation to prevent loose weld material, welding rods, small tools, and miscellaneous scrap metal from getting into the boiler. Where possible, an inspection of the interior of the boiler and its appurtenances shall be made for the presence of foreign debris prior to making the final closure.

b) Safe operation should be verified by a person familiar with boiler system operations for all boilers and connected appurtenances and all pressure piping connecting them to the appurtenances and all piping up to and including the first stop valve, or the second stop valve when two are required.

c) The wall thickness of all pipe connections shall comply with the requirements of the code of construction for the boiler.
d) All threaded pipe connections shall engage at least five full threads of the pipe or fitting.

e) In bolted connections, the bolts, studs, and nuts shall be marked as required by the original Code of Construction and be fully engaged (e.g., the end of the bolt or stud shall protrude through the nut).

f) Washers shall only be used when specified by the manufacturer of the part being installed.

2.10.2 PRESSURE TEST

Prior to initial operation, the completed boiler, including pressure piping, water columns, superheaters, economizers, stop valves, etc., shall be pressure tested in accordance with the original code of construction. Any pressure piping and fittings such as water columns, blowoff valves, feedwater regulators, superheaters, economizers, stop valves, etc., which are shipped connected to the boiler as a unit, shall be hydrostatically tested with the boiler and witnessed by an Inspector.

2.10.3 NONDESTRUCTIVE EXAMINATION

Boiler components and subcomponents shall be nondestructively examined as required by the governing Code of Construction.

2.10.4 SYSTEM TESTING

Prior to final acceptance, an operational test shall be performed on the complete installation. The test data shall be recorded and the data made available to the jurisdictional authorities as evidence that the installation complies with the provisions of the governing code(s) of construction. This operational test may be used as the final acceptance of the unit.

2.10.5 FINAL ACCEPTANCE

A boiler may not be placed into service until its installation has been inspected and accepted by the appropriate jurisdictional authorities.

2.10.6 BOILER INSTALLATION REPORT

a) Upon completion, inspection, and acceptance of the installation, the installer shall complete and certify the Boiler Installation Report I-1. See 1.4.5.1.

b) The Boiler Installation Report I-1 shall be submitted as follows:

1) one copy to the Owner; and

2) one copy to the Jurisdiction, if required.
Insert
Section 3
Tab
Here
PART 1, SECTION 3
INSTALLATION — STEAM HEATING
BOILERS, HOT-WATER HEATING BOILERS,
HOT-WATER SUPPLY BOILERS, AND
POTABLE WATER HEATERS
PART 1, SECTION 3
INSTALLATION — STEAM HEATING BOILERS,
HOT-WATER HEATING BOILERS, HOT-WATER SUPPLY BOILERS,
AND POTABLE WATER HEATERS

3.1 SCOPE

The scope of this Section shall apply to those steam heating boilers, hot-water heating boilers, hot-water supply boilers, and potable water heaters as defined in 3.2, Definitions. For installation of items that do not fall within the scope of this section, refer to the following sections as applicable:

Section 2 — Power Boilers
Section 4 — Pressure Vessels
Section 5 — Piping

3.2 DEFINITIONS

3.2.1 STEAM HEATING BOILERS

Steam heating boilers are steam boilers installed to operate at pressures not exceeding 15 psig (100 kPa).

3.2.2 HOT-WATER HEATING AND HOT-WATER SUPPLY BOILERS

Hot-water heating and hot-water supply boilers are hot water boilers installed to operate at pressures not exceeding 160 psig (1100 kPa) and/or temperatures not exceeding 250°F (121°C), at or near the boiler outlet.

3.2.3 POTABLE WATER HEATERS

a) Potable water heaters are corrosion resistant water heaters supplying potable hot water at pressures not exceeding 160 psig (1100 kPa) and temperatures not in excess of 210°F (99°C).

b) Water heaters are exempted from Section 3 of this Part when none of the following limitations are exceeded:

1) Heat input of 200,000 Btu/hr (59 kW)

2) Water temperature of 210°F (99°C)

3) Nominal water containing capacity of 120 gal. (454 l), except that they shall be equipped with safety devices in accordance with the requirements of 3.9.4.

3.3 GENERAL REQUIREMENTS

3.3.1 SUPPORTS

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.

3.3.1.1 METHODS OF SUPPORT FOR STEAM HEATING, HOT-WATER HEATING, AND HOT-WATER SUPPLY BOILERS

a) Loadings

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

2) In applying the requirements of (1) above, provision shall be made for localized stresses due to concentrated support loads, temperature changes, and restraint against movement of the boiler due to pressure. Lugs, hangers, brackets, saddles, and pads shall conform satisfactorily to the shape of the shell or surface to which they are attached or are in contact.

b) Horizontal Return Firetube Boilers

1) Boilers over 72 in. (1800 mm) in diameter
A horizontal-return tubular boiler over 72 in. (1800 mm) in diameter shall be supported from steel hangers by the outside-suspension type of setting, independent of the furnace wall. The hangers shall be so designed that the load is properly distributed.

2) Boilers 14 ft. (4.3 m) or over in length, or over 54 in. (1370 mm) up to 72 in. (1800 mm) in diameter
A horizontal-return tubular boiler over 54 in. (1370 mm) and up to and including 72 in. (1800 mm) in diameter shall be supported by the outside-suspension type of setting, or at four points by not less than eight steel brackets set in pairs, the brackets of each pair to be spaced not over 2 in. (50 mm) apart and the load to be equalized between them. See Figure 3.3.1.1-a.

3) Boilers up to 54 in. (1370 mm) in diameter
A horizontal-return boiler up to and including 54 in. (1370 mm) in diameter shall be supported by the outside-suspension type of setting, or by not less than two steel brackets on each side.

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

d) Lugs or Hangers
Lugs, hangers, or brackets made of materials in accordance with the requirements of the code of construction may be attached by fusion welding provided they are attached by fillet welds along the entire periphery or contact edges. Figure 3.3.1.1-b illustrates an acceptable design of hanger bracket with the additional requirement that the center pin be located at the vertical center line over the center of the welded contact surface. The bracket plates shall be spaced at least 2-1/2 in. (64 mm) apart, but this dimension shall be increased if necessary to permit access for the welding operation. The stresses computed by dividing the total load on each lug, hanger, or bracket, by the minimum cross-sectional area of the weld shall not exceed 2800 psig (19 MPa). Where it is impractical to attach lugs, hangers, or brackets by welding, studs with not less than 10 threads/in. (approximately 4 threads/cm) may be used. In computing the shearing stresses, the root area at the bottom of the thread shall be used. The shearing and crushing stresses on studs shall not exceed that permitted by the code of construction.

3.3.2 SETTINGS
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.

3.3.3 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 industry standards as appropriate.
3.3.4 CLEARANCES

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. (2135 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 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.

3.4 BOILER ROOM REQUIREMENTS

3.4.1 EXIT

Two means of exit shall be provided for boiler 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.

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. (1070 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. (1070 mm) high with an intermediate grid.

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

3 Maintenance – This includes the removal of tubes.
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 SOURCE REQUIREMENTS

3.5.1 WATER

a) A means to add water to or fill the boiler, while not under pressure, shall be provided. A valve or threaded plug may be used to shut off the fill connection when the boiler is in service.

b) Water fill connections shall be installed and provisions shall be made to prevent boiler water from back-feeding into the service water supply.

c) Provision should also be made in every boiler room for a convenient water supply that can be used to flush out the boiler and to clean the boiler room floor.

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.

3.5.3 ELECTRICAL

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

c) If the boiler 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 boiler 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.

d) Controls and Heat Generating Apparatus

1) Oil- and gas-fired and electrically heated boilers and water heaters shall be equipped with suitable primary (flame safeguard) safety switches, safety limit switches, and burners or electric elements as required by a nationally or internationally recognized standard.

2) The symbol of the certifying organization that has investigated such equipment as having complied with a nationally recognized standard shall be affixed to the equipment and shall be considered as evidence that the unit was manufactured in accordance with that standard.
3) These devices shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

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 boiler room must still be considered.

f) The size of openings specified in 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.

3.5.4 VENTILATION AND COMBUSTION AIR

a) The boiler 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 may be supplied by either an unobstructed air opening or by power ventilation or fans.4

b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (645 sq mm) free area per 2000 Btu/hr (586 W) maximum fuel input of the combined burners located in the boiler room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The boiler 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 (.0057 cu meters per minute) 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 boiler 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.

3.5.5 LIGHTING

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

3.5.6 EMERGENCY VALVES AND CONTROLS

All emergency shut-off valves and controls shall be accessible from a floor, platform, walkway or runway. Accessibility shall mean within a 6 ft. (1.8 m) elevation of the standing space and not more than 12 in. (305 mm) horizontally from the standing space edge.

3.6 DISCHARGE REQUIREMENTS

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.

---

4 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 boiler room must still be considered.
3.6.2 ASH REMOVAL

Ash removal systems shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

3.6.3 DRAINS

Unobstructed floor drains, properly located in the boiler room, will facilitate proper cleaning of the boiler room. Floor drains that are used infrequently should have water poured into them periodically to prevent the entrance of sewer gasses and odors. If there is a possibility of freezing, an environmentally safe antifreeze mixture should be used in the drain traps. Drains receiving blowdown water should be connected to the sanitary sewer by way of an acceptable blowdown tank or separator or an air gap that will allow the blowdown water to cool to at least 140°F (60°C) and reduce the pressure to 5 psig (34 kPa) or less.

3.7 OPERATING SYSTEMS

3.7.1 OIL HEATERS

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

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

3.7.2 BREECHING AND DAMPERS

Breeching and dampers shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

3.7.3 BURNERS AND STOKERS

Burners and stokers shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

3.7.4 FEEDWATER, MAKEUP WATER, AND WATER SUPPLY

a) Steam Boilers

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

b) Hot-Water Boilers

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

1) Water supply shall be introduced into a water heater through an independent water supply connection. Feedwater shall not be introduced through openings or connections provided for cleaning, safety relief valves, drain, pressure gage, or temperature gage.

2) If the water supply pressure to a water heater exceeds 75% of the set pressure of the safety relief valve, a pressure reducing valve is required.

3.7.5 STOP VALVES

3.7.5.1 STEAM HEATING, HOT-WATER HEATING, AND HOT-WATER SUPPLY BOILERS

a) For Single Installations
Stop valves shall be located at an accessible point in the supply and return pipe connections, as near the boiler as is convenient and practicable.

b) For Multiple Boiler Installations
A stop valve shall be used in each supply and return pipe connection of two or more boilers connected to a common system. See Figures 3.7.5-a, 3.7.5-b, and 3.7.5-c.

c) Type of Stop Valve(s)

1) All valves or cocks shall conform with the applicable portions of an acceptable code of construction and may be ferrous or nonferrous.

2) The minimum pressure rating of all valves or cocks shall be at least equal to the pressure stamped upon the boiler, and the temperature rating of such valves or cocks, including all internal components, shall be not less than 250°F (121°C).

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

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

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

3.7.5.2 POTABLE WATER HEATERS

Stop valves shall be installed in the supply and discharge pipe connections of a water heater installation to permit draining the water heater without emptying the system. See Figure 3.7.5(d)

3.7.6 RETURN PIPE CONNECTIONS

a) The return pipe connections of each boiler supplying a gravity return steam heating system shall be so arranged as to form a loop substantially as shown in Figure 3.7.5-b so that the water in each boiler cannot be forced out below the safe water level.

b) For hand-fired boilers with a normal grate line, the recommended pipe sizes detailed as “A” in Figures 3.7.5-a and 3.7.5-b are NPS 1-1/2 (DN 40) for 4 sq. ft (0.37 sq. m) or less firebox area at the normal grate line, NPS 2-1/2 (DN 65) for areas more than 4 sq. ft (0.37 sq. m) up to 14.9 sq. ft (1.38 sq. m), and NPS 4 (DN 100) for 15 sq. ft (1.39 sq. m) or more.

c) For automatically-fired boilers that do not have a normal grate line, the recommended pipe sizes detailed as “A” in Figures 3.7.5-

4.1
a and 3.7.5-b are NPS 1-1/2 (DN 40) for boilers with minimum safety valve relieving capacity 250 lb/hr (113 kg/hr) or less, NPS 2-1/2 (DN 65) for boilers with minimum safety valve relieving capacity from 251 lb/hr (114 kg/hr) to 2000 lb/hr (907 kg/hr), inclusive, and NPS 4 (DN 100) for boilers with more than 2000 lb/hr (907 kg/hr) minimum safety valve relieving capacity.

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

FIGURE 3.7.5-a
Steam boilers in battery — pumped return — acceptable piping installation

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

Note:
(1) Recommended for 1 in. (25 mm) and larger safety valve discharge.
FIGURE 3.7.5-b
Steam boilers in battery — gravity return — acceptable piping installation

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

Note:
(1) Recommended for 1 in. (25 mm) and larger safety valve discharge.
FIGURE 3.7.5-c
Hot-water boilers in battery — acceptable piping installation

General Notes:
(1) Recommended control. See HG-614. Acceptable shutoff valves or cocks in the connecting piping may be installed for convenience of control testing and/or service.
(2) The common return header stop valves may be located on either side of the check valves.
FIGURE 3.7.5-d
Storage Potable Water Heaters in Battery – Acceptable Piping Installation

Expansion Tank if Required  Drain Valve with Suitable Drain

Point of Use

Pressure Reducing Valve if Required

Cold Water Supply

Water Heater with Vertical Top Safety Relief Opening To Open Drain

Water Heater with Side Safety Relief Opening & within 4 in. of the top of the shell To Open Drain

Water Heater with Top Relief Opening

Water Heater with Side Relief Opening

Optical Recirculation Line (Note (1))

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

FIGURE 3.7.5-e
Flow Through Potable Water Heater Without Provision for Piping Expansion – Acceptable Piping Installation

Flow switch on flow through water heater

Optical recirculation line

Drain valve
3.7.7 BOTTOM BLOWOFF AND DRAIN VALVES

3.7.7.1 STEAM HEATING, HOT-WATER HEATING, AND HOT-WATER SUPPLY BOILERS

a) Bottom Blowoffs

1) Each steam boiler shall have a bottom blowoff connection fitted with a valve or cock connected to the lowest water space practicable with a minimum size as shown in Table 3.7.7.1. The discharge piping shall be full size to the point of discharge.

2) Boilers having a capacity of 25 gallons (95 l) or less are exempt from the above requirements, except that they shall have a NPS 3/4 (DN 20) minimum drain valve.

b) Drains

1) Each steam or hot-water boiler shall have one or more drain connections, fitted with valves or cocks connecting to the lowest water containing spaces. All parts of the boiler must be capable of being drained (the boiler design will dictate the number and size of drains). The minimum size of the drain piping, valves, and cocks shall be NPS 3/4 (DN 20). The discharge piping shall be full size to the point of discharge.

2) When the blowoff connection is located at the lowest water containing space, a separate drain connection is not required.

c) Minimum Pressure Rating

The minimum pressure rating of valves and cocks used for blowoff or drain purposes shall be at least equal to the pressure stamped on the boiler but in no case less than 30 psig (200 kPa). The temperature rating of such valves and cocks shall not be less than 250°F (121°C).

<table>
<thead>
<tr>
<th>Minimum Required Safety Valve Capacity, lb of steam/hr (Note 1)</th>
<th>Blowoff Piping, Valve, and Cock Sizes, in. (mm)(min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 500 (up to 227 kg)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td>501 to 1,250 (over 227 kg to 567 kg)</td>
<td>1 (25)</td>
</tr>
<tr>
<td>1,251 to 2,500 (over 567 kg to 1134 kg)</td>
<td>1-1/4 (32)</td>
</tr>
<tr>
<td>2,501 to 6,000 (over 1134 kg to 2722 kg)</td>
<td>1-1/2 (38)</td>
</tr>
<tr>
<td>6,001 and larger (over 2722 kg)</td>
<td>2 (50)</td>
</tr>
</tbody>
</table>

Note 1: To determine the discharge capacity of the safety relief valves in terms total energy absorbed, use 1 lb steam per hour per 1000 Btu (1 kg steam per hour per 2326 kJ)

3.7.7.2 POTABLE WATER HEATERS

Drain Valve

a) Each water heater shall have a bottom drain pipe connection fitted with a valve or cock connected with the lowest water space practicable. The minimum size bottom valve shall be NPS 3/4 (DN 20).

b) Any discharge piping connected to the bottom drain connection shall be full size to the point of discharge. See Figures 3.7.5-d and 3.7.5-e

3.7.8 MODULAR STEAM HEATING AND HOT-WATER HEATING BOILERS
3.7.8.1 INDIVIDUAL MODULES

a) The individual modules shall comply with all the requirements of the code of construction and this paragraph. The individual modules shall be limited to a maximum input of 400,000 Btu/hr (117 kW/hr), gas 3 gal./hr (11.4 l/hr), oil or 117 kW (electricity).

b) Each module of a modular steam heating boiler shall be equipped with:
   1) Safety valve, see 3.9.2
   2) Blowoff valve, see 3.7.7.1(a)
   3) Drain valve, see 3.7.7.1(b).

c) Each module of a modular hot-water heating boiler shall be equipped with:
   1) Safety relief valve, see 3.9.3
   2) Drain valve, see 3.7.7.1(b).

3.7.8.2 ASSEMBLED MODULAR BOILERS

a) The individual modules shall be manifolded together at the job-site without any intervening valves.

b) The assembled modular steam heating boiler shall also be equipped with:
   1) Feedwater connection, see Figures 3.7.5-a and 3.7.5-b
   2) Return pipe connection, see Figures 3.7.5-a and 3.7.5-b

c) The assembled modular hot water boiler shall also be equipped with:
   1) Makeup water connection, see Figure 3.7.5-c
   2) Provision for thermal expansion, see Figures 3.7.5-c and Table 3.7.9.1-a
   3) Stop valves, see Figure 3.7.5-c (treating the assembled modular boiler as a single unit).

3.7.9 PROVISIONS FOR THERMAL EXPANSION

3.7.9.1 EXPANSION TANKS AND PIPING FOR STEAM HEATING, HOT-WATER HEATING, HOT-WATER SUPPLY BOILERS, AND POTABLE WATER HEATERS

a) Expansion Tanks for Hot-Water Heating, and Hot-Water Supply Boilers
   All hot-water heating systems incorporating hot-water tanks or fluid relief columns shall be so installed as to prevent freezing under normal operating conditions.
   1) Heating Systems With Open Expansion Tank
      An indoor overflow from the upper portion of the expansion tank shall be provided in addition to an open vent, the indoor overflow shall be carried within the building to a suitable plumbing fixture or drain.
   2) Closed Heating Systems
      An expansion tank shall be installed that will be consistent with the volume and capacity of the system. If the system is designed for a working pressure of 30 psig (200 kPa) or less, the tank shall be suitably designed for a minimum hydrostatic test pressure of 75 psig (520 kPa). Expansion tanks for systems designed to operate above 30 psig (200 kPa) shall be constructed in accordance with an acceptable code of construction. Provisions shall be made for draining the tank without emptying the system. Except for prepressurized tanks, the minimum capacity of the closed-type expansion tank should be determined from Tables 3.7.9.1-a and 3.7.9.1-b or
from the following formula where the necessary information is available:

**US Customary:**

\[
V_i = \frac{(0.00047T - 0.0466)V_s}{(P_i/P) - (P_a/P_o)}
\]

where,

- \(V_i\) = minimum volume of tanks, gallons
- \(V_s\) = volume of system, not including tanks, gallons
- \(T\) = (t2-t1) °F
- \(t_i\) = lower temperature
- \(t_o\) = higher temperature
- \(P_a\) = atmospheric pressure, psia
- \(P_i\) = fill pressure, psia
- \(P_o\) = maximum operating pressure, psia

**Metric:**

\[
V_i = \frac{(0.000738T - 0.03348)V_s}{(P_i/P) - (P_a/P_o)}
\]

where,

- \(V_i\) = minimum volume of tanks, liters
- \(V_s\) = volume of system, not including tanks, liters
- \(T\) = average operating temperature, °C
- \(P_a\) = atmospheric pressure, kPa
- \(P_i\) = fill pressure, kPa
- \(P_o\) = maximum operating pressure, kPa

### Table 3.7.9.1-a

**Expansion Tank Capacities for Gravity Hot-Water Systems**

(Based on two-pipe system with average operating water temperature 170°F (77°C), using cast-iron column radiation with heat emission rate 150 Btu/hr sq. ft. (473 W/sq. m) equivalent direct radiation.)

<table>
<thead>
<tr>
<th>Installed Equivalent</th>
<th>Direct Radiation, sq. ft. (sq. m) (Note)</th>
<th>No.</th>
<th>Tank Capacity, gallon (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 350 (33)</td>
<td>1</td>
<td>18 (68)</td>
<td></td>
</tr>
<tr>
<td>up to 450 (42)</td>
<td>1</td>
<td>21 (80)</td>
<td></td>
</tr>
<tr>
<td>up to 650 (60)</td>
<td>1</td>
<td>24 (91)</td>
<td></td>
</tr>
<tr>
<td>up to 900 (84)</td>
<td>1</td>
<td>30 (114)</td>
<td></td>
</tr>
<tr>
<td>up to 1,100 (102)</td>
<td>1</td>
<td>35 (132)</td>
<td></td>
</tr>
<tr>
<td>up to 1,400 (130)</td>
<td>1</td>
<td>40 (151)</td>
<td></td>
</tr>
<tr>
<td>up to 1,600 (149)</td>
<td>2</td>
<td>60 (228)</td>
<td></td>
</tr>
<tr>
<td>up to 1,800 (167)</td>
<td>2</td>
<td>60 (228)</td>
<td></td>
</tr>
<tr>
<td>up to 2,000 (186)</td>
<td>2</td>
<td>70 (264)</td>
<td></td>
</tr>
<tr>
<td>up to 2,400 (223)</td>
<td>2</td>
<td>80 (302)</td>
<td></td>
</tr>
</tbody>
</table>

Note: For systems with more than 2,400 sq. ft. (223 sq. m) of installed equivalent direct water radiation, the required capacity of the cushion tank shall be increased on the basis of 1 gallon (3.81 l) tank capacity/33 sq. ft. (3 sq. m) of additional equivalent direct radiation.

3) Hot-water Supply Systems and Potable Water Systems

If a system is equipped with a check valve or pressure reducing valve in the cold water inlet line, consideration should be given to the installation of an airtight expansion tank or other suitable air cushion. Otherwise due to the thermal expansion of the water, the safety relief valve may lift periodically. If an expansion tank is provided, it shall be constructed in accordance with an acceptable code of construction. Except for prepressurized tanks, which should be installed on the cold water side, provisions shall be made for draining the tank without emptying the system. See Figures 3.7.5-d and 3.7.5-e for a typical acceptable installation.

b) Piping for Steam Heating, Hot-water Heating, and Hot-water Supply Boilers

Provisions shall be made for the expansion and contraction of steam and hot water mains connected to boiler(s) so there will be no undue strain transmitted to the boiler(s). See Figures 3.7.5-a, 3.7.5-b, and 3.7.5-c for typical schematic arrangements of piping incorporating strain absorbing joints for steam and hot-water heating boilers.
Table 3.7.9.1-b
Expansion Tank Capacities for Forced Hot-Water Systems (Note)

<table>
<thead>
<tr>
<th>System Volume, gal (l)</th>
<th>Prepressurized Diaphragm type</th>
<th>Nonpressurized type</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 (380)</td>
<td>9 (34)</td>
<td>18 (57)</td>
</tr>
<tr>
<td>200 (760)</td>
<td>17 (64)</td>
<td>30 (114)</td>
</tr>
<tr>
<td>300 (1140)</td>
<td>25 (95)</td>
<td>45 (170)</td>
</tr>
<tr>
<td>400 (1514)</td>
<td>33 (125)</td>
<td>60 (227)</td>
</tr>
<tr>
<td>500 (1890)</td>
<td>42 (159)</td>
<td>75 (284)</td>
</tr>
<tr>
<td>1,000 (3790)</td>
<td>83 (315)</td>
<td>150 (568)</td>
</tr>
<tr>
<td>2,000 (7570)</td>
<td>165 (625)</td>
<td>300 (1136)</td>
</tr>
</tbody>
</table>

Note: System volume includes volume of water in boiler, radiation, and piping, not including the expansion tank. Expansion tank capacities are based on an acceptance factor of 0.4027 for prepressurized types and 0.222 for nonpressurized types.

For other cases or metric calculations see Chapter 12 of the 1996 HVAC Systems and Equipment Volume of the ASHRAE Handbook.

Table 3.7.9.1-c
Expansion Tank Capacities for a Water Heater (Note)

<table>
<thead>
<tr>
<th>System Volume, gal (l)</th>
<th>Prepressurized Diaphragm type</th>
<th>Nonpressurized type</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 (190)</td>
<td>1 (4)</td>
<td>3 (11)</td>
</tr>
<tr>
<td>100 (380)</td>
<td>2 (8)</td>
<td>6 (23)</td>
</tr>
<tr>
<td>200 (760)</td>
<td>3 (11)</td>
<td>12 (45)</td>
</tr>
<tr>
<td>300 (1140)</td>
<td>4 (15)</td>
<td>18 (68)</td>
</tr>
<tr>
<td>400 (1514)</td>
<td>5 (19)</td>
<td>24 (91)</td>
</tr>
<tr>
<td>500 (1890)</td>
<td>6 (23)</td>
<td>30 (114)</td>
</tr>
<tr>
<td>1,000 (3790)</td>
<td>12 (45)</td>
<td>60 (227)</td>
</tr>
<tr>
<td>2,000 (7570)</td>
<td>24 (91)</td>
<td>120 (454)</td>
</tr>
</tbody>
</table>

Note: Capacities in this table are given as a guide to reduce or eliminate relief valve weeping under conditions of partial water system demands or occasional water draw during recovery.

System volume includes water heater capacity plus all piping capacity for a recirculation system or water heater capacity only for a nonrecirculation system.

The capacities are based upon a water temperature rise from 40°F to 180°F (4°C to 80°C), 60 psig (414 kPa) fill pressure, maximum operating pressure of 125 psig (862 kPa) 20% water recovery, and an acceptance factor of 0.465 for prepressurized types, and 0.09156 for nonpressurized types.

For other cases or metric calculations see Chapter 12 of the 1996 HVAC Systems and Equipment Volume of the ASHRAE Handbook.

3.7.9.2 EXPANSION TANKS AND PIPING FOR POTABLE WATER HEATERS

a) Expansion Tanks

If a system is equipped with a check valve or pressure-reducing valve in the cold water inlet line, consideration should be given to the installation of an airtight expansion tank or other suitable air cushion. Otherwise, due to the thermal expansion of the water, the safety relief valve may lift periodically. If an expansion tank is provided, it shall be constructed in accordance with an acceptable code of construction. The minimum capacity of the expansion tank may be determined from Table 3.7.9.1-c. See Figures 3.7.5-d and 3.7.5-e for a typical acceptable installation. Except for prepressurized diaphragm-type tanks, which should be installed on the cold water side, provisions shall be made for draining the tank without emptying the system.

b) Piping

Provisions shall be made for the expansion and contraction of hot water mains connected to water heater(s) so that there will be no undue strain transmitted to the water heater(s). See Figures 3.7.5-d and 3.7.5-e for typical schematic arrangements of piping incorporating strain absorbing joints.
3.8 INSTRUMENTS, FITTINGS, AND CONTROLS

3.8.1 STEAM HEATING BOILERS

3.8.1.1 STEAM GAGES

a) Each steam boiler shall have a steam gage or a compound steam gage connected to its steam space or to its water column or to its steam connection. The gage or connection shall contain a siphon or equivalent device that will develop and maintain a water seal that will prevent steam from entering the gage tube. The connection shall be so arranged that the gage cannot be shut off from the boiler except by a cock placed in the pipe at the gage and provided with a tee-handle or lever-handle arranged to be parallel to the pipe in which it is located when the cock is open. The connections to the boiler shall be not less than NPS 1/4 (DN 8). Where steel or wrought iron pipe or tubing is used, the connection and external siphon shall be not less than NPS 1/2 (DN 15). The minimum size of a siphon, if used, shall be NPS 1/4 (DN 8). Ferrous and nonferrous tubing having inside diameters at least equal to that of standard pipe sizes listed above may be substituted for pipe.

b) The scale on the dial of a steam boiler gage shall be graduated to not less than 30 psig (200 kPa) nor more than 60 psig (400 kPa). The travel of the pointer from 0 psig (0 kPa) to 30 psig (200 kPa) pressure shall be at least 3 in. (75 mm).

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

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

e) Tubular water glasses on electric boilers having a normal water content not exceeding 100 gal. (380 l) shall be equipped with a protective shield.

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

3.8.1.3 WATER COLUMN AND WATER LEVEL CONTROL PIPES

a) The minimum size of ferrous or nonferrous pipes connecting a water column to a steam boiler shall be NPS 1 (DN 25). No outlet connections, except for damper regulator, feedwater regulator, steam gages, or apparatus that does not permit the escape of any steam or water except for manually operated blowdown, shall be attached to a water column or the piping connecting a water column to a boiler (see 3.7.4[a]) for introduction of feedwater into a boiler. If the water column, gage glass, low-water fuel cutoff, or other water level control device is connected to the boiler by pipe and fittings, no shutoff valves of any type shall be placed in such pipe and a cross or equivalent fitting to which a drain valve and piping may be attached shall be placed in the water piping connection at every right angle turn to facilitate cleaning. The water column drain pipe and valve shall be not less than NPS 3/4 (DN 20).

b) The steam connections to the water column of a horizontal firetube wrought boiler shall be taken from the top of the shell or the upper part of the head, and the water connection shall be taken from a point not above the center line of the shell. For a cast-iron boiler, the steam connection to the water column shall be taken from the top of an end section or the top of the steam header, and the water connection shall be made on an end section not less than 6 in. (150 mm) below the bottom connection to the water gage glass.

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 to 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 1/4 (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.

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 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) Fuel cutoffs and water feeding devices embodying a separate chamber shall have a vertical drain pipe 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.

3.8.1.6 MODULAR STEAM HEATING BOILERS

a) Each module of a modular steam boiler shall be equipped with:

1) Steam gage, see 3.8.1.1
2) Water gage glass, see 3.8.1.2
3) Pressure control, see 3.8.1.4(a)
4) Low-water cutoff, see 3.8.1.5

b) The assembled modular steam heating boiler shall also be equipped with a pressure control. See 3.8.1.4(b).

3.8.1.7 INSTRUMENTS, FITTINGS, AND CONTROLS MOUNTED INSIDE BOILER JACKETS

Any or all instruments, fittings, and controls required by these rules may be installed inside of boiler jackets provided the water gage and pressure gage on a steam boiler are visible through an opening or openings at all times.

3.8.2 HOT-WATER HEATING OR HOT-WATER SUPPLY BOILERS

3.8.2.1 PRESSURE OR ALTITUDE GAGES

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

b) The scale on the dial of the pressure or altitude gage shall be graduated approximately to not less than 1-1/2 nor more than 3-1/2 times the pressure at which the safety relief valve is set.

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

3.8.2.2 THERMOMETERS

Each hot-water heating or hot-water supply boiler shall have a thermometer so located and connected that it shall be easily readable. The thermometer shall be so located that it shall at all times indicate the temperature of the water in the boiler at or near the outlet.
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 automatically fired hot-water heating or hot-water supply boiler shall have a safety limit control that will cut off the fuel supply to prevent water temperature from exceeding the maximum allowable temperature at the boiler outlet. This water temperature safety control shall be constructed to prevent a temperature setting above the maximum allowable temperature.

b) Each individual hot-water heating or hot-water supply boiler or each system of commonly connected boilers without intervening valves 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.

3.8.2.4 LOW-WATER FUEL CUTOFF

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

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

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

d) A means shall be provided for testing the operation of the external low-water fuel cutoff without resorting to draining the entire system. Such means shall not render the device inoperable except as follows. If the means temporarily isolates the device from the boiler during this testing, it shall automatically return to its normal position. The connection may be so arranged that the device cannot be shut off from the boiler except by a cock placed at the device and provided with a tee or lever-handle arranged to be parallel to the pipe in which it is located when the cock is open.

3.8.2.5 MODULAR HOT-WATER HEATING BOILERS

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

1) Pressure/altitude gage, See 3.8.2.1

2) Thermometer, See 3.8.2.2

3) Temperature control, See 3.8.2.3(a).

b) The assembled modular hot-water heating boiler shall be equipped with:

1) Temperature control, See 3.8.2.3(b)

2) Low-water fuel cutoff, See 3.8.2.4.

3.8.2.6 INSTRUMENTS, FITTINGS, AND CONTROLS MOUNTED INSIDE BOILER JACKETS

Any or all instruments, fittings, and controls required by these rules may be installed inside
of boiler jackets provided the thermometer and pressure gage are visible through an opening or openings at all times.

3.8.3 POTABLE WATER HEATERS

3.8.3.1 TEMPERATURE CONTROLS

Each individual automatically-fired water heater, in addition to the operating control used for normal water heater operation, shall have a separate high limit temperature actuated combustion control that will automatically cut off the fuel supply. The temperature range of the high limit temperature actuated control shall not allow a setting over 210°F (99°C).

a) On gas-fired water heaters, the high limit temperature control when actuated shall shut off the fuel supply with a shutoff means other than the operating control valve. Separate valves may have a common body.

b) On electrically heated water heaters, the high limit temperature control when actuated shall cut off all power to the operating controls.

c) On oil-fired water heaters, the high limit temperature control when actuated shall cut off all current flow to the burner mechanism.

d) On indirect water heating systems, the high limit temperature control when activated shall cut off the source of heat.

3.8.3.2 THERMOMETER

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

3.9 PRESSURE-RELIEVING VALVES

3.9.1 SAFETY VALVE REQUIREMENTS — GENERAL

The following general requirements pertain to installing, mounting, and connecting safety valves on boilers.

3.9.1.1 MOUNTING SAFETY AND SAFETY RELIEF VALVES FOR STEAM HEATING, HOT-WATER HEATING, AND HOT-WATER SUPPLY BOILERS

3.9.1.1.1 PERMISSIBLE MOUNTING

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

3.9.1.2 REQUIREMENTS FOR COMMON CONNECTIONS FOR TWO OR MORE VALVES

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

5 Side — 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 safety relief valve be located below the lowest permissible water level.
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 (DN100), 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.

3.9.1.2 THREADING CONNECTIONS

A threaded connection may be used for attaching a valve.

3.9.1.3 PROHIBITED MOUNTINGS

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 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 SAFETY RELIEF VALVE DISCHARGE PIPING

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

b) The discharge from safety or safety relief valves shall be so arranged that there will be no danger of scalding attendants. The safety or safety relief valve discharge shall be piped away from the boiler to 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 valves installed. The requirements of 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 SAFETY VALVE REQUIREMENTS FOR STEAM BOILERS

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

b) Each steam boiler shall have one or more National Board capacity certified safety valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 psig (100 kPa).
c) No safety valve for a steam boiler shall be smaller than NPS 1/2 (DN 15). No safety 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 pounds (kilograms) per hour shall be the greater of that determined by dividing the maximum Btu (Watts) output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1000 Btu/lb (645 W/hr/kg), or shall be determined on the basis of the pounds (kilograms) of steam generated per hour per square foot (square meter) of boiler heating surface as given in Table 3.9.2. 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 3.9.2(e) shall be met.

e) The safety valve capacity for each steam boiler shall be such that with the fuel burning equipment installed, and operated at maximum capacity, the pressure cannot rise more than 5 psig (34 kPa) above the maximum allowable working pressure.

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**TABLE 3.9.2**

Minimum Pounds of Steam per Hour per Square Foot of Heating Surface (1 lb steam/hr/sq. ft. [kg/hr/sq. m])

<table>
<thead>
<tr>
<th></th>
<th>Firetube Boilers</th>
<th>Watertube Boilers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiler heating surface</strong></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><strong>Waterwall heating surface</strong></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><strong>Copper-finned watertubes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hand-fired</td>
<td>4 (20)</td>
<td>4 (20)</td>
</tr>
<tr>
<td>stoker-fired</td>
<td>5 (24)</td>
<td>5 (24)</td>
</tr>
<tr>
<td>oil, gas, or pulverized fuel-fired</td>
<td>5 (24)</td>
<td>6 (29)</td>
</tr>
</tbody>
</table>

Note: When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/cu. ft. (7.5MJ/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 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.
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 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.

e) No safety 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 relief valve of NPS 1/2 (DN 15).

f) The required relieving capacity, in pounds per hour (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 (Watts) at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1000 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 Table 3.9.2. 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 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 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 relief valve capacity for each boiler with a single safety relief valve shall be such that, with the fuel burning equipment installed and operated at maximum capacity, the pressure cannot rise more than 10% above the maximum allowable working pressure. When more than one safety relief valve is used, the over pressure shall be limited to 10% above the set pressure of the highest set valve allowed by 3.9.3(b).
3.9.4 SAFETY 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 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 relief valve(s) shall be based upon the component with the lowest maximum allowable working pressure rating. If more than one safety 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 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 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. Safety 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.

d) If operating conditions are changed or additional heating surface is installed, the safety 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.

3.9.4.1 INSTALLATION

Safety relief valves shall be installed by either the installer or the manufacturer before a water heater is placed in operation.

3.9.4.2 PERMISSIBLE MOUNTINGS

Safety 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 relief valves shall be installed with their spindles upright and vertical with no horizontal connecting pipe, except that when the safety 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 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 valve shall be of nominal pipe size less than that of the valve inlet.

3.9.4.3 REQUIREMENTS FOR COMMON CONNECTION FOR TWO OR MORE VALVES

a) When a potable water heater 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 release 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 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 water heater, they may be single, directly attached, or mounted on a Y-base.

3.9.4.4 THREADED CONNECTIONS

A threaded connection may be used for attaching a valve.

3.9.4.5 PROHIBITED MOUNTINGS

Safety 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.

3.9.4.6 USE OF SHUTOFF VALVES PROHIBITED

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

3.9.4.7 SAFETY RELIEF VALVE DISCHARGE PIPING

a) When a discharge pipe is 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. When an elbow is placed on a safety relief discharge pipe, it shall be located close to the valve outlet.

b) The discharge from safety relief valves shall be so arranged that there will be no danger of scalding attendants. When the safety 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.

3.9.5 SAFETY 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 3.2, Definitions, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a safety relief valve at least NPS 1 (DN 25), set to relieve at or below the maximum allowable working pressure of the tank, shall be applied on the tank.

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 3.2, Definitions, the heat exchanger shall be equipped with one or more National Board capacity certified safety 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 3.2, Definitions, the heat exchanger shall be equipped with one or more National Board capacity certified safety 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 Section 2 or Section 4 of this Part.

3.10 TESTING AND ACCEPTANCE

3.10.1 PRESSURE TEST

Prior to initial operation, the completed boiler, individual module, or assembled module, shall be subjected to a pressure test in accordance with the requirements of the original code of construction.

3.10.2 FINAL ACCEPTANCE

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.

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.

3.10.3 BOILER INSTALLATION REPORT

a) Upon completion, inspection, and acceptance of the installation, the installer shall complete and certify the Boiler Installation Report I-1. See 1.4.5.1.

b) The Boiler Installation Report I-1 shall be submitted as follows:

1) One copy to the Owner;

2) One copy to the Jurisdiction, if required.

3.10.4 TABLES AND FIGURES

a) Table 3.7.9.1-a, Expansion Tank Capacities for Gravity Hot-Water Systems

b) Table 3.7.9.1-b, Expansion Tank Capacities for Forced Hot-Water Systems

c) Table 3.7.9.1-c, Expansion Tank Capacities for a Water Heater

d) Table 3.7.7.1, Size of Bottom Blowoff Piping, Valves, and Cocks

e) Table 3.9.2, Minimum Pounds of Steam Per Hour Per Square Foot of Heating Surface

f) Figure 3.3.1.1-a, Spacing and Weld Details for Supporting Lugs in Pairs on Horizontal Return Tubular Boilers

g) Figure 3.3.1.1-b, Welded Bracket Connection for Horizontal-Return Tubular Boilers

h) Figure 3.7.5-a, Steam Boilers in Battery – Pumped Return – Acceptable Piping Installation

i) Figure 3.7.5-b, Steam Boilers in Battery – Gravity Return – Acceptable Piping Installation
j) Figure 3.7.5-c, Hot-Water Boilers in Battery – Acceptable Piping Installation

k) Figure 3.7.5-d, Storage Potable Water Heaters in Battery – Acceptable Piping Installation

l) Figure 3.7.5-e, Flow Through Potable Water Heater Without Provision for Piping Expansion – Acceptable Piping Installation
Insert
Section 4
Tab
Here
PART 1, SECTION 4
INSTALLATION — PRESSURE VESSELS

4.1 SCOPE

This section provides requirements for the installation of pressure vessels as defined in 4.2, Definitions. For installation of items that do not fall within the scope of this section, refer to the following sections as applicable:

Section 2 — Power Boilers
Section 3 — Steam Heating Boilers, Hot-Water Heating Boilers, Hot-Water Supply Boilers, and Potable Water Heaters
Section 5 — Piping

4.2 DEFINITIONS

Pressure vessels are containers other than boilers or piping used for the containment of pressure.

4.3 GENERAL REQUIREMENTS

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.

4.3.2 CLEARANCES

a) All pressure vessel installations must allow sufficient clearance for normal operation, maintenance, and inspection (internal and external).

b) Orientation of nozzles, manways, and attachments shall be such that sufficient clearance between the nozzles, manways and attachments, and the surrounding structure(s) is maintained during installation, the attachment of associated piping, and operation.

4.3.3 PIPING

Piping loads on the vessel nozzles shall be considered. Piping loads include weight of the pipe, weight of the contents of the pipe, expansion of the pipe from temperature and pressure changes (wind and seismic loads). The effects of piping vibration on the vessel nozzles shall also be considered.

4.4 INSTRUMENTS AND CONTROLS

4.4.1 LEVEL INDICATING DEVICES

Steam drums of unfired steam boilers shall be provided with two level indicating devices. Direct level indicating devices should be connected to a single water column or connected directly to the drum, and the connections and pipe shall be not less than NPS 1/2 (DN 15). Indirect level indicating devices acceptable to the Jurisdiction may be used.

4.4.2 PRESSURE INDICATING DEVICES

The need for pressure indicating devices should be considered in the design of the pressure vessel, and when required, the scale on the
dial of the pressure gage shall be at least 25% above the highest set pressure of the pressure relief device.

4.5 PRESSURE RELIEF DEVICES

All pressure vessels shall be protected by pressure relief devices in accordance with 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 Section 2 of this Part. (See 2.9)

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.

4.5.2 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.

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 allowable working pressure, then the device may be installed elsewhere in the system provided it is in communication with the vessel at all times.

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.

4.5.4 CAPACITY

a) The pressure relief device(s) shall have sufficient capacity to assure 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.

c) Vessels connected together by a system of piping not containing valves that can isolate any pressure vessel should 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.

4.5.5 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.

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 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 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 also be placed on the discharge side of a pres-
sure 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 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.

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.

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

4.6 TESTING AND ACCEPTANCE

a) The installer shall exercise care during installation to prevent loose weld material, welding rods, small tools, and miscellaneous scrap metal from getting into the vessel. The installer shall inspect the interior of the vessel and its appurtenances where possible prior to making the final closures for the presence of foreign debris.

b) The completed pressure vessel shall be pressure tested in the shop or in the field in accordance with the original code of construction. When required by the Jurisdiction, owner or user, the Inspector shall witness the pressure test of the completed installation, including piping to the pressure gage, pressure relief device, and, if present, level control devices.
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Section 5
Tab
Here
5.1 **SCOPE**

This section provides requirements for the installation of pressure piping. For installation of items that do not fall within the scope of this section, refer to the following sections as applicable:

Section 2 — *Power Boilers*
Section 3 — *Steam Heating Boilers, Hot-Water Heating Boilers, Hot-Water Supply Boilers, and Potable Water Heaters*
Section 4 — *Pressure Vessels*

5.2 **GENERAL REQUIREMENTS**

5.2.1 **ADDITIONS TO EXISTING PIPING**

Additions to existing piping systems shall conform to this section. That portion of the existing piping system that is not part of the addition need not comply with this section provided the addition does not result in a change in piping system operation or function that would exceed the design conditions of the existing piping system or result in unsafe conditions.

5.2.2 **PROXIMITY TO OTHER EQUIPMENT AND STRUCTURES**

The arrangement of the piping and its appurtenances shall take into consideration the location of other structures and equipment adjacent to the piping, which may result in interference and/or damage as a result of expansion, contraction, vibration, or other movements.

5.2.3 **FLANGES AND OTHER NON-WELDED JOINTS**

The layout of the piping shall take into consideration the need for required access to maintain and inspect piping joints.

5.2.4 **VALVES**

Consideration should be given to the appropriate location and orientation of valves necessary for safe operation and isolation of the piping.

5.2.5 **MATERIALS**

All materials for piping and its appurtenances shall comply with the requirements of the code of construction.

5.2.6 **HANGERS AND SUPPORTS**

Support of piping shall consider loads (including wind and seismic loads) imposed on equipment or existing piping to which it is attached. Non-piping attachments such as ladders and walkways, equipment supports, temporary supports, structural supports, etc., shall not be connected to the piping unless such loads have been considered in the design of the piping and its supports. Design of hangers and supports for piping shall consider loads imposed by hydrostatic pressure testing. The installer shall remove pins from non-rigid hangers, seal plugs from hydraulic snubbers and temporary supports used for installation prior to placing the piping in service.

5.2.7 **PROTECTION AND CLEANING**

The installer shall exercise care during installation to prevent loose weld material, welding
rods, small tools, and miscellaneous scrap metal from getting into the piping. The installer shall inspect, and where necessary clean the interior of the piping and its appurtenances where possible, prior to making the final closures for the presence of foreign debris.

5.2.8 WELDING AND BRAZING

The installer should consider the impact of performing any preheating, welding, brazing, or postweld heat treatment on valves, instrumentation, or other heat sensitive equipment and, where appropriate, review the equipment manufacturer’s recommended installation procedures prior to performing the work.

5.3 PRESSURE RELIEF DEVICES

When required by the original code of construction, piping shall be protected by pressure relief devices in accordance with the following requirements.

5.3.1 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 disc devices) by the National Board.

1) In certain cases piping standards 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.

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.

5.3.2 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 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.

5.3.3 LOCATION

The pressure relief device, except those covered by Sections 2 and 3 of this Part, may be installed at any location in the system provided the pressure in any portion of the system cannot exceed the maximum allowable working pressure. Pressure drop to the pressure relief device under flowing conditions shall be considered when determining pressure relief device location. The device shall be in communication with the piping system it is protecting at all times.

5.3.4 CAPACITY

a) The pressure relief device(s) shall have sufficient capacity to assure 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.

5.3.5 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 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.

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) 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 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.

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.

4) 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.

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.

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

5.4 EXAMINATION, INSPECTION, AND TESTING

The owner shall ensure that all examinations, inspections, and tests required by the code of construction have been performed prior to operation.
PART 1, SECTION 6  
SUPPLEMENT 1  
INSTALLATION OF YANKEE DRYERS

SUPPLEMENT 1  
INSTALLATION OF YANKEE DRYERS (ROTATING CAST-IRON PRESSURE VESSELS) WITH FINISHED SHELL OUTER SURFACES

S1.1 SCOPE

a) This Supplement describes guidelines for the installation of a Yankee dryer. A Yankee dryer is a rotating steam-pressurized cylindrical vessel commonly used in the paper industry, and is typically made of cast iron, finished to a high surface quality, and characterized by a center shaft connecting the heads.

b) Yankee dryers are primarily used in the production of tissue-type paper products. When used to produce machine-glazed (MG) paper, the dryer is termed an MG cylinder. A wet paper web is pressed onto the finished dryer surface using one or two pressure (pressing) rolls. Paper is dried through a combination of mechanical dewatering by the pressure roll(s); thermal drying by the pressurized Yankee dryer, and a steam-heated or fuel-fired hood. After drying, the paper web is removed from the dryer.

c) A Yankee dryer is typically manufactured in a range of outside diameters from eight to 23 ft (2.4 m to 7 m), widths from eight to 28 ft (2.4 m to 8.5 m), pressurized and heated with steam up to 160 psi (1100 kPa), and rotated at speeds up to 7000 ft/min (2135 m/min). Typical pressure roll loads against the Yankee dryer are up to 600 pounds per linear inch (105 kN/m). A thermal load results from the drying process due to difference in temperature between internal and external shell surfaces. The dryer has an internal system to remove steam and condensate. These vessels can weigh up to 220 tons (200 tonnes).

d) The typical Yankee dryer is an assembly of several large castings. The shell is normally a gray iron casting, in accordance with ASME designation SA-278. Shells internally may be smooth bore or ribbed. Heads, center shafts, and journals may be gray cast iron, ductile cast iron, or steel.

S1.2 ASSESSMENT OF INSTALLATION

a) The Inspector verifies that the owner or user is properly controlling the operating conditions of the dryer. The Inspector does this by reviewing the owner's comprehensive assessments of the complete installation.

b) The dryer is subjected to a variety of loads over its life. Some of the loads exist individually, while others are combined. Considerations of all the loads that can exist on a Yankee dryer are required to determine the maximum allowable operating parameters. There are four loads that combine during normal operation to create the maximum operating stresses, usually on the outside surface of the shell at the axial center line. These loads and the associated protection devices provided to limit these loads are:

1) Pressure load due to internal steam pressure. Overpressure protection is provided by a safety relief valve;

2) Inertial load due to dryer rotation. Over-speed protection is usually provided by an alarm that indicates higher-than-allowable machine speed;
3) Thermal gradient load due to the drying of the web. Protection against unusual drying loads is usually provided by logic controls on the machine, primarily to detect a "sheet-off" condition that changes the thermal load on the shell exterior from being cooled by the tissue sheet to being heated by the hot air from the hood;

4) Pressure roll load (line or nip load) 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.

c) Steam pressure, inertial, and thermal gradient loads impose steady-state stresses. These stresses typically change when the dryer shell thickness (effective thickness for ribbed dryers) is reduced to restore a paper-making surface, the grade of tissue is changed or speed of the dryer is changed.

d) The pressure roll(s) load imposes an alternating stress on the shell face. The resulting maximum stress is dependent on the magnitude of the alternating and steady-state stresses.

e) Section VIII, Div. 1, of the ASME Code only provides specific requirements for the analysis of pressure loads. Although the Code requires analysis of other loads, no specific guidance for thermal, inertial, or pressure roll loads is provided. Hence, additional criteria must be applied by the manufacturer to account for all the steady-state and alternating stresses.

f) To maintain product quality, the dryer surface is periodically refurbished by grinding. This results in shell thickness reduction. Therefore, the manufacturer does not provide a single set of maximum allowable operating parameters relating steam pressure, rotational speed, and pressure roll load for a single design shell thickness. The manufacturer, or another qualified source acceptable to the Inspector, instead provides a series of curves that graphically defines these maximum allowable operating parameters across a range of shell thicknesses. This document is known as the "De-rate Curve." (See Figure S1.1).

g) In addition to the loads on the Yankee dryer due to operation, other nonstandard load events can occur during shipment and installation into the paper machine. These nonstandard load events should be recorded in an incident log. Examples of nonstandard load events include:

1) Damage to the protective packaging of the Yankee dryer during transport;

2) Scratches, gouges, dents in the Yankee dryer shell during packaging removal or installation into the paper machine;

3) Excessive heating of the Yankee dryer shell during the installation and testing of the hot air hood. If the hot air hood will be generating air that is hotter than the Yankee dryer shell material's Maximum Allowable Working Temperature (MAWT), then temperature sensors should be installed to monitor and record the Yankee dryer shell temperature during the hood testing;

4) Impact load from improperly installed rolls, wires, nuts, dropped wrenches, etc., that may travel thru the pressure roll nip causing external impact loads on the Yankee dryer shell.

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6 Pressure roll load, line load, and nip load are terms that are used interchangeably to refer to the interaction between the pressure rolls 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).
h) If nonstandard load events (incidents) have occurred during installation, then the Inspector should ensure that an appropriate assessment of the structural integrity of the Yankee dryer has been performed. For additional details see Yankee dryer supplements in Part 2, Inspections and in Part 3, Repairs & Alterations.

S1.3 DETERMINATION OF ALLOWABLE OPERATING PARAMETERS

a) A Yankee dryer is designed and intended to have its shell thickness reduced over the life of the vessel through routine grinding and machining. The Yankee dryer shell is ground or machined on the outside surface to restore the quality or shape of the papermaking surface essential to the manufacturing of tissue or other paper products.
b) Design documentation, called the "De-rate Curve," is required which dictates the maximum allowable operating parameters as shell thickness is reduced (see Figure S1.1). Calculations, used to determine those parameters, are in accordance with ASME Code requirements for primary membrane stress by the vessel manufacturer or design criteria based on relevant stress categories, e.g., fatigue and maximum principal stress. Calculation of these parameters requires that the respective stresses, resulting from the imposed loads, be compared to the appropriate material strength properties. Hence, knowledge of the applied stresses in the shell and the tensile and fatigue properties of the material are essential.

c) Yankee dryers are subjected to a variety of loads that create several categories of stress. Yankee dryers are designed such that the stress of greatest concern occurs at the centerline of the shell.

1) Steam Pressure Load — The internal steam pressure is one of the principal design loads applied to the Yankee dryer. The steam pressure expands the shell radially, causing a predominately circumferential membrane tensile stress. Because the shell is constrained radially by the heads at either end of the shell, the steam pressure also causes a primary bending stress in the vicinity of the head-to-shell joint. The ends of the shell are in tension on the inside and compression on the outside due to the steam pressure. The steam pressure also causes a bending stress in the heads.

2) Inertia Load — The rotation of the Yankee dryer causes a circumferential membrane stress in the shell similar to that caused by the pressure load. This stress is included in the design of the shell and increases with dryer diameter and speed.

3) Thermal Load — The wet sheet, applied to the shell, causes the outside surface to cool and creates a thermal gradient through the shell wall. This thermal gradient results in the outside surface being in tension and the inside surface in compression. With this cooling, the average shell temperature is less than the head temperature, which creates bending stresses on the ends of the shell and in the heads. The ends of the shell are in tension on the outside and compression on the inside.

a. Other thermal loadings also occur on a Yankee dryer. The use of full width showers for a variety of papermaking purposes affects the shell similar to a wet sheet. The use of edge sprays produce high bending stress in the ends of the shell due to the mechanical restraint of the heads.

b. Warm-up, cool-down, hot air impingement from the hood, moisture profiling devices, fire fighting, and wash-up can all produce non-uniform thermal stresses in the pressure containing parts of the Yankee dryer. Heating or cooling different portions of the Yankee dryer at different rates causes these non-uniform stresses.

4) Nip Load — The nip load from the contacting pressure roll(s), results in an alternating, high cycle, bending stress in the shell. This stress is greatest at the centerline of the shell. The load of the pressure roll deflects the shell radially inward causing a circumferential compressive stress on the outside surface and a tensile stress on the inside. Because the shell has been deflected inward at the pressure roll nip, it bulges outward about 30 degrees on each side of the nip. The outward bulge causes a tensile stress on the outside shell sur-
face at that location and a corresponding compressive stress on the inside. Since the shell is passing under the pressure roll, its surface is subjected to an alternating load every revolution.

S1.4 ASME CODE PRIMARY MEMBRANE STRESS CRITERIA

a) Yankee dryers are typically designed and fabricated in accordance with Section VIII, Division 1, of the ASME Pressure Vessel Code. The maximum allowable stress for cast iron is specified in UCI-23 and UG-22 of the ASME Code.

b) Section VIII, Division 1, requires design stresses to be calculated such that any combination of loading expected to occur simultaneously during normal operation of the Yankee dryer will not result in a general primary stress exceeding the maximum allowable stress value of the material. In the ASME code, the combination of loading resulting in the primary membrane stress in the shell is interpreted to be only composed of the circumferential stress from steam pressure. Sometimes, the stress from the inertial loading is included in this consideration.

c) In Section VIII, Division 1, it is very important to note that no formulas are given for determining the stresses from thermal operating loads and pressure roll nip load(s). Hence, additional criteria need to be incorporated to establish the maximum allowable operating parameters of the Yankee dryer. Two such additional criteria are based upon the maximum principal and fatigue stress.

1) Maximum Principal Stress Criteria
   The maximum principal stress in a Yankee dryer shell is the sum of the stresses that are simultaneously applied to the shell, and is always aligned in the circumferential direction. The purpose of these criteria is to recognize the paper making application of the Yankee dryer and to prevent catastrophic failure by including all stresses. The ASME Code does not provide specific formulas for the full array of Yankee dryer shell stresses encountered in tissue making.

2) Fatigue Stress Criteria
   Under normal operation, the stresses due to the steam pressure, inertial and thermal operating loads are considered to be steady-state stresses. When acting simultaneously, the sum of these stresses must be judged against the cyclic, or alternating, stress due to the pressure roll nip load. Fatigue stress criteria limit the alternating stress at a given mean stress using fatigue failure criteria described by the Goodman or Smith Diagram. The purpose of this limitation is to prevent crack initiation in the outside wall due to the combination of stresses. As the thickness of the shell is reduced, one or more of these criteria will control the various operating parameters.

S1.5 PRESSURE TESTING

a) Water pressure testing in the field is not recommended because of the large size of Yankee dryers and the resulting combined weight of the Yankee dryer and the water used in the testing. This combined weight can lead to support structure overload. Several failures of Yankee dryers have occurred during field pressure testing using water. If this test must occur, the following review is recommended:

1) The testing area should be evaluated for maximum allowable loading, assuming the weight of the Yankee dryer, the weight of the water filling the Yankee dryer, and the weight of the support structure used to hold the Yankee dryer during the test.
2) The manufacturer should be contacted to provide information on building the Yankee dryer support structure for the water pressure test. Typically, the Yankee dryer is supported on saddles that contact the Yankee dryer shell at each end near the head-to-shell joint. The manufacturer can provide information on saddle sizing and location so that the Yankee dryer is properly supported for the test.

b) When pressure testing is desired to evaluate the Yankee dryer for fitness for service, an alternative to water pressure testing is acoustic emission testing using steam or air pressure. Typically, the test pressure used is the operating pressure. Caution needs to be exercised to insure personnel safety. Entry to the test area needs to be controlled and all personnel need to maintain a safe distance from the Yankee dryer during the test. The steam or air test pressure should never exceed the Maximum Allowable Working Pressure (MAWP) of the Yankee dryer.

Acoustic Emission Testing can be used to locate and determine if a linear indication is active, e.g., propagating crack. Metallographic analysis is useful in differentiating between original casting discontinuities and cracks.

c) When nondestructive testing produces an indication, the indication is subject to interpretation as false, relevant, or nonrelevant. If it has been interpreted as relevant, the necessary subsequent evaluation will result in a decision to accept, repair, replace, monitor, or adjust the maximum allowable operating parameters.

51.6 NONDESTRUCTIVE EXAMINATION

a) Nondestructive examination (NDE) methods should be implemented by individuals qualified and experienced with the material to be tested using written NDE procedures. For Yankee dryers, cast iron knowledge and experience are essential.

b) Typical nondestructive examination methods should be employed to determine indication length, depth, and orientation (sizing) of discontinuities in Yankee Dryers. Magnetic particle, specifically the wet fluorescent method, and dye penetrant methods are applicable in the evaluation of surface-breaking indications. Ultrasound testing is the standard method for evaluation of surface-breaking and embedded indications. Radiographic methods are useful in the evaluation of embedded indications.
SUPPLEMENT 2
SAFETY VALVES ON THE LOW-PRESSURE SIDE OF STEAM
PRESSURE-REDUCING VALVES

S2.1 SCOPE

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 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 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 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 VALVE CAPACITY

a) The capacity of the safety 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 S2.3 below, Inspectors may calculate the required relieving capacities of the safety 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 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 VALVE RELIEVING CAPACITY

a) When a pressure-reducing valve is installed, there are two possibilities of intro-
duling 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 (a) and (b) and check that the size of the safety valve under either condition will be adequate. The following formula should be used:

1) steam flow, W in lbs/hr through the pressure-reducing valve

\[ W = A \cdot K \cdot C \]

where,
\[ A \] = internal area in sq. in. of the inlet pipe size of the pressure-reducing valve (ref. 2.5)
\[ K \] = flow coefficient for the pressure-reducing valve (see 2.4)
\[ C \] = flow of saturated steam through a 1 sq. in. pipe at various pressure differentials from Table S2.3-a, Table S2.3-b, or Table S2.3-c.

2) steam flow, W in lbs/hr through the bypass valve

\[ W = A_1 \cdot K_1 \cdot C_1 \]

where,
\[ A_1 \] = internal area in sq. in. of the pipe size of the bypass around the pressure-reducing valve
\[ K_1 \] = flow coefficient for the bypass valves (see 2.4)
\[ C_1 \] = flow of saturated steam through a 1 sq. in. pipe at various pressure differentials from Table S2.3-a, Table S2.3-b, and Table S2.3-c.

S2.4 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 S2.3 then becomes:

\[ W = 1/3 \cdot A \cdot C \] for the capacity through the pressure-reducing valve; and

\[ W = 1/2 \cdot A_1 \cdot C_1 \] for the capacity through the bypass valve.

b) Caution should be exercised when substituting these factors for the actual coefficients since this method will provide approximate values only and the capacities so obtained may in fact be lower than actual. It is recommended that the actual flow coefficient be obtained from the pressure-reducing valve manufacturer and reference books be consulted for the flow coefficient of the bypass valve.

S2.5 TWO-STAGE PRESSURE-REDUCING VALVE STATIONS

The safety 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 relief valves sized on the basis of the high-side pressure and the inlet size of the first pressure-reducing valve. See Table S2.5.
### TABLE S2.3-a
Capacity of Saturated Steam, in lb./hr., per sq. in. of Pipe Area

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<thead>
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<th>Outlet pres., psi</th>
<th>Pressure-reducing valve inlet pressure, psi</th>
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Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

### TABLE S2.3M-a
Capacity of Saturated Steam, in kg/hr., per sq. mm of Pipe Area

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Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.
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Capacity of Saturated Steam, in lb./hr., per sq. in. of Pipe Area

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Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

TABLE S2.3M-b
Capacity of Saturated Steam, in kg./hr., per sq. mm of Pipe Area

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Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.
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Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

*Metric equivalents will appear in the 2005 Addendum.*

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<th>800.00</th>
<th>700.00</th>
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Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.
<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 Diameter, in.</th>
<th>Average Outside Diameter, mm</th>
<th>Nominal Wall Thickness of Standard Weight Pipe, in.</th>
<th>Nominal Wall Thickness of Standard Weight Pipe, mm</th>
<th>Approx. Internal Area, sq. in.</th>
<th>Approx. Internal Area, sq. mm</th>
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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.
Part 1, Section 7
Installation — NBIC Policy
For Metrication
PART 1, SECTION 7
INSTALLATION — NBIC POLICY FOR METRICATION

7.1 GENERAL

This policy provides guidance for the use of US customary units and metric units. Throughout the NBIC, metric units are identified and placed in parentheses after the US customary units referenced in the text and associated tables. For each repair or alteration performed, selection of units shall be based on the units used in the original code of construction. For example, items constructed using US customary units shall be repaired or altered using US customary units. The same example applies to items constructed using metric units. Whenever units are selected, those units are to be used consistently throughout each repair or alteration. Consistent use of units includes all aspects of work required for repairs or alterations (i.e., materials, design, procedures, testing, documentation, and stamping, etc.).

The following examples are provided for further clarification and understanding of soft conversions versus hard conversions:

Example 1: Using 1 in. = 25.4 mm;
12 in. = 304.8 mm (soft conversion)

Example 2: Using the above conversion, a hard conversion may be 300 mm or 305 mm depending on the degree of precision needed.

7.3 PROCEDURE FOR CONVERSION

The following guidelines shall be used to convert between US customary units and metric units within the text of the NBIC:

a) All US customary units will be converted using a soft conversion.

b) Soft conversion calculations will be reviewed for accuracy.

c) Based on specified value in the NBIC, an appropriate degree of precision shall be identified.

d) Once the degree of precision is decided, rounding up or down may be applied to each soft conversion in order to obtain a hard conversion.

e) Use of hard conversion units shall be used consistently throughout the NBIC wherever soft conversions are not required.

Note: Care shall be taken to minimize percentage difference between units.
7.4 REFERENCING TABLES

The following tables are provided for guidance and convenience when converting between US customary units and metric units. See Tables 7.4-1 through 7.4-8.

Temperature shall be converted to within 1°C as shown in Table 7.4-2

Fractions of an inch shall be converted according to Table 7.4-3. Even increments of inches are in even multiples of 25 mm. For example, 40 inches is equivalent to 1000 mm. Intermediate values may be interpolated rather than converting and rounding to the nearest mm.

For nominal pipe sizes, the following relationships were used as shown in Table 7.4-4.

Areas in square inches (in²) were converted to square mm (mm²) and areas in square feet (ft²) were converted to square meters (m²). See examples in Tables 7.4-5a and 7.4-5b.

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 Tables 7.4-6a and 7.4-6b.

Although the pressure should always be in MPa for calculations, there are cases where other units are used in the text. For example, kPa is used for small pressures. Also, rounding was to two significant figures. See examples in Table 7.4-7. (Note that 14.7 psi converts to 101 kPa, while 15 psi converts to 100 kPa. While this may seem at first glance to be an anomaly, it is consistent with the rounding philosophy.)

Material properties that are expressed in psi or ksi (e.g., allowable stress, yield and tensile

TABLE 7.4-1
Soft Conversion Factors
(US x Factor = Metric)

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<th>Metric</th>
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<tr>
<td>ft.-lb</td>
<td>N-m</td>
<td>1.3558181</td>
</tr>
<tr>
<td>ksi/in</td>
<td>MPa/in</td>
<td>1.0988434</td>
</tr>
<tr>
<td>Btu/hr</td>
<td>W</td>
<td>0.2930711</td>
</tr>
<tr>
<td>lb/ft²</td>
<td>kg/m²</td>
<td>16.018463</td>
</tr>
<tr>
<td>in.-wc</td>
<td>kPa</td>
<td>0.249089</td>
</tr>
</tbody>
</table>

Note: The actual pressure corresponding to the height of a vertical column of fluid depends on the local gravitational field and the density of the fluid, which in turn depends upon the temperature. This conversion factor is the conventional value adopted by ISO. The conversion assumes a standard gravitational field \( (g, \approx 9.80665 \text{ N/kg}) \) and a density of water equal to \( 1,000 \text{ kg/m}^3 \).

TABLE 7.4-2
Temperature Equivalents

<table>
<thead>
<tr>
<th>Temperature °F</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>16</td>
</tr>
<tr>
<td>70</td>
<td>21</td>
</tr>
<tr>
<td>100</td>
<td>38</td>
</tr>
<tr>
<td>120</td>
<td>49</td>
</tr>
<tr>
<td>350</td>
<td>177</td>
</tr>
<tr>
<td>400</td>
<td>204</td>
</tr>
<tr>
<td>450</td>
<td>232</td>
</tr>
<tr>
<td>800</td>
<td>427</td>
</tr>
<tr>
<td>1150</td>
<td>621</td>
</tr>
</tbody>
</table>
strength, elastic modulus) were generally converted to MPa to three significant figures. See example in Table 7.4-8.

An often seen metric pressure rating is the expression BAR, one BAR equals 14.5 psi — to convert psi rating to a BAR rating, multiply by 0.069.

### TABLE 7.4-3
**US Fractions/Metric Equivalents**

<table>
<thead>
<tr>
<th>Inches</th>
<th>Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/32</td>
<td>0.8</td>
</tr>
<tr>
<td>3/64</td>
<td>1.2</td>
</tr>
<tr>
<td>1/16</td>
<td>1.5</td>
</tr>
<tr>
<td>3/32</td>
<td>2.5</td>
</tr>
<tr>
<td>1/8</td>
<td>3</td>
</tr>
<tr>
<td>5/32</td>
<td>4</td>
</tr>
<tr>
<td>3/16</td>
<td>5</td>
</tr>
<tr>
<td>7/32</td>
<td>5.5</td>
</tr>
<tr>
<td>1/4</td>
<td>6</td>
</tr>
<tr>
<td>5/16</td>
<td>8</td>
</tr>
<tr>
<td>3/8</td>
<td>10</td>
</tr>
<tr>
<td>7/16</td>
<td>11</td>
</tr>
<tr>
<td>1/2</td>
<td>13</td>
</tr>
<tr>
<td>9/16</td>
<td>14</td>
</tr>
<tr>
<td>5/8</td>
<td>16</td>
</tr>
<tr>
<td>11/16</td>
<td>17</td>
</tr>
<tr>
<td>3/4</td>
<td>19</td>
</tr>
<tr>
<td>7/8</td>
<td>22</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
</tr>
</tbody>
</table>

### TABLE 7.4-4
**Pipe Sizes/Equivalents**

<table>
<thead>
<tr>
<th>US Customary Practice</th>
<th>Metric Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS 1/8</td>
<td>DN 6</td>
</tr>
<tr>
<td>NPS 1/4</td>
<td>DN 8</td>
</tr>
<tr>
<td>NPS 3/8</td>
<td>DN 10</td>
</tr>
<tr>
<td>NPS 1/2</td>
<td>DN 15</td>
</tr>
<tr>
<td>NPS 3/4</td>
<td>DN 20</td>
</tr>
<tr>
<td>NPS 1</td>
<td>DN 25</td>
</tr>
<tr>
<td>NPS 1-1/4</td>
<td>DN 32</td>
</tr>
<tr>
<td>NPS 1-1/2</td>
<td>DN 40</td>
</tr>
<tr>
<td>NPS 2</td>
<td>DN 50</td>
</tr>
<tr>
<td>NPS 2-1/2</td>
<td>DN 65</td>
</tr>
<tr>
<td>NPS 3</td>
<td>DN 80</td>
</tr>
<tr>
<td>NPS 3-1/2</td>
<td>DN 90</td>
</tr>
<tr>
<td>NPS 4</td>
<td>DN 100</td>
</tr>
<tr>
<td>NPS 5</td>
<td>DN 125</td>
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<tr>
<td>NPS 6</td>
<td>DN 150</td>
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<tr>
<td>NPS 8</td>
<td>DN 200</td>
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<td>NPS 10</td>
<td>DN 250</td>
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<td>NPS 12</td>
<td>DN 300</td>
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<td>NPS 14</td>
<td>DN 350</td>
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<td>NPS 16</td>
<td>DN 400</td>
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<td>NPS 18</td>
<td>DN 450</td>
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<td>NPS 20</td>
<td>DN 500</td>
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<tr>
<td>NPS 22</td>
<td>DN 550</td>
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<td>NPS 24</td>
<td>DN 600</td>
</tr>
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<td>NPS 26</td>
<td>DN 650</td>
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<td>NPS 28</td>
<td>DN 700</td>
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<td>NPS 30</td>
<td>DN 750</td>
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<td>NPS 32</td>
<td>DN 800</td>
</tr>
<tr>
<td>NPS 34</td>
<td>DN 850</td>
</tr>
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<td>NPS 36</td>
<td>DN 900</td>
</tr>
<tr>
<td>NPS 38</td>
<td>DN 950</td>
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<td>NPS 40</td>
<td>DN 1000</td>
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<td>NPS 42</td>
<td>DN 1050</td>
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<td>NPS 44</td>
<td>DN 1100</td>
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<td>NPS 46</td>
<td>DN 1150</td>
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<td>DN 1200</td>
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<td>DN 1250</td>
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<td>DN 1300</td>
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<td>NPS 54</td>
<td>DN 1350</td>
</tr>
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<td>NPS 56</td>
<td>DN 1400</td>
</tr>
<tr>
<td>NPS 58</td>
<td>DN 1450</td>
</tr>
<tr>
<td>NPS 60</td>
<td>DN 1500</td>
</tr>
</tbody>
</table>
### Table 7.4-5a

<table>
<thead>
<tr>
<th>Area (US Customary)</th>
<th>Area (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 in²</td>
<td>650 mm²</td>
</tr>
<tr>
<td>6 in²</td>
<td>3,900 mm²</td>
</tr>
<tr>
<td>10 in²</td>
<td>6,500 mm²</td>
</tr>
</tbody>
</table>

### Table 7.4-5b

<table>
<thead>
<tr>
<th>Area (US Customary)</th>
<th>Area (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ft²</td>
<td>0.46 mm²</td>
</tr>
</tbody>
</table>

### Table 7.4-6a

<table>
<thead>
<tr>
<th>Area (US Customary)</th>
<th>Area (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in³</td>
<td>16,000 mm³</td>
</tr>
<tr>
<td>6 in³</td>
<td>96,000 mm³</td>
</tr>
<tr>
<td>10 in³</td>
<td>160,000 mm³</td>
</tr>
</tbody>
</table>

### Table 7.4-6b

<table>
<thead>
<tr>
<th>Area (US Customary)</th>
<th>Area (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ft³</td>
<td>0.14 m³</td>
</tr>
</tbody>
</table>

### Table 7.4-7

**Pressure/Equivalents**

<table>
<thead>
<tr>
<th>Pressure (US Customary)</th>
<th>Pressure (Metric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 psi</td>
<td>3 kPa</td>
</tr>
<tr>
<td>2 psi</td>
<td>15 kPa</td>
</tr>
<tr>
<td>3 psi</td>
<td>20 kPa</td>
</tr>
<tr>
<td>10 psi</td>
<td>70 kPa</td>
</tr>
<tr>
<td>15 psi</td>
<td>100 kPa</td>
</tr>
<tr>
<td>30 psi</td>
<td>200 kPa</td>
</tr>
<tr>
<td>50 psi</td>
<td>350 kPa</td>
</tr>
<tr>
<td>100 psi</td>
<td>700 kPa</td>
</tr>
<tr>
<td>150 psi</td>
<td>1.03 MPa</td>
</tr>
<tr>
<td>200 psi</td>
<td>1.38 MPa</td>
</tr>
<tr>
<td>250 psi</td>
<td>1.72 MPa</td>
</tr>
<tr>
<td>300 psi</td>
<td>2.10 MPa</td>
</tr>
<tr>
<td>350 psi</td>
<td>2.40 MPa</td>
</tr>
<tr>
<td>400 psi</td>
<td>2.76 MPa</td>
</tr>
<tr>
<td>500 psi</td>
<td>3.45 MPa</td>
</tr>
<tr>
<td>600 psi</td>
<td>4.14 MPa</td>
</tr>
<tr>
<td>1,200 psi</td>
<td>8.27 MPa</td>
</tr>
<tr>
<td>1,500 psi</td>
<td>10.34 MPa</td>
</tr>
</tbody>
</table>

### Table 7.4-8

**Strength (US Customary) | Strength (Metric)**

| 95,000 psi              | 655 MPa           |
Insert
Section 8
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Here
PART 1, SECTION 8
INSTALLATION — PREPARATION OF
TECHNICAL INQUIRIES TO THE NATIONAL
BOARD INSPECTION CODE COMMITTEE
PART 1, SECTION 8
INSTALLATION — PREPARATION OF TECHNICAL INQUIRIES TO
THE NATIONAL BOARD INSPECTION CODE COMMITTEE

8.1 INTRODUCTION

The NBIC Committee meets regularly to consider written requests for interpretations and revisions to the Code rules. This section provides guidance to Code users for submitting technical inquiries to the Committee. Technical inquiries include requests for additions to the Code rules and requests for Code Interpretations, as described below.

a) Code Revisions
   Code revisions are considered to accommodate technological developments, address administrative requirements, or to clarify Code intent.

b) Code Interpretations
   Code Interpretations provide clarification of the meaning of existing rules in the Code, and are also presented in question and reply format. Interpretations do not introduce new requirements. In cases where existing Code text does not fully convey the meaning that was intended, and revision of the rules is required to support an Interpretation, an intent Interpretation will be issued and the Code will be revised. As a matter of published policy, the National Board does not approve, certify, or endorse any item, construction, property, device or activity and, accordingly, inquiries requiring such consideration will be returned. Moreover, the National Board does not act as a consultant on specific engineering problems or on the general application or understanding of the Code rules.

Inquiries that do not comply with the provisions of this Section or that do not provide sufficient information for the Committee’s full understanding may result in the request being returned to the inquirer with no action.

8.2 INQUIRY FORMAT

Inquiries submitted to the Committee shall include:

a) Purpose
   Specify one of the following:

   1) revision of present Code rules;
   2) new or additional Code rules; or
   3) Code Interpretation.

b) Background
   Provide concisely the information needed for the Committee’s understanding of the inquiry, being sure to include reference to the applicable Code Edition, Addenda, paragraphs, figures, and tables. Preferably, provide a copy of the specific referenced portions of the Code.

c) Presentations
   The inquirer may attend a meeting of the Committee to make a formal presentation or to answer questions from the Committee members with regard to the inquiry. Attendance at a Committee meeting shall be at the expense of the inquirer. The inquirer’s attendance or lack of attendance at a meeting shall not be a basis for acceptance or rejection of the inquiry by the Committee.
8.3 CODE REVISIONS OR ADDITIONS

Request for Code revisions or additions shall provide the following:

a) Proposed Revisions or Additions
   For revisions, identify the rules of the Code that require revision and submit a copy of the appropriate rules as they appear in the Code, marked up with the proposed revision. For additions, provide the recommended wording referenced to the existing Code rules.

b) Statement of Need
   Provide a brief explanation of the need for the revision or addition.

c) Background Information
   Provide background information to support the revision or addition, including any data or changes in technology that form the basis for the request that will allow the Committee to adequately evaluate the proposed revision or addition. Sketches, tables, figures, and graphs should be submitted as appropriate. When applicable, identify any pertinent paragraph in the Code that would be affected by the revision or addition and identify paragraphs in the Code that reference the paragraphs that are to be revised or added.

8.4 CODE INTERPRETATIONS

Requests for Code Interpretations shall provide the following:

a) Inquiry
   Provide a condensed and precise question, omitting superfluous background information and, when possible, composed in such a way that a “yes” or a “no” reply, with brief provisos if needed, is acceptable. The question should be technically and editorially correct.

b) Reply
   Provide a proposed reply that will clearly and concisely answer the inquiry question. Preferably the reply should be “yes” or “no” with brief provisos, if needed.

c) Background Information
   Provide any background information that will assist the Committee in understanding the proposed Inquiry and Reply Requests for Code Interpretations must be limited to an interpretation of the particular requirement in the Code. The Committee cannot consider consulting type requests such as:

   1) A review of calculations, design drawings, welding qualifications, or descriptions of equipment or parts to determine compliance with Code requirements;

   2) A request for assistance in performing any Code-prescribed functions relating to, but not limited to, material selection, designs, calculations, fabrication, inspection, pressure testing, or installation;

   3) A request seeking the rationale for Code requirements.

8.5 SUBMITTALS

Submittals to and responses from the Committee shall meet the following:

a) Submittal
   Inquiries from Code users shall be in English and preferably be submitted in typewritten form; however, legible handwritten inquiries will be considered. They shall include the name, address, telephone number, fax number, and email address, if available, of the inquirer and be mailed to the following address:

   Secretary, NBIC Committee
   The National Board of Boiler and Pressure Vessel Inspectors
   1055 Crupper Avenue
   Columbus, OH 43229
As an alternative, inquiries may be submitted via fax or email to:

Secretary NBIC Committee
Fax: 614.847.1828
Email: NBICinquiry@nationalboard.org

b) Response
The Secretary of the NBIC Committee shall acknowledge receipt of each properly prepared inquiry and shall provide a written response to the Inquirer upon completion of the requested action by the NBIC Committee.
Insert
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07

Part 1, Section 9
Installation — Glossary of Terms
PART 1, SECTION 9
INSTALLATION — GLOSSARY OF TERMS

9.1 DEFINITIONS

For the purpose of applying the rules of the NBIC, the following terms and definitions shall
be used herein as applicable to each Part:

Additional terms and definitions specific to DOT Transport Tanks are defined in Part 2,
Supplement 6.

Accumulator — A vessel in which the test medium is stored or accumulated prior to its
use for testing.

Alteration — Any change in the item described on the original Manufacturer’s Data Report that
affects the pressure containing capability of the pressure-retaining item. Nonphysical changes
such as an increase in the maximum allowable working pressure (internal or external), increase
in design temperature, or a reduction in minimum temperature of a pressure-retaining item
shall be considered an alteration.

ANSI — The American National Standards Institute

ASME Code — The American Society of Mechanical Engineers’ Boiler and Pressure Vessel
Code published by that Society, including addenda and Code Cases, approved by the
associated ASME Board.

Assembler — An organization who purchases or receives from a manufacturer the necessary
component parts of valves and assemblies, adjusts, tests, seals, and ships safety or safety
relief valves at a geographical location, and using facilities other than those used by the
manufacturer.

Authorized Inspection Agency —

New Construction: An Authorized Inspection Agency is one that is accredited by the
National Board meeting the qualification and duties of NB-360, Criteria for Acceptance of Authorized Inspection Agencies for New Construction.

Inservce: An Authorized Inspection Agency is either:

a) a jurisdictional authority as defined in the National Board Constitution; or

b) an entity that is accredited by the National Board meeting NB 369, Qualifications and Duties for Authorized Inspection Agencies Performing Inservce Inspection Activities and Qualifications for Inspectors of Boilers and Pressure Vessels; NB-371, Accreditation of Owner-User Inspection Organizations (OUIO) or NB-390, For Federal Inspection Agencies (FIAs) Performing Inservce Inspection Activities.

Capacity Certification — The verification by the National Board that a particular valve design or
model has successfully completed all capacity testing as required by the ASME Code.

Chimney or Stack — A device or means for providing the venting or escape of combustion
gases from the operating unit.

Conversion —

Pressure Relief Devices: The change of a pressure relief valve from one capacity-certified
configuration to another by use of manufacturer’s instructions.

Units of Measure: Changing the numeric value of a parameter from one system of units to
another.

Demonstration — A program of making evident by illustration, explanation, and completion of
tasks documenting evaluation of an applicant’s
ability to perform code activities, including the adequacy of the applicant’s quality program, and by a review of the implementation of that program at the address of record and/or work location.

**Dutchman** — Generally limited to tube or pipe cross-section replacement. The work necessary to remove a compromised section of material and replace the section with material meeting the service requirements and installation procedures acceptable to the Inspector. Also recognized as piecing.

**Examination** — In process work denoting the act of performing or completing a task of interrogation of compliance. Visual observations, radiography, liquid penetrant, magnetic particle, and ultrasonic methods are recognized examples of examination techniques.

**Exit** — A doorway, hallway, or similar passage that will allow free, normally upright unencumbered egress from an area.

**Field** — A temporary location, under the control of the Certificate Holder, that is used for repairs and/or alterations to pressure-retaining items at an address different from that shown on the Certificate Holder’s Certificate of Authorization.

**Forced-Flow Steam Generator** — A steam generator with no fixed steamline and waterline.

**Inspection** — A process of review to assure engineering design, materials, assembly, examination and testing requirements have been met and are compliant with the Code.

**Inspector** — See National Board Commissioned Inspector and National Board Owner-User Commissioned Inspector.

**Intervening** — Coming between or inserted between, as between the test vessel and the valve being tested.

**Jurisdiction** — A governmental entity with the power, right, or authority to interpret and enforce law, rules, or ordinances pertaining to boilers, pressure vessels, or other pressure-retaining items. It includes National Board member jurisdictions defined as “jurisdictional authorities”.

**Jurisdictional Authority** — A member of the National Board, as defined in the National Board Constitution.

**Lift Assist Device** — A device used to apply an auxiliary load to a pressure relief valve stem or spindle, used to determine the valve set pressure as an alternative to a full pressure test.

**Manufacturer’s Documentation** — The documentation that includes technical information and certification required by the original code of construction.

**NBIC** — The National Board Inspection Code published by The National Board of Boiler and Pressure Vessel Inspectors.

**“NR” Certificate Holder** — An organization in possession of a valid “NR” Certificate of Authorization issued by the National Board.

**National Board** — The National Board of Boiler and Pressure Vessel Inspectors.

**National Board Commissioned Inspector** — An individual who holds a valid and current National Board Commission.

**Nuclear Items** — Items constructed in accordance with recognized standards to be used in nuclear power plants or fuel processing facilities.

**Original Code of Construction** — Documents promulgated by recognized national standards writing bodies that contain technical requirements for construction of pressure-retaining items or equivalent to which the pressure-retaining item was certified by the original manufacturer.
**Owner or User** — As referenced in lower case letters means any person, firm or corporation legally responsible for the safe operation of any pressure-retaining item.

**Owner-User Inspection Organization** — An owner or user of pressure-retaining items that maintains an established inspection program, whose organization and inspection procedures meet the requirements of the National Board rules and are acceptable to the jurisdiction or jurisdictional authority wherein the owner or user is located.

**Owner-User Inspector** — An individual who holds a valid and current National Board Owner-User Commission.

**Piecing** — A repair method used to remove and replace a portion of piping or tubing material with a suitable material and installation procedure.

**Pressure-Retaining Items (PRI)** — Any boiler, pressure vessel, piping, or material used for the containment of pressure, either internal or external. The pressure may be obtained from an external source, or by the application of heat from a direct source, or any combination thereof.

**Pressure Test** — Prior to initial operation, the completed boiler, including pressure piping, water columns, superheaters, economizers, stop valves, etc., shall be pressure tested in a test performed in accordance with the original code of construction prior to initial operation of an installed unit that is witnessed by an Inspector.

**Repair** — The work necessary to restore pressure-retaining items to a safe and satisfactory operating condition.

**Re-ending** — A method used to join original code of construction piping or tubing with replacement piping or tubing material for the purpose of restoring a required dimension, configuration or pressure-retaining capacity.

**Re-rating** — See alteration.

**“R” Certificate Holder** — An organization in possession of a valid “R” Certificate of Authorization issued by the National Board.

**Safety Relief Valves** — A safety relief valve is a pressure relief valve characterized by rapid opening or pop action, or by opening in proportion to the increase in pressure over the opening pressure, depending on application.

**Settings** — Those components and accessories required to provide support for the component during operation and during any related maintenance activity.

**Shop** — A permanent location, the address that is shown on the Certificate of Authorization, from which a Certificate Holder controls the repair and/or alteration of pressure-retaining items.

**Testing Laboratory** — National Board accepted laboratory that performs functional and capacity tests of pressure relief devices.

**Transient** — An occurrence that is maintained only for a short interval as opposed to a steady state condition.

**Velocity Distortion** — The pressure decrease that occurs when fluid flows past the opening of a pressure sensing line. This is a distortion of the pressure that would be measured under the same conditions for a non or slowly moving fluid.

**“VR” Certificate Holder** — An organization in possession of a valid “VR” Certificate of Authorization issued by the National Board.

**Water Head** — The pressure adjustment that must be taken into account due to the weight of test media (in this case, water) that is 0.433 psi per vertical ft. (10 kPa per m.) added (subtracted) from the gage pressure for each foot the gage is below (above) the point at which the pressure is to be measured.
Insert

Section 10

Tab

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NBIC

Part 1, Section 10
Installation — NBIC-Approved Interpretations
10.1 SCOPE

a) This section provides all approved interpretations for this edition and all subsequent addenda associated with this edition. A complete listed index is provided for reference to previously approved interpretations. These previously approved interpretations can be found on the National Board Web site.

b) Each interpretation references the edition and addenda applicable at the time of committee response and approval. Use of interpretations for other than approved edition and addenda may not be appropriate for reference.

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