



2015 NBIC

NATIONAL BOARD INSPECTION CODE



PART 1 INSTALLATION

AN AMERICAN NATIONAL STANDARD

THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

NATIONAL BOARD INSPECTION CODE

2015 EDITION

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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 ensure 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.

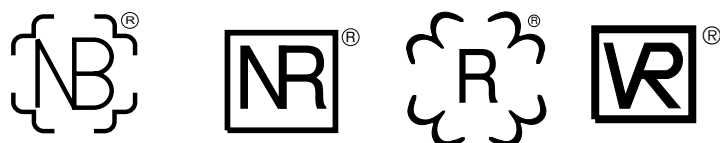
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PART 1 — INSTALLATION

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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

- 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 shall, should, 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 ensure 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 identifi

SUPPLEMENTS

Supplements are contained in each part of the NBIC to provide rules, information, and guidance 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 be tabbed to identify the supplement number.

EDITIONS

Editions, which include revisions and additions to this code, are published every two years. Editions are permissive on the date issued and become mandatory six months after the date of issue.

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 clarification of existing rules in the code 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 U.S. customary units and metric units are used in the NBIC. The value stated in U.S. customary units or metric units are to be regarded separately as the standard. Within the text, the metric units are shown in

parentheses. In Part 2, Supplement 6 and Part 3, Supplement 6 regarding DOT Transport Tanks, the metric units are shown first with the U.S. customary units shown in parentheses.

U.S. 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 metrication is outlined in each part of the NBIC.

ACCREDITATION PROGRAMS

The National Board administers and accredits three specific repair programs¹ 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.

The National Board also administers and accredits four specific

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 Website at www.nationalboard.org. For questions or further information regarding these programs contact the National Board by phone at (614) 888-8320 or by fax at (614) 847-1828

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.

¹ Caution, some Jurisdictions may independently administer a program of authorization for organizations to perform repairs and alterations within that Jurisdiction.

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 ensuring 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, uniformity, and 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 fi

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 from 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 not be retroactive. Unless the Jurisdiction imposes the use of an earlier edition, the latest effective edition is the governing document.

2015 National Board Inspection Code

PERSONNEL

The National Board of Boiler and Pressure Vessel Inspectors

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PART 1, SECTION 1 INSTALLATION — GENERAL GUIDELINES

1.1 SCOPE

NBIC Part 1 provides requirements for the installation of power boilers, steam heating boilers, hot-water heating boilers, hot-water supply boilers, potable water heaters, pressure vessels and piping. (15)

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

1.2 PURPOSE

- a) The purpose of these rules are 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 Installation 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 specifi
 - 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 identifi
 - 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 (e.g., 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 comply with the requirements of the code of construction. The certification shall identify the "Addenda" for a code of construction to which all pressure-retaining items were 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 (e.g., certifi 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 (e.g., certifi 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 potable 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.

1.4.5.1 BOILER INSTALLATION REPORT FORM, see Pg. 6

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's 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 Jurisdiction 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, e.g., watertube, firetube, cast iron, electric, etc.
- 11) BOILER USE: Enter the service for which or for how the boiler will be used, e.g., heating (steam or water), potable water, etc.
- 12) FUEL: Enter the type of fuel, e.g., natural gas, diesel, wood, etc. If more than one fuel type, enter the types for which the boiler is equipped.
- 13) METHOD OF FIRING: Enter the method of firing, e.g., 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 certifi
- 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) FEEDWATER 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 are 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.
- 35) MANUFACTURER'S CERTIFICATION ATTACHED: Indicate if manufacturer's certificate is attached (mandatory for new installations).
- 36) CLEARANCE REQUIREMENTS AND REPLACEMENT OF EXISTING BOILER: Indicate clearances and whether the installation replaced an existing boiler.
- 37) ADDITIONAL REMARKS: Enter any remarks or comments you deem appropriate.
- 38) INSTALLER'S NAME AND SIGNATURE: Print installer name and registration number and sign completed report.
- 39) BOTTOM BLOWDOWN CONNECTIONS: Indicate number of valves, valve size, and MAWP. Indicate if piping run is full size to point of discharge.
- 40) EXTERNAL PIPING ASME CODE AND FUEL TRAIN: Indicate if external piping is ASME Code, if not, indicate what code or standard external piping is manufactured to. Indicate if the fuel train meets the requirements of CSD-1 or NFPA-85. If other, indicate code or standard used.

1.5 CHANGE OF SERVICE

- (15) See NBIC Part 2, Supplement 9 for requirements and guidelines to be followed when a change of service or service type is made to a pressure-retaining item.

Whenever there is a change of service, the Jurisdiction where the pressure-retaining item is to be operated shall be notified for acceptance, when applicable. Any specific jurisdictional requirements shall be met.

BOILER INSTALLATION REPORT I-1

 INSTALLATION: ① ☐ New ☐ Reinstalled ☐ Second Hand Date ____/____/____

② INSTALLER	③ OWNER-USER	④ OBJECT LOCATION
Name	Name	Name
Street	Street, PO Box, RR	Street
City, State, ZIP	City, State, ZIP	City, State, ZIP

Jurisdiction No. ⑤	National Board No. ⑥	Manufacturer ⑦		Mfg. Serial No. ⑧	Year Built ⑨	Boiler Type ⑩	Boiler Use ⑪
Fuel ⑫	Method of Firing ⑬	Btu/kw input ⑭	Btu/kw output ⑮	Operating PSI ⑯	Code Stamp(s) ⑰	☐ A ☐ S ☐ U ☐ HLW ☐ M ☐ E ☐ H ☐ Other	
Stamped MAWP ⑱	Heating Surface, Sq. Ft. ⑲	Cast Iron ⑳	Manhole ㉑	Specific On-Site Location, i.e., Utility Room ㉒			
Pressure Relief Valve Size ㉓	Pressure Relief Valve Set Pressure ㉔	Pressure Relief Valve Capacity ☐ BTU/hr ☐ Lb/hr ㉕	Manufacturer ㉖	Low-Water Fuel Cutoff Mfg. No. ㉗ Probe Type _____ Flow Switch _____ Float & Chamber _____ Other (Specify) _____			
1. _____ 2. _____ 3. _____ 4. _____	1. _____ 2. _____ 3. _____ 4. _____	1. _____ 2. _____ 3. _____ 4. _____	1. _____ 2. _____ 3. _____ 4. _____				

PRESSURE/ALTITUDE GAGE: ㉘ Dial Graduation _____ Valve/Cock Size _____ MAWP _____ Pipe Connection Size _____ Siphon or Equivalent Device ☐ Yes ☐ No	EXPANSION TANK: ㉙ ASME Constructed ☐ Yes ☐ No Other _____ MAWP _____ No. Gallons _____	VENTILATION AND COMBUSTION AIR ㉚ Unobstructed Opening (sq. in.) _____ Power Ventilator Fan (CFM) _____
WATER LEVEL INDICATORS: ㉛ Number of Gage Glasses _____ Number of Remote Indicators _____ Size of Connection Piping _____	FEEDWATER SUPPLY: ㉜ Number of Feeding Means _____ Pipe Size _____ Stop Valve Size _____ MAWP _____ Check Valve Size _____ MAWP _____	
STOP VALVES: ㉝ Number of Valves _____ Valve Size _____	EXTERNAL PIPING ASME CODE: ㉞ ☐ Yes ☐ No ☐ Other _____	FUEL TRAIN: ㉟ ☐ CSD-1 ☐ NFPA-85 ☐ Other _____
BOTTOM BLOWDOWN CONNECTIONS: ㊱ Number of Valves _____ Valve Size _____ MAWP _____ Piping Run Full Size ☐ Yes ☐ No	POTABLE WATER HEATER UNIQUE REQUIREMENTS ☐ Yes ☐ No Inlet Stop Valve Size _____ MAWP _____ Outlet Stop Valve Size _____ MAWP _____ Drain Valve Size _____ Thermometer ☐ Yes ㊲	
Manufacturer's Certification Attached: ☐ Yes ☐ No ㊳ Does boiler replace existing one: ☐ Yes ☐ No ㊴	Clearance from walls and floors: Side _____ Bottom _____ Top ㊵	

Additional recommendations and remarks by installer:

③⑦

 ③⑧
 Installer Name (PRINT)

Registration #

I HEREBY CERTIFY THAT THE INSTALLATION COMPLIES WITH APPENDIX I

 ③⑧
 Installer Signature

PART 1, SECTION 2 POWER BOILERS

(15)

2.1 SCOPE

NBIC Part 1, Section 2 provides requirements for the installation of power boilers.

2.2 DEFINITIONS

See NBIC Part 1, Section 9, *Glossary*.

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

(15)

- 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 equipment 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 EQUIPMENT ROOM REQUIREMENTS

2.4.1 EXIT

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

2.4.2 LADDERS AND RUNWAYS

- a) All walkways, runways, and platforms shall be:
- 1) of metal construction;
 - 2) provided between or over the top of boilers that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;
 - 3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);
 - 4) of bolted, welded, or riveted construction; and
 - 5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe-board.
- b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and shall be equipped with handrails 42 in. (1070 mm) high with an intermediate rail.
- c) Ladders that serve as a means of access to walkways, runways, or platforms shall:
- 1) be of metal construction and not less than 18 in. (460 mm) wide;
 - 2) have rungs that extend through the side members and are permanently secured;
 - 3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;
 - 4) have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and
 - 5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.
- d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.

2.4.3 DRAINS

- (15) At least one fl

2.4.4 WATER (CLEANING)

- (15) 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 equipment 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 high temperature gases or to direct radiation from the fl
- 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 blowoff.
- 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 maximum allowable working 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 3% 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 feedwater pump differential: (15)

TABLE 2.5.1.3
GUIDE FOR FEEDWATER PUMP DIFFERENTIAL

(15)

Boiler Pressure		Boiler Feedwater Pump Discharge Pressure	
psig	(MPa)	psig	(MPa)
200	(1.38)	250	(1.72)
400	(2.76)	475	(3.28)
800	(5.52)	925	(6.38)
1,200	(8.27)	1,350	(9.31)

- 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 disconnecting means capable of being locked in the open position shall be installed at an accessible location at the boiler so that the boiler can be disconnected from all sources of potential. This disconnecting means shall be an integral part of the boiler or adjacent to it. (15)

2.5.3.1 WIRING

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.

2.5.3.2 REMOTE EMERGENCY SHUTDOWN SWITCHES

- a) A manually operated remote shutdown switch or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch in order to safeguard against tampering. (15)
- b) For equipment rooms exceeding 500 ft.² (46 m²) floor area or containing one or more boilers having a combined fuel capacity of 1,000,000 Btu/hr (293 kW) or more, additional manually operated remote emergency shutdown switches shall be located at suitably identified points of egress acceptable to the Jurisdiction.
- c) Where a boiler is located indoors in a facility and not in a equipment room, a remote emergency shutdown switch shall be located within 50 ft. (15 m) of the boiler along the primary egress route from the boiler area.
- d) Consideration should be given to the type and location of the remote emergency shutdown switch(es) in order to safeguard against tampering. Where approved by the Jurisdiction, alternate locations of remote emergency switch(es) may be provided.
- e) For atmospheric-gas burners and for oil burners where a fan is on the common shaft with the oil pump, the emergency remote shutdown switch(es) or circuit breaker(s) must disconnect all power to the burner controls.
- f) For power burners with detached auxiliaries, the emergency remote shutdown switch(es) or circuit breaker(s) need only shut off the fuel input to the burner.

2.5.3.3 CONTROLS AND HEAT-GENERATING APPARATUS

- a) 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.
- b) 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.
- c) 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

- (15) a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the boiler room. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans.²
- b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2,000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room air supply openings shall be kept clear at all times.
- c) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all boilers located in the equipment room. Additional capacity may be required for any other fuel-burning equipment in the boiler room.
- d) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.
- e) The size of openings specified in NBIC Part 1, 2.5.4 b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.
- f) Care should be taken to ensure that steam and water lines are not routed across combustion air openings, where freezing may occur in cold climates.

2.5.5 LIGHTING

- (15) The equipment room should be well lit 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

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

- 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 NBIC Part 1, 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

Drain piping from the drain connection, including the required valve(s) or the blanked flange connection, shall be designed for the temperature and pressure of the drain connection. The remaining piping shall be designed for the expected maximum temperature and pressure. Static head and possible choked flow conditions shall be considered. In no case shall the design pressure and temperature be less than 100 psig (700 kPa) and 220°F (104°C), respectively.

(15)

2.6.3.3 PARTS

- e) When parts (e.g., 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 NBIC Part 1, 2.6.3, as applicable.
- f) 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 NBIC Part 1, 2.6.3, 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 cause 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.
- (15) f) Provision for an ample 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.
- g) When boilers are connected to a common header, the connection from each boiler having a manhole opening shall be fitted with two stop valves having an ample free-blow drain between them. The discharge of this drain shall be visible to the operator while operating the valve. The stop valves shall consist of one stop check valve (set next to the boiler) and a second valve of the outside screw-and-yoke type; or two valves of the outside screw-and-yoke type.
 - h) The second steam stop valve shall have a pressure rating at least equal to that required for the expected steam temperature and pressure at the valve; or the pressure rating shall be not less than 85% of the lowest set pressure of any safety valve on the boiler drum and for the expected temperature of the steam at the valve, whichever is greater.
 - i) Pressure-reducing valves may be installed in the steam supply piping downstream from the required stop valve or valves.

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.
- 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) When two valves are required, each bottom blowoff pipe shall have two slow-opening valves, or one quick-opening valve, at the boiler nozzle followed by a slow-opening valve.

- d) Two independent slow-opening valves or a slow-opening valve and quick-opening valve may be combined in one body provided the combined fitting is the equivalent of two independent slow-opening valves or a slow-opening valve and a quick-opening valve, and 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) or less of heating surface 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).
- 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).³
- 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 deconcentrators 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).

³ The *Guide for Blowoff Vessels* (NB-27) can be found on the National Board web-site, www.nationalboard.org.

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, it shall be 3 in. (75 mm) above the lowest permissible water level as determined by the manufacturer. Horizontal firetube boilers that do not exceed 16 in. (400 mm) in inside diameter shall have the lowest visible level in the gage glass at least 1 in. (25 mm) above the lowest permissible level as determined by the manufacturer.
- m) Each water-gage glass shall be equipped with a top and a bottom shutoff valve of such through-fl 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 and no greater than two times the pressure at which the lowest pressure-relief valve is set.

2.8.2.1 CONNECTION

- a) For a steam boiler 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. 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 siphon, 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 siphon, 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 fl
- 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. (46.5 sq. m.) of heating surface, or if an electric boiler has a power input of more than 3.76 million Btu/hr (1,100 kW), two or more National Board capacity certified safety or safety 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 NBIC Part 1, Table 2.9.1.3, but in no case should the minimum relieving capacity be less than the maximum designed steaming capacity as determined by the manufacturer.
- c) The required relieving capacity in pounds per hour of the safety or safety 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. (metrication)
- 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**

	Firetube Boiler	Watertube Boiler
Boiler Heating Surface lb steam/hr ft ² (kg steam/hr m ²)		
Hand-fired	5 (24)	6 (29)
Stoker-fired	7 (34)	8 (39)
Oil, gas, or pulverized coal	8 (39)	10 (49)
Waterwall Heating Surface		
Hand-fired	8 (39)	8 (39)
Stoker-fired	10 (49)	12 (59)
Oil, gas, or pulverized coal	14 (68)	16 (78)
Copper-finned Watertubes		
Hand-fired		4 (20)
Stoker-fired		5 (24)
Oil, gas, or pulverized coal		6 (29)

(15)

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 to be considered, except that for vertical firetube steam boilers, only that portion of the tube surface up to the middle gage cock is to be computed.
- For firetube boiler units exceeding 8,000 Btu/ft.² (9,085 J/cm.²) (total fuel Btu (J) Input divided by total heating surface), the factor from the table will be increased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) above 8,000 Btu/ft.² (9,085 J/cm.²). For units less than 7,000 Btu/ft.² (7,950 J/cm.²), the factor from the table will be decreased by 1 (4.88).
- For watertube boiler units exceeding 16,000 Btu/ft.² (18,170 J/cm.²) (total fuel Btu input divided by the total heating surface) the factor from the table will be increased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) above 16,000 Btu/ft.² (18,170 J/cm.²). For units with less than 15,000 Btu/ft.² (17,034 J/cm.²), the factor in the table will be decreased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) below 15,000 Btu/ft.² (17,034 J/cm.²).

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 may be provided in accordance with the above paragraphs identified in NBIC Part 1, 2.9.1 or the following protection against overpressure shall be provided:

- a) One or more power-actuated pressure-relieving valves shall be provided in direct communication with the boiler when the boiler is under pressure and shall receive a control impulse to open when the maximum allowable working pressure at the superheater outlet is exceeded. The total combined relieving capacity of the power-actuated pressure-relieving valves shall be not less than 10% of the maximum design steaming capacity of the boiler under any operating condition as determined by the manufacturer. The valves shall be located in the pressure part system where they will relieve the overpressure. An isolating stop valve of the outside-screw-and-yoke type should be installed between the power-actuating pressure-relieving valve and the boiler to permit repairs provided an alternate power-actuated pressure-relieving valve of the same capacity is so installed as to be in direct communication with the boiler;
- b) Spring-loaded safety valves shall be provided having a total combined relieving capacity, including that of the power-actuated pressure-relieving valve, of not less than 100% of the maximum designed steaming capacity of the boiler, as determined by the manufacturer. In this total, credit in excess of 30% of the total relieving capacity shall not be allowed for the power-actuated pressure-relieving valves actually installed. Any or all of the spring-loaded safety 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 fi
 - 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; and
 - 3) A reliable pressure-recording device shall always be in service and records kept to provide evidence of conformity to the above requirements.

(15)

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 6 pounds of steam per hr/sq. ft. (29 kg per hr per sq. m) of superheater surface measured on the side exposed to the hot gases.
- d) Every safety valve used on a superheater discharging superheated steam at a temperature over 450°F (230°C) shall have a casing, including the base, body, bonnet, and spindle constructed of steel, steel alloy, or equivalent heat-resistant material. The valve shall have a flanged inlet connection or a welded-end inlet connection. The seat and disk shall be constructed of suitable heat-erosive and corrosive-resistant material, and the spring fully exposed outside of the valve casing so that it is protected from contact with the escaping steam.

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 1,000 (2,326). The safety relief valve shall be installed in a location recommended by the manufacturer, when no recommendation exists the location shall be as close as practical to the economizer outlet.

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.

2.9.6 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 10 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 and the inlet pipe to the pressure relief valve shall be no longer than the face to face dimension of the corresponding tee fitting of the same diameter and pressure class. When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet or of the total of the areas of the valve outlets discharging thereinto and shall be as short and straight as possible and arranged to avoid undue stresses on the valve or valves.
- d) No valve of any description except a changeover valve as defined below, shall be placed between the safety or safety relief valves and the boiler, nor on the discharge pipe between the safety or safety relief valves and the atmosphere.

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

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

- e) When two or more 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.
- f) When two valves of different sizes are mounted singly, the relieving capacity of the smaller valve shall not be less than 50% of that of the larger valve.
- g) When a boiler is fitted with two or more 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.
- h) 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. Provision for an ample 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).
- i) Discharge piping from safety relief valves on high-temperature water boilers shall have adequate provisions for water drainage as well as steam venting.
- j) If a muffler is used on a safety or safety 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 fi
- 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 fi

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 NBIC Part 1, 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.

2.11 TABLES AND FIGURES

- (15) a) NBIC Part 1, Table 2.5.1.3 - Guide for Feedwater Pump Differential
- b) NBIC Part 1, Table 2.9.1.3 - Minimum Pounds of Steam per Hour Per Square Foot of Heating Surface

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 NBIC Part 1, Section 3 shall apply to steam heating boilers, hot-water heating boilers, hot-water supply boilers, and potable water heaters. (15)

3.2 DEFINITIONS

See in NBIC Part 1, Section 9, *Glossary*.

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

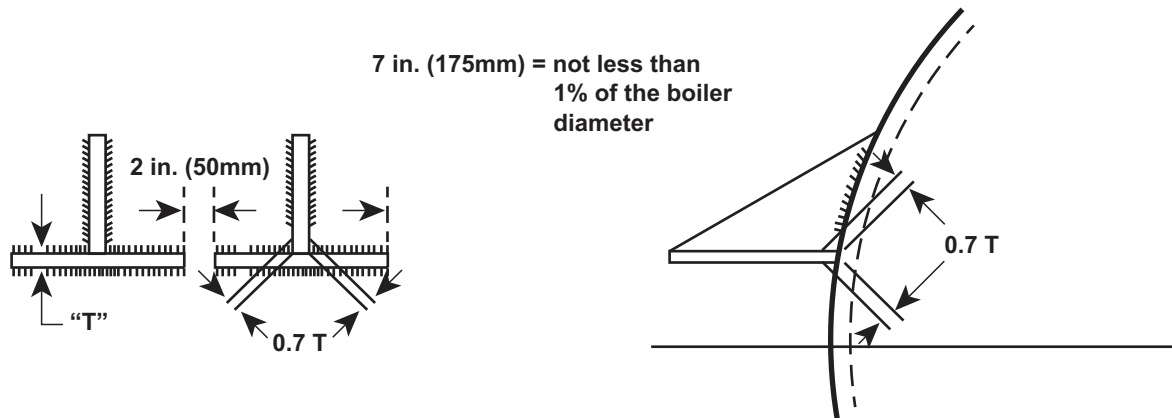
- 1) The design and attachment of lugs, hangers, saddles, and other supports shall take into account the stresses due to hydrostatic head of fully flooded equipment in determining the minimum thicknesses required. Additional stresses imposed by effects other than working pressure or static head that 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

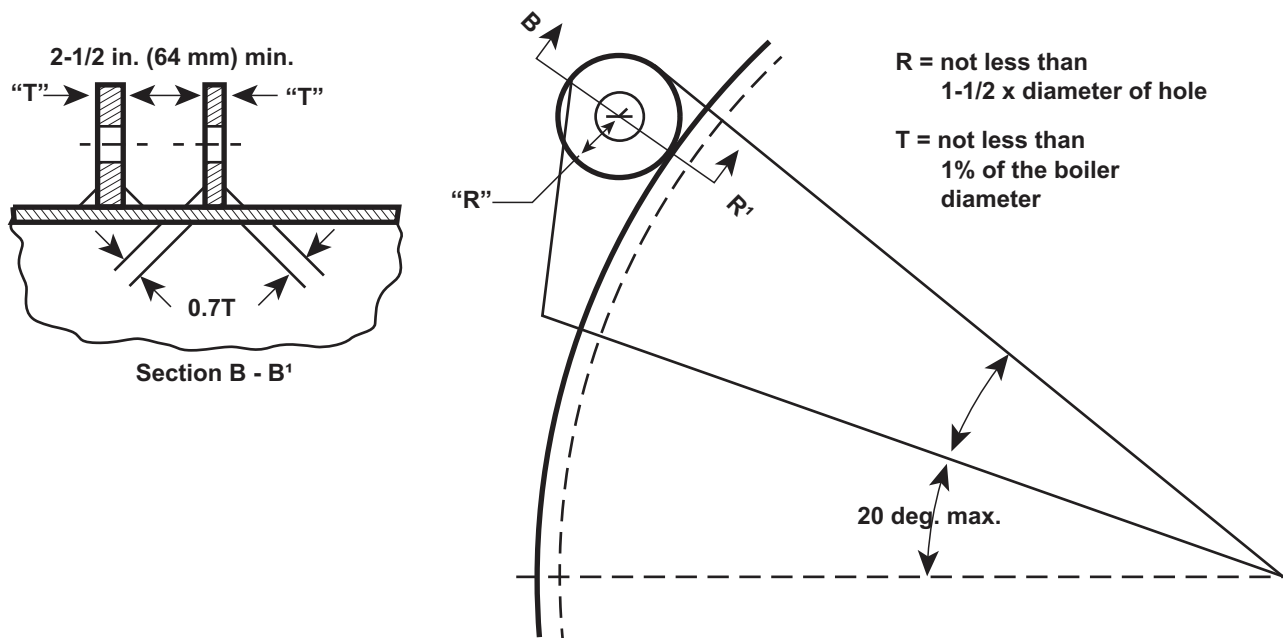
- 1) Boilers over 72 in. (1,800 mm) in diameter. A horizontal-return tubular boiler over 72 in. (1,830 mm) in diameter shall be supported from steel hangers by the outside-suspension type of setting, independent of the furnace wall. The hangers shall be so designed that the load is properly distributed.
- 2) Boilers 14 ft. (4.3 m) or over in length, or over 54 in. (1,370 mm) up to 72 in. (1,830 mm) in diameter: A horizontal-return tubular boiler over 54 in. (1,370 mm) and up to and including 72 in. (1,800 mm) in diameter shall be supported by the outside-suspension type of setting, or at four points by not less than eight steel brackets set in pairs, the brackets of each pair to be spaced not over 2 in. (50 mm) apart and the load to be equalized between them. See NBIC Part 1, Figure 3.3.1.1-a.

FIGURE 3.3.1.1-a

SPACING AND WELD DETAILS FOR SUPPORTING LUGS IN PAIRS ON HORIZONTAL-RETURN TUBULAR BOILER

**FIGURE 3.3.1.1-b**

WELDED BRACKET CONNECTION FOR HORIZONTAL-RETURN TUBULAR BOILER



- 3) Boilers up to 54 in. (1,370 mm) in diameter

A horizontal-return boiler up to and including 54 in. (1,370 mm) in diameter shall be supported by the outside-suspension type of setting, or by not less than two steel brackets on each side. See NBIC Part 1, Figures 3.3.1.1-b.

- 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. NBIC Part 1, 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 2,800 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. (2,135 mm) of clearance between the manhole opening and any wall, ceiling, piping, or other equipment that may prevent a person from entering the heating boiler. Alternative clearances in accordance with the manufacturer's recommendations are subject to 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,⁴ and inspection of equipment and appurtenances.

⁴ Maintenance – This includes the removal of tubes.

3.4 EQUIPMENT ROOM REQUIREMENTS

3.4.1 EXIT

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

3.4.2 LADDERS AND RUNWAYS

- a) All walkways, runways, and platforms shall be:
- 1) of metal construction;
 - 2) provided between or over the top of boilers that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;
 - 3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);
 - 4) of bolted, welded, or riveted construction; and
 - 5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe board.
- b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.
- c) Ladders that serve as a means of access to walkways, runways, or platforms shall:
- 1) be of metal construction and not less than 18 in. (460 mm) wide;
 - 2) have rungs that extend through the side members and are permanently secured;
 - 3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;
 - 4) have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and
 - 5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.
- d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.

3.5 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. A means shall be provided at or near the boiler to prevent back-feeding. Such means shall be rated for the boiler design pressure and temperature.

- c) Provision should also be made in every equipment room for a convenient water supply that can be used to fill

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

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

- a) All wiring for controls, heat generating apparatus, and other appurtenances necessary for the operation of the boiler or boilers shall be installed in accordance with the provisions of national or international standards and comply with the applicable local electrical codes. (15)
- b) A manually operated remote shutdown switch or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch to safeguard against tampering.
- c) A disconnecting means capable of being locked in the open position shall be installed at an accessible location at the boiler so that the boiler can be disconnected from all sources of potential. This disconnecting means shall be an integral part of the boiler or adjacent to it. (15)
- d) If the equipment room door is on the building exterior, the switch shall be located just inside the door. If there is more than one door to the equipment room, there shall be a switch located at each door of egress.
 - 1) For atmospheric-gas burners, and oil burners where a fan is on a common shaft with the oil pump, the complete burner and controls should be shut off.
 - 2) For power burners with detached auxiliaries, only the fuel input supply to the firebox need be shut off.

3.5.3.2 POTABLE WATER HEATERS

- a) All wiring for controls, heat generating apparatus, and other appurtenances necessary for the operation of the potable water heaters shall be installed in accordance with the provisions of national or international standards and comply with the applicable local electrical codes. (15)
- b) A manually operated remote shutdown switch or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch to safeguard against tampering.
- c) A disconnecting means capable of being locked in the open position shall be installed at an accessible location at the heater so that the heater can be disconnected from all sources of potential. This disconnecting means shall be an integral part of the heater or adjacent to it.
- d) If the equipment room door is on the building exterior, the switch shall be located just inside the door. If there is more than one door to the equipment room, there shall be a switch located at each door of egress.
 - 1) For atmospheric-gas burners, and oil burners where a fan is on a common shaft with the oil pump, the complete burner and controls should be shut off.

- 2) For power burners with detached auxiliaries, only the fuel input supply needs be shut off.

3.5.3.3 CONTROLS AND HEAT GENERATING APPARATUS

- a) Oil- and gas-fired and electrically heated boilers and water heaters shall be equipped with suitable primary (flame safeguard) safety controls, safety limit controls, and burners or electric elements as required by a nationally or internationally recognized standard.
- b) 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.
- c) These devices shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

3.5.4 VENTILATION AND COMBUSTION AIR

- a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room. The combustion and ventilation air may be supplied by either an unobstructed air opening or by power ventilation or fans.⁵
- b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (645 sq mm) free area per 2,000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room air supply openings shall be kept clear at all times.
- c) Power ventilators or fans shall be sized on the basis of 0.2 ft³ (0.006 m³) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all boilers and/or water heaters located in the equipment room. Additional capacity may be required for any other fuel burning equipment in the equipment room.
- d) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.
- e) When combustion air is supplied to the heating boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.
- f) The size of openings specified in NBIC Part 1, 3.5.4 b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.
- g) Care should be taken to ensure that steam and water lines are not routed across combustion air openings, where freezing may occur in cold climates.

3.5.5 LIGHTING

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

⁵ Fans – When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.

3.5.6 EMERGENCY VALVES AND CONTROLS

All emergency shut-off valves and controls shall be accessible from a floor. 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.

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 equipment room, will facilitate proper cleaning of the equipment 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, or a backfl -
taining 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, or a backflow preventer containing 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 Steam Heating Boilers

When a stop valve is used in the supply pipe connection of a single steam boiler, there shall be one installed in the return pipe connection.

b) For Single Hot-Water Heating & Hot-Water Supply Boilers

- 1) 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, of a single hot water boiler installation to permit draining the boiler without emptying the system.
- 2) When the boiler is located above the system and can be drained without draining the system stop valves required in NBIC Part 1, 3.7.5.1 b) 1) may be eliminated.

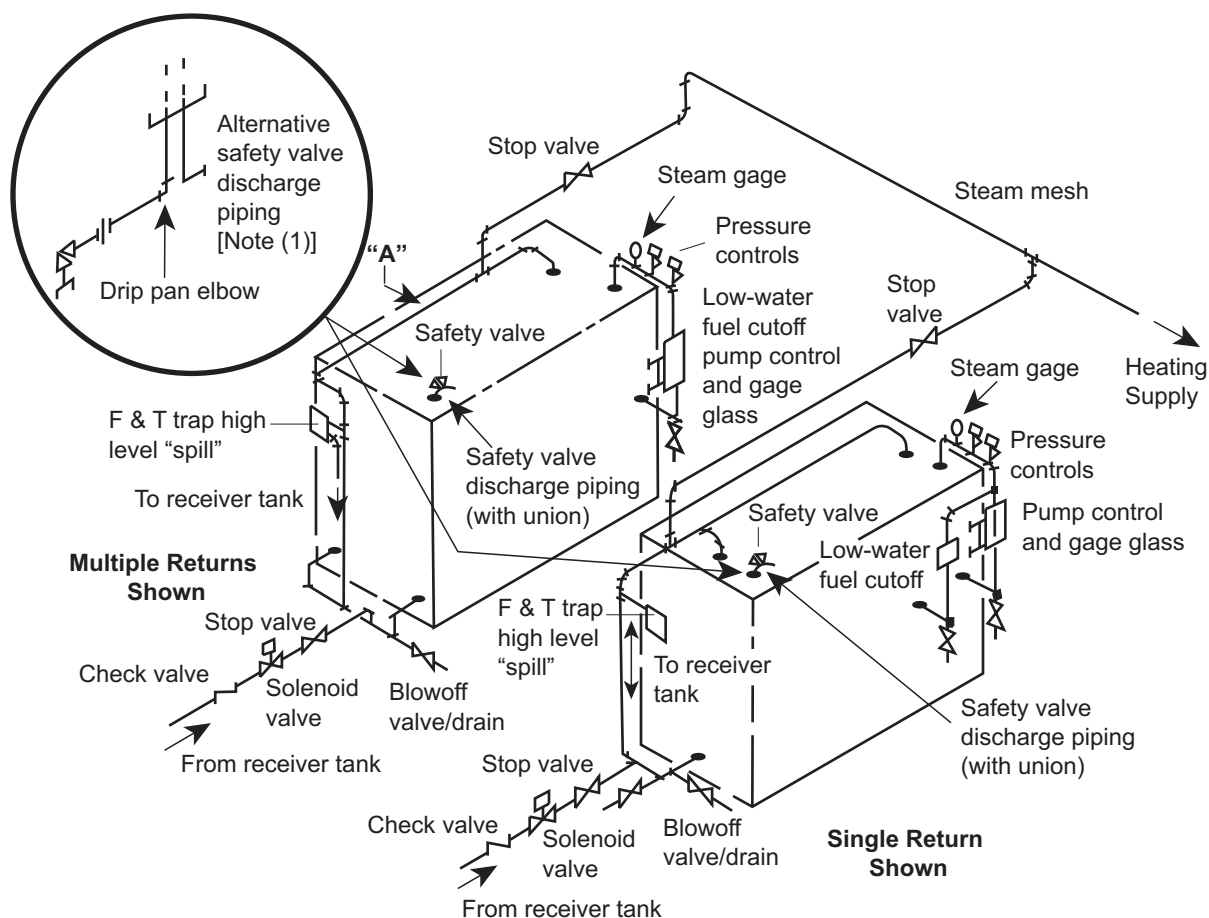
c) For Multiple Boiler Installations

A stop valve shall be used in each supply- and-return pipe connection of two or more boilers connected to a common system. See NBIC Part 1, Figures 3.7.5.1-a, 3.7.5.1-b, and 3.7.5.1-c.

d) Types 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).

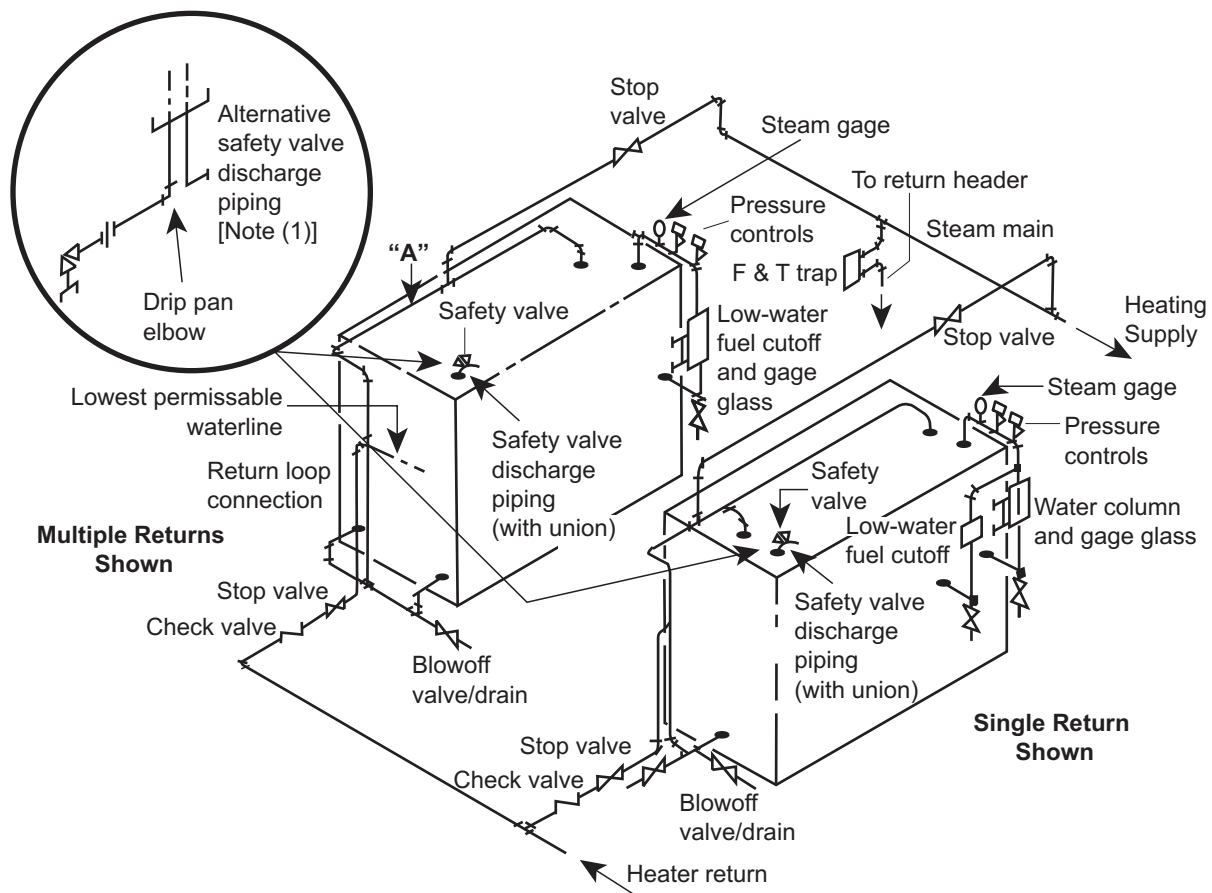
- 3) Valves or cocks shall be fl
- 4) All valves or cocks with stems or spindles shall have adjustable pressure-type packing glands and, in addition, all plug-type cocks shall be equipped with a guard or gland. The plug or other operating mechanism shall be distinctly marked in line with the passage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

FIGURE 3.7.5.1-a**STEAM BOILERS IN BATTERY — PUMPED RETURN — ACCEPTABLE PIPING INSTALLATION****General Note:**

Return connections shown for 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:

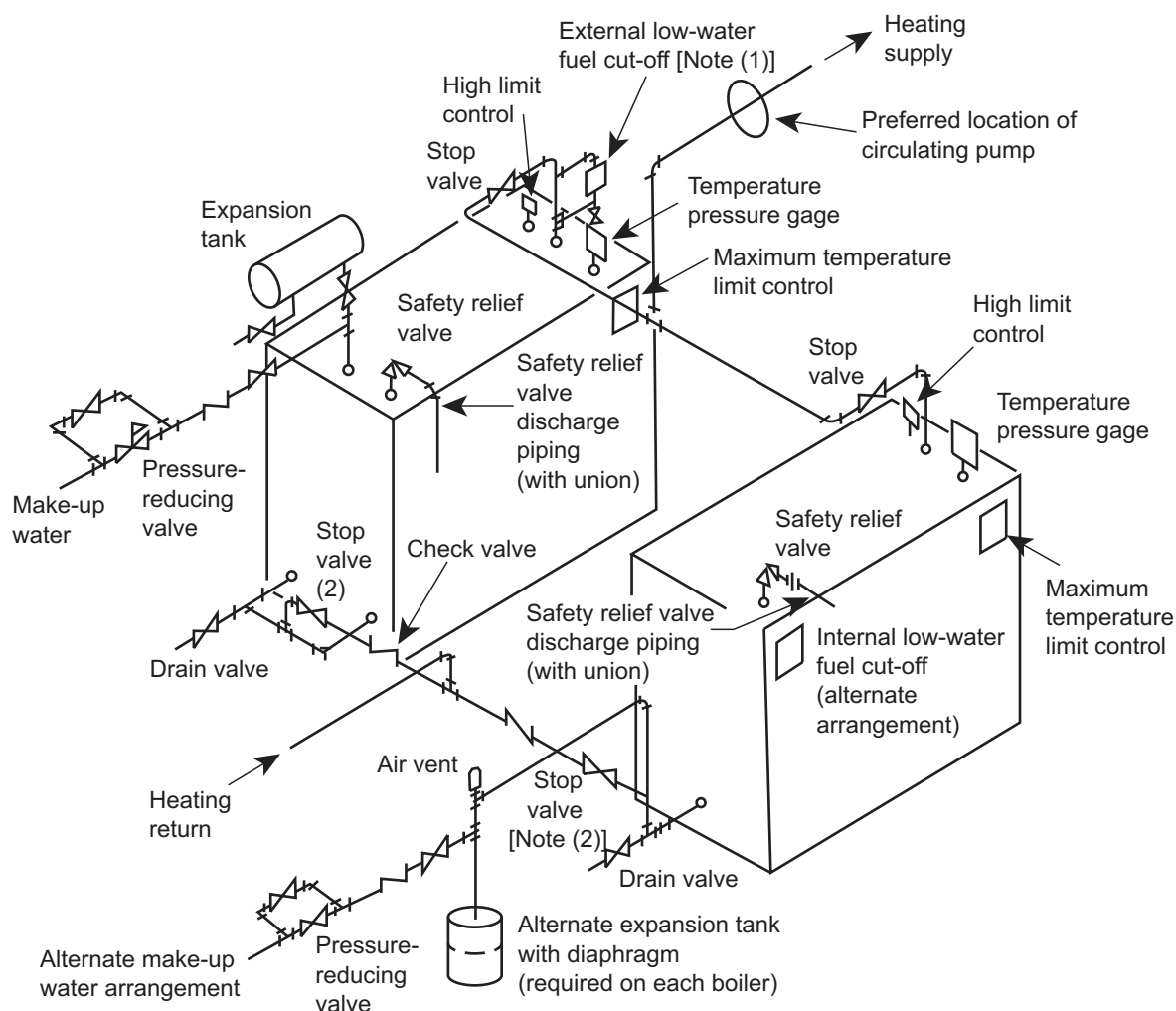
(1) Recommended for 1 in. (25mm) and larger safety valve discharge.

FIGURE 3.7.5.1-b**STEAM BOILERS IN BATTERY — GRAVITY RETURN — ACCEPTABLE PIPING INSTALLATION****General Note:**

Return connections shown for 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. (25mm) and larger safety valve discharge.

FIGURE 3.7.5.1-c**HOT-WATER BOILERS IN BATTERY — ACCEPTABLE PIPING INSTALLATION****General Notes:**

(1) Recommended control. See ASME Section IV, HG-614. Acceptable shutoff valve or cocks in the connecting piping may be installed for convenience or control testing and/or service.

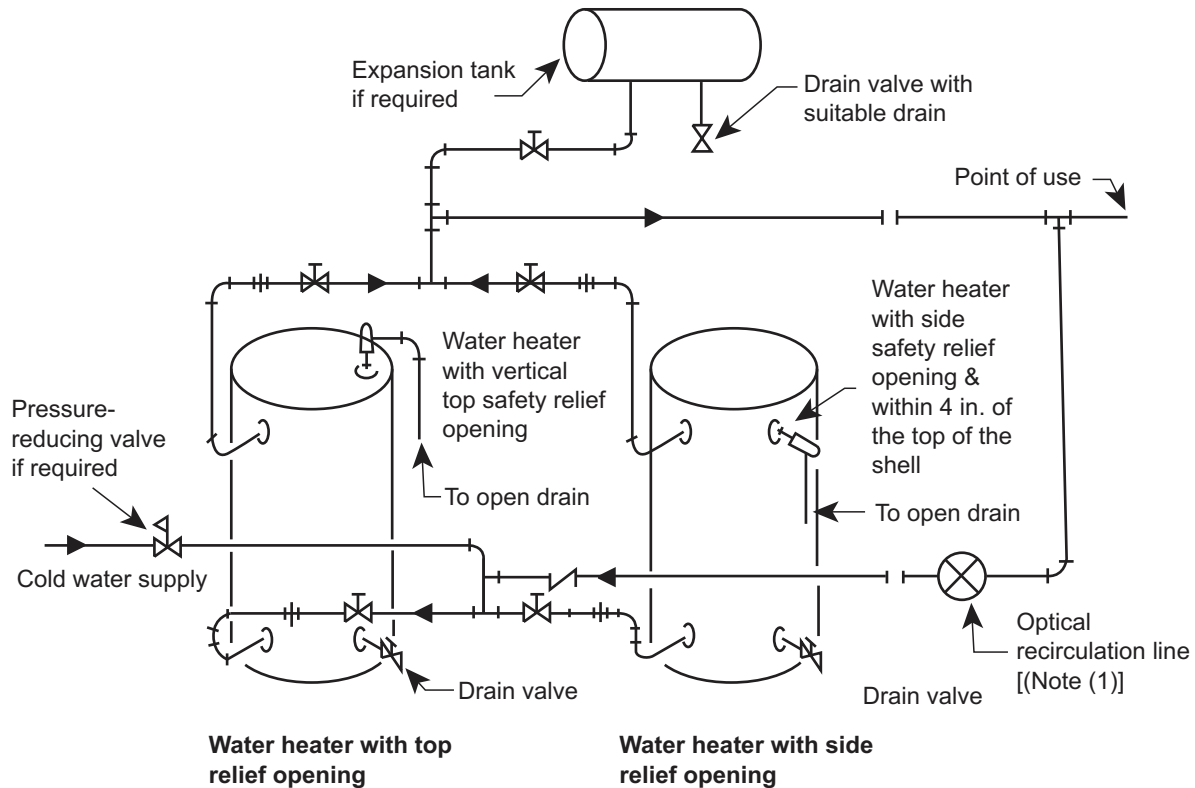
(2) The common return header stop valves may be located on either side of the check valves.

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 NBIC Part 1, Figures 3.7.5.2-a and 3.7.5.2-b.

FIGURE 3.7.5.2-a

STORAGE POTABLE WATER HEATERS IN BATTERY – ACCEPTABLE PIPING INSTALLATION

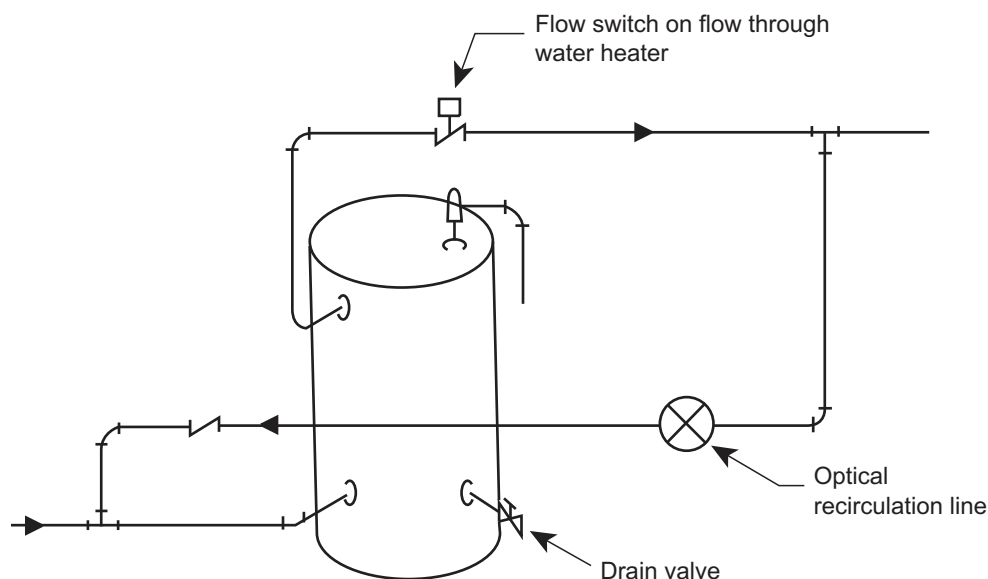


Note:

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

FIGURE 3.7.5.2-b

FLOW THROUGH PORTABLE WATER HEATER WITHOUT PROVISION FOR PIPING EXPANSION—ACCEPTABLE PIPING INSTALLATION.



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 NBIC Part 1, Figure 3.7.3.2-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 3.7.5.1-a and 3.7.3.2-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 with a normal grate line, the recommended pipe sizes detailed as “A” in Figures 3.7.5.1-a and 3.7.3.2-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 2,000 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.

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 NBIC Part 1, 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 3.7.7.1

SIZE OF BOTTOM BLOWOFF PIPING, VALVE, AND COCKS

(15)

Minimum Required Safety Valve Capacity, lbs. of steam/hr (kg steam/hr)	Blowoff
Up to 500 (227)	¾ (19)
501 to 1,250 (over 227 to 567)	1 (25)
1,251 to 2,500 (227 to 1,134)	1-1/4 (32)
2,501 to 6,000 (1,134 to 2,722)	1-1/2 (38)
6,001 and larger (2,722)	2 (50)

Note:

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

3.7.7.2 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.

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) for gas, 3 gal./hr (11.4 l/hr) for oil, or 117 kW for electricity.
- b) Each module of a modular steam heating boiler shall be equipped with:
 - 1) Safety valve, see NBIC Part 1, 3.9.2;
 - 2) Blowoff valve, see NBIC Part 1, 3.7.7.1 a); and
 - 3) Drain valve, see NBIC Part 1, 3.7.7.1 b).
- c) Each module of a modular hot-water heating boiler shall be equipped with:
 - 1) Safety relief valve, see NBIC Part 1, 3.9.3; and
 - 2) Drain valve, see NBIC Part 1, 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 NBIC Part 1, Figures 3.7.5-a and 3.7.5-b; and
 - 2) Return pipe connection, see NBIC Part 1, 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 NBIC Part 1, Figure 3.7.5-c;
 - 2) Provision for thermal expansion, see NBIC Part 1, Figures 3.7.5-c and Table 3.7.9.1-a; and
 - 3) Stop valves, see NBIC Part 1, 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 AND HOT-WATER SUPPLY BOILERS

- 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 NBIC Part 1, 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:

$$V_t = \frac{(0.00047T - 0.0466)V_s}{(P_a/P_f) - (P_a/P_o)}$$

where,

- V_t = minimum volume of tanks,
gallons
- V_s = volume of system, not
including tanks, gallons
- T = average operating
temperature, °F
- t_1 = lower temperature
- t_2 = higher temperature
- P_a = atmospheric pressure, psia
- P_f = fill pressure, psia
- P_o = maximum operating
pressure, psia

Metric:

$$V_t = \frac{(0.000738T - 0.3348)V_s}{(P_a/P_f) - (P_a/P_o)}$$

where,

- V_t = 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_f = fill pressure, kPa
- P_o = maximum operating
pressure, kPa

3) Hot-Water Supply Systems

If a system is equipped with a check valve or pressure-reducing valve in the cold water inlet line, consideration should be given to the installation of an airtight expansion tank or other suitable air cushion. Otherwise, due to the thermal expansion of the water, the safety relief valve may lift periodically. If an expansion tank is provided, it shall be constructed in accordance with an acceptable code of construction. Except for pre-pressurized tanks, which should be installed on the cold water side, provisions shall be made for draining the tank without emptying the system. See NBIC Part 1, 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 NBIC Part 1, 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-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/ft ² (473 W/m ²) equivalent direct radiation.		
Installed Equivalent Direct Radiation, ft ² (m ²) (Note)	No.	Tank Capacity, gallon (l)
up to 350 (33)	1	18 (68)
up to 450 (42)	1	21 (79)
up to 650 (60)	1	24 (91)
up to 900 (84)	1	30 (114)
up to 1,100 (102)	1	35 (132)
up to 1,400 (130)	1	40 (151)
up to 1,600 (149)	2	60 (227)
up to 1,800 (167)	2	60 (227)
up to 2,000 (186)	2	70 (265)
up to 2,400 (223)	2	80 (303)

Note:

For systems with more than 2,400 ft² (223 m²) of installed equivalent direct water radiation, the required capacity of the cushion tank shall be increased on the basis of 1 gallon (3.79 l) tank capacity/33 ft² (3.1 m²) of additional equivalent direct radiation.

TABLE 3.7.9.1-b**EXPANSION TANK CAPACITIES FOR FORCED HOT-WATER SYSTEMS**

Based on average operating water temperature 195°F [91 °C], fill maximum operati		
Tank Capacities, gallon (l)		
System Volume	Pressurized Diaphragm Type	Nonpressurized Type
100 (379)	9 (34)	18 (68)
200 (757)	17 (64)	30 (114)
300 (1136)	25 (95)	45 (170)
400 (1514)	33 (125)	60 (227)
500 (1893)	42 (159)	75 (284)
1,000 (3785)	83 (314)	150 (568)
2,000 (7571)	165 (625)	300 (1 136)

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 pre-pressurized types and 0.222 for non-pressurized 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 NBIC Part 1, Table 3.7.9.2. (See NBIC Part 1, Figures 3.7.5.2-a and 3.7.5.2-b for a typical acceptable installation). Except for pre-pressurized diaphragm-type tanks, which should be installed on the cold water side, provisions shall be made for draining the tank without emptying the system.

Piping

Provisions shall be made for the expansion and contraction of hot water mains connected to potable water heater(s) so that there will be no undue stress transmitted to the potable water heater(s). (See NBIC Part 1, Figures 3.7.5.2-a and 3.7.5.2-b for typical schematic arrangements of piping incorporating strain absorbing joints.)

TABLE 3.7.9.2

EXPANSION TANK CAPACITIES FOR A POTABLE WATER HEATER (NOTE)

TANK CAPACITIES, GALLON (L)

	System Volume	Pre-pressurized Diaphragm Type	Non-pressurized Type
(15)	50 (189)	1 (4)	3 (11)
	100 (379)	2 (8)	6 (23)
	200 (757)	3 (11)	12 (45)
	300 (1140)	4 (15)	18 (68)
	400 (1514)	5 (19)	24 (91)
	500 (1893)	6 (23)	30 (114)
	1,000 (3785)	12 (45)	60 (227)
	2,000 (7571)	24 (91)	120 (454)

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 potable 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 82°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.

3.8 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 (414 kPa). The travel of the pointer from 0 psig (0 kPa) to 30 psig (200 kPa) pressure shall be at least 3 in. (76 mm).

3.8.1.2 WATER-GAGE GLASSES

- a) Each steam boiler shall have one or more water-gage glasses attached to the water column or boiler by means of valved fittings not less than NPS 1/2 (DN 15), with the lower fitting provided with a drain valve of a type having an unrestricted drain opening not less than NPS 1/4 (DN 8) to facilitate cleaning. Gage glass replacement shall be possible under pressure. Water glass fittings may be attached directly to a boiler. Boilers having an internal vertical height of less than 10 in. (254 mm) should be equipped with a water level indicator of the glass bulls-eye type provided the indicator is of sufficient size to show the water at both normal operating and low-water cutoff levels.
- b) The lowest visible part of the water-gage glass shall be at least 1 in. (25 mm) above the lowest permissible water level recommended by the boiler manufacturer. With the boiler operating at this lowest permissible water level, there shall be no danger of overheating any part of the boiler.
- 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 NBIC Part 1, 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. (152 mm) below the bottom connection to the water-gage glass.

3.8.1.4 PRESSURE CONTROL

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

- a) Each individual steam boiler or each system of commonly connected steam boilers shall have a control that will cut off the fuel supply when the steam pressure reaches an operating limit, which shall be less than the maximum allowable pressure.
- b) Each individual automatically fired steam boiler shall have a safety limit control, with a manual reset, that will cut off the fuel supply to prevent steam pressure from exceeding the 15 psig (100 kPa) maximum allowable working pressure of the boiler. Each control shall be constructed to prevent a pressure setting above 15 psig (100 kPa).
- c) Shutoff valves of any type shall not be placed in the steam pressure connection between the boiler and the controls described in a) and b) above. These controls shall be protected with a siphon or equivalent means of maintaining a water seal that will prevent steam from entering the control. The connections to the boiler shall not be less than NPS 1/4 (DN 8), but where steel or wrought iron pipe or tubing is used, they shall not be less than NPS 1/2 (DN 15). The minimum size of an external siphon shall be NPS 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) In addition to the requirements in a) and b) above, a secondary low-water fuel cutoff with manual reset shall be provided on each automatically fired steam or vapor system boiler.
- d) Fuel cutoffs and water feeding devices embodying a separate chamber shall have a vertical drain pipe 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 filled.

3.8.1.6 MODULAR STEAM HEATING BOILERS

- a) Each module of a modular steam boiler shall be equipped with:
 - 1) Steam gage, see NBIC Part 1, 3.8.1.1;
 - 2) Water-gage glass, see NBIC Part 1, 3.8.1.2;
 - 3) Pressure control, see 3.8.1.4 a); and
 - 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 NBIC Part 1, 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 hot-water heating or hot-water supply boiler or each system of commonly connected boilers shall have a control that will cut off the fuel supply when the water temperature reaches an operating limit, which shall be less than the maximum allowable temperature.
- b) In addition to a) above, each individual automatically fired hot-water heating or hot-water supply boiler shall have a safety limit control with manual reset that will cut off the fuel supply to prevent the water temperature from exceeding the maximum allowable temperature at the boiler outlet.

3.8.2.4 LOW-WATER FUEL CUTOFF

- a) Each automatically fired hot-water boiler shall have an automatic low-water fuel cutoff with manual reset. The low-water fuel cutoff shall be 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) In lieu of the requirements for low-water fuel cutoffs in paragraph a), boilers requiring forced circulation to prevent overheating of the tubes, coils, or vessel, shall have an accepted flow rate-sensing device to prevent burner operation at a flow rate inadequate to protect the boiler unit against overheating at all allowable firing rates. This safety control(s) shall shut down the burner and prevent restarting until an adequate flow is restored and shall be independent of all other controls.
- 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 NBIC Part 1, 3.8.2.1;
 - 2) Thermometer, see NBIC Part 1, 3.8.2.2; and
 - 3) Temperature control, see NBIC Part 1, 3.8.2.3 a).
- b) The assembled modular hot-water heating boiler shall be equipped with:
 - 1) Temperature control, see NBIC Part 1, 3.8.2.3 b); and
 - 2) Low-water fuel cutoff, see NBIC Part 1, 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 side⁶ of the boiler. They shall be connected directly to a tapped or fl

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

⁶ 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.

valves and safety relief valves shall be installed with their spindles vertical. The opening or connection between the boiler and any safety valve or safety relief valve shall have at least the area of the valve inlet.

3.9.1.1.2 REQUIREMENTS FOR COMMON CONNECTIONS FOR TWO OR MORE VALVES

- a) When a boiler is fitted with two or more safety valves on one connection, this connection shall have a cross-sectional area not less than the combined areas of inlet connections of all the safety valves with which it connects.
- b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas. When the size of the boiler requires a safety valve or safety relief valve larger than NPS 4 (DN 100), two or more valves having the required combined capacity shall be used. When two or more valves are used on a boiler, they may be single, directly attached, or mounted on a Y-base.

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

3.9.1.6 TEMPERATURE AND PRESSURE SAFETY RELIEF VALVES

Hot-water heating or supply boilers limited to a water temperature of 210°F (99°C) may have one or more National Board capacity certified temperature and pressure safety relief valves installed. The requirements of NBIC Part 1, 3.9.1.1 through 3.9.1.5 shall be met, except as follows:

- a) A Y-type fi
- 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/hr (Watts) output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000 BTU/hr/lb (646 W/kg), or shall be determined on the basis of the pounds (kilograms) of steam generated per hour per square foot (square meter) of boiler heating surface as given in NBIC Part 1, 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 NBIC Part 1, 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.
- 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 NBIC Part 1, 3.9.2 e). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

TABLE 3.9.2

MINIMUM POUNDS OF STEAM PER HOUR PER SQUARE FOOT OF HEATING SURFACE

	Firetube Boiler	Watertube Boiler
Boiler Heat	² (kg steam/hr m ²)	
Hand-fired	5 (24)	6 (29)
Stoker-fired	7 (34)	8 (39)
Oil, gas, or pulverized coal	8 (39)	10 (49)
Waterwall Heat		
Hand-fired	8 (39)	8 (39)
Stoker-fired	10 (49)	12 (59)
Oil, gas, or pulverized coal	14 (68)	16 (78)
Copper-finned Watertubes		
Hand-fired		4 (20)
Stoker-fired		5 (24)
Oil, gas, or pulverized coal		6 (29)

(15)

Notes:

- When a boiler is fi cu. m), the minimum relieving capacity should be based on the values given for hand-fired boilers above.
- The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tubesheets, and the projected area of headers need to be considered, except that for vertical firetube steam boilers, only that portion of the tube surface up to the middle gage cock is to be computed.
- For firetube boiler units exceeding 8,000 Btu/ft.² (9,085 J/cm.²) (total fuel Btu (J) Input divided by total heating surface), the factor from the table will be increased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) above 8,000 Btu/ft.² (9,085 J/cm.²) For units less than 7,000 Btu/ft.² (7,950 J/cm.²), the factor from the table will be decreased by 1 (4.88).
- For watertube boiler units exceeding 16,000 Btu/ft.² (18,170 J/cm.²)(total fuel Btu input divided by the total heating surface) the factor from the table will be increased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) above 16,000 Btu/ft.² (18,170 J/cm.²). For units with less than 15,000 Btu/ft.² (17,034 J/cm.²), the factor in the table will be decreased by 1 (4.88) for every 1,000 Btu/ft.² (1,136 J/cm.²) below 15,000 Btu/ft.² (17,034 J/cm.²).

3.9.3 SAFETY RELIEF VALVE REQUIREMENTS FOR HOT-WATER HEATING OR HOT-WATER SUPPLY BOILERS

- a) Safety relief valves are to be manufactured in accordance with a national or international standard.
- b) Each hot-water heating or hot-water supply boiler shall have at least one National Board capacity certified safety relief valve, of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.
- c) Hot-water heating or hot-water supply boilers limited to a water temperature not in excess of 210°F (99°C) may have, in lieu of the valve(s) specified in b) above, one or more National Board capacity certified temperature and pressure safety relief valves of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.
- d) When more than one safety relief valve is used on either hot-water heating or hot-water supply boilers, the additional valves shall be National Board capacity certified and may have a set pressure within a range not to exceed 6 psig (40 kPa) above the maximum allowable working pressure of the boiler up to and including 60 psig (414 kPa), and 5% for those having a maximum allowable working pressure exceeding 60 psig (413 kPa).
- 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/hr (Watts) at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1,000 BTU/hr/lb (646 W/kg), or shall be determined on the basis of pounds (kilograms) of steam generated per hour per square foot (square meter) of boiler heating surface as given in NBIC Part 1, Table 3.9.2. For cast-iron boilers, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirements of NBIC Part 1, 3.9.3 h) shall be met.

- g) When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and shall be in accordance with NBIC Part 1, 3.9.3 h). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.
- h) Safety 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 NBIC Part 1, 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 3,500 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 NBIC Part 1, 3.2, *Definition*, 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 NBIC Part 1, 3.2, *Definition*, 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 NBIC Part 1, 3.2, *Definition*, 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 NBIC Part 1, Section 2 or Section 4.

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 NBIC Part 1, 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.

3.11 TABLES AND FIGURES

- a) NBIC Part 1, Figure 3.3.1.1-a, *Spacing and Weld Details for Supporting Lugs in Pairs on Horizontal Return Tubular Boilers*
- b) NBIC Part 1, Figure 3.3.1.1-b, *Welded Bracket Connection for Horizontal-Return Tubular Boilers*
- c) NBIC Part 1, Figure 3.7.5.1-a, *Steam Boilers in Battery – Pumped Return – Acceptable Piping Installation*
- d) NBIC Part 1, Figure 3.7.5.1-b, *Steam Boilers in Battery – Gravity Return – Acceptable Piping Installation*
- e) NBIC Part 1, Figure 3.7.5.1-c, *Hot-Water Boilers in Battery – Acceptable Piping Installation*

- f) NBIC Part 1, Figure 3.7.5.2-a, *Storage Potable Water Heaters in Battery – Acceptable Piping Installation*
- g) NBIC Part 1, Figure 3.7.5.2-b, *Flow Through Potable Water Heater Without Provision for Piping Expansion – Acceptable Piping Installation*
- h) NBIC Part 1, Table 3.7.7.1, *Size of Bottom Blowoff Piping, Valves, and Cocks*
- i) NBIC Part 1, Table 3.7.9.1-a, *Expansion Tank Capacities for Gravity Hot-Water Systems*
- j) NBIC Part 1, Table 3.7.9.1-b, *Expansion Tank Capacities for Forced Hot-Water Systems*
- k) NBIC Part 1, Table 3.7.9.2, *Expansion Tank Capacities for a Potable Water Heater*
- l) NBIC Part 1, Table 3.9.2, *Minimum Pounds of Steam Per Hour Per Square Foot of Heating Surface*

PART 1, SECTION 4 INSTALLATION — PRESSURE VESSELS

4.1 SCOPE

NBIC Part 1, Section 4 provides requirements for the installation of pressure vessels.

(15)

4.2 DEFINITIONS

See NBIC Part 1, Section 9, *Glossary*.

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.

4.3.4 BOLTING

All mechanical joints and connections shall conform to manufacturers' installation instructions and recognized standards acceptable to the jurisdiction having authority.

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 NBIC Part 1, 2.9.
- d) Pressure relief devices shall be selected (e.g., material, pressure, etc.) and installed such that their proper functioning will not be hindered by the nature of the vessel's contents.

4.5.2 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 overpressure permitted by the original code of construction and the pressure relief device cannot be isolated from the vessel, except as permitted by NBIC Part 1, 4.5.6 e) 2).
- b) Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or in the piping system connected to the vapor space.
- c) Pressure relief devices intended for use in liquid service shall be connected below the normal liquid line.

4.5.4 CAPACITY

- a) The pressure relief device(s) shall have sufficient capacity to ensure that the pressure vessel is not exposed to pressure greater than that specified in the original code of construction.
- b) If an additional hazard can be created by exposure of a pressure vessel to fire or other unexpected source of external heat, supplemental pressure relief devices shall be installed to provide any additional capacity that should be required.
- 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 nonreclosing device shall be determined in accordance with the code of construction by use of a National Board certified Combination Capacity Factor (CCF). For rupture disks, if a certified combination capacity factor is not available, the capacity of the pressure relief valve shall be multiplied by 0.9 and this value used as the capacity of the combination installation.
- f) The owner shall make information regarding the basis of pressure relief device selection, including required capacity, available to the Jurisdiction. (15)

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.

4.5.6 INSTALLATION AND DISCHARGE PIPING REQUIREMENTS

- a) The opening through all pipe and fittings between a pressure vessel and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. When a discharge pipe is used, the size shall be such that any pressure that may exist or develop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.
- b) A non-reclosing device installed between a pressure vessel and a pressure relief valve shall meet the requirements of 4.5.6 a).
- c) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device.
- d) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of NBIC Part 1, 4.5.6 a).
- e) There shall be no intervening stop valves between the vessel and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge, except under the following conditions:
 - 1) When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity; or,
 - 2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a pressure vessel and its pressure relief device should 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 pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked and sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is fi
 - 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.
 - 5) Pressure vessels designed for human occupancy (such as decompression or hyperbaric chambers) shall be provided with a quick opening stop valve between the pressure vessel and its pressure relief valve. The stop valve shall be normally sealed open with a frangible seal and be readily accessible to the pressure relief attendant.
- f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.
 - g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.
 - h) Pressure relief devices shall be installed so they are readily accessible for inspection, repair, or replacement.

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.

4.7 REQUIREMENTS FOR HOT WATER STORAGE TANKS

4.7.1 SUPPORTS

Each hot water storage tank shall be supported in accordance with NBIC Part 1, 4.3.1.

4.7.2 CLEARANCE AND ACCEPTABILITY

- a) The required nameplate (marking or stamping) should be exposed and accessible.
- b) The openings when required should be accessible to allow for entry for inspection and maintenance.
- c) Each hot water storage tank shall meet the requirements of NBIC Part 1, 4.3.2.

4.7.3 SAFETY RELIEF DEVICES

- a) Each hot water storage tank shall be equipped with an ASME/NB certified temperature and pressure relieving device set at a pressure not to exceed the maximum allowable working pressure and 210°F (99°C).
- b) The temperature and pressure relieving device shall meet the requirements of NBIC Part 1, 4.5.

4.7.4 THERMOMETERS

- a) Each hot water storage tank shall be equipped with a thermometer.
- b) Each hot water storage tank shall have a thermometer so located that it shall be easily readable at or near the outlet. The thermometer shall be so located that it shall at all times indicate the temperature of the water in the storage tank.

4.7.5 SHUT OFF VALVES

- a) Each hot water storage tank shall be equipped with stop valves in the water inlet piping and the outlet piping in order for the hot water storage tank to be removed from service without having to drain the complete system.
- b) Each hot water storage tank shall be equipped with a bottom drain valve to provide for flushing and draining of the vessel.

4.7.6 TESTING AND ACCEPTANCE

Testing and acceptance shall be in accordance with NBIC Part 1, 4.6

PART 1, SECTION 5 INSTALLATION — PIPING

5.1 SCOPE

- (15) NBIC Part 1, Section 5 provides requirements for the installation of piping.

5.2 GENERAL REQUIREMENTS

For piping, the basic considerations are: the design temperature, the pressure retained by the pipe, the fluid in the pipe, the load resulting from the thermal expansion or contraction, and impact or shock loads imparted (such as water hammer, external loads, wind loads and vibration from equipment).

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 freezing, 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

Valves are used in piping systems to stop and start the flow of fluids, to regulate the flow, to prevent the backflow, and to relieve excessive pressure buildup in piping.

Consideration should be given to the appropriate location and orientation of valves necessary for safe operation and isolation of the piping. To reduce the effects of downstream disturbances, if possible, install the valve at least the distance of eight pipe diameters downstream from the closest elbow or pump.

Verify the pressure and temperature information on the valve conforms to the piping design requirements.

Clean the piping of all debris which could cause damage to the valve seat, disc, or bearings. Failure to lift the valve properly may cause damage. Lift the valve assembly with slings, chains, or cables fastened around the valve body. Lifting devices may be fastened to rods running through bolt holes in the flanges. Do not fasten lifting devices to the actuator or the disc and never put any lifting devices through the seat opening.

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 and 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.

5.2.9 BOLTING

All mechanical joints and connections shall conform to manufacturers' installation instructions and recognized standards acceptable to the Jurisdiction having authority.

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

Pressure relief devices, 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 overpressure permitted by the original code of construction. Pressure drop to the pressure relief device under flowing conditions shall be considered when determining pressure relief device location. The pressure-relief device shall not be isolated from the piping system except as permitted by NBIC Part 1, 5.3.6 e).

5.3.4 CAPACITY

- a) The pressure relief device(s) shall have sufficient capacity to ensure that the piping is not exposed to pressures greater than that specified.
- 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.

5.3.6 INLET AND DISCHARGE PIPING REQUIREMENTS

- a) The opening through all pipes and fittings between a piping system and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the operation of the pressure relief device.
- b) A non-reclosing device installed between a piping system and a pressure relief valve shall meet the requirements of NBIC Part 1, 5.3.6 a).
- c) The opening in the pipe shall be designed to provide unobstructed flow between the pipe and its pressure relief device.
- d) When two or more required pressure relief devices are placed on the connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of NBIC Part 1, 5.3.6 a).
- e) There shall be no intervening stop valves between the piping system and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge except under the following conditions:

- 1) 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;
 - 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 fi
 - 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. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.
 - h) The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping.
 - i) Pressure relief devices shall be installed so they are accessible for inspection, repair, or replacement.

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 INSTALLATION SUPPLEMENTS

SUPPLEMENT 1

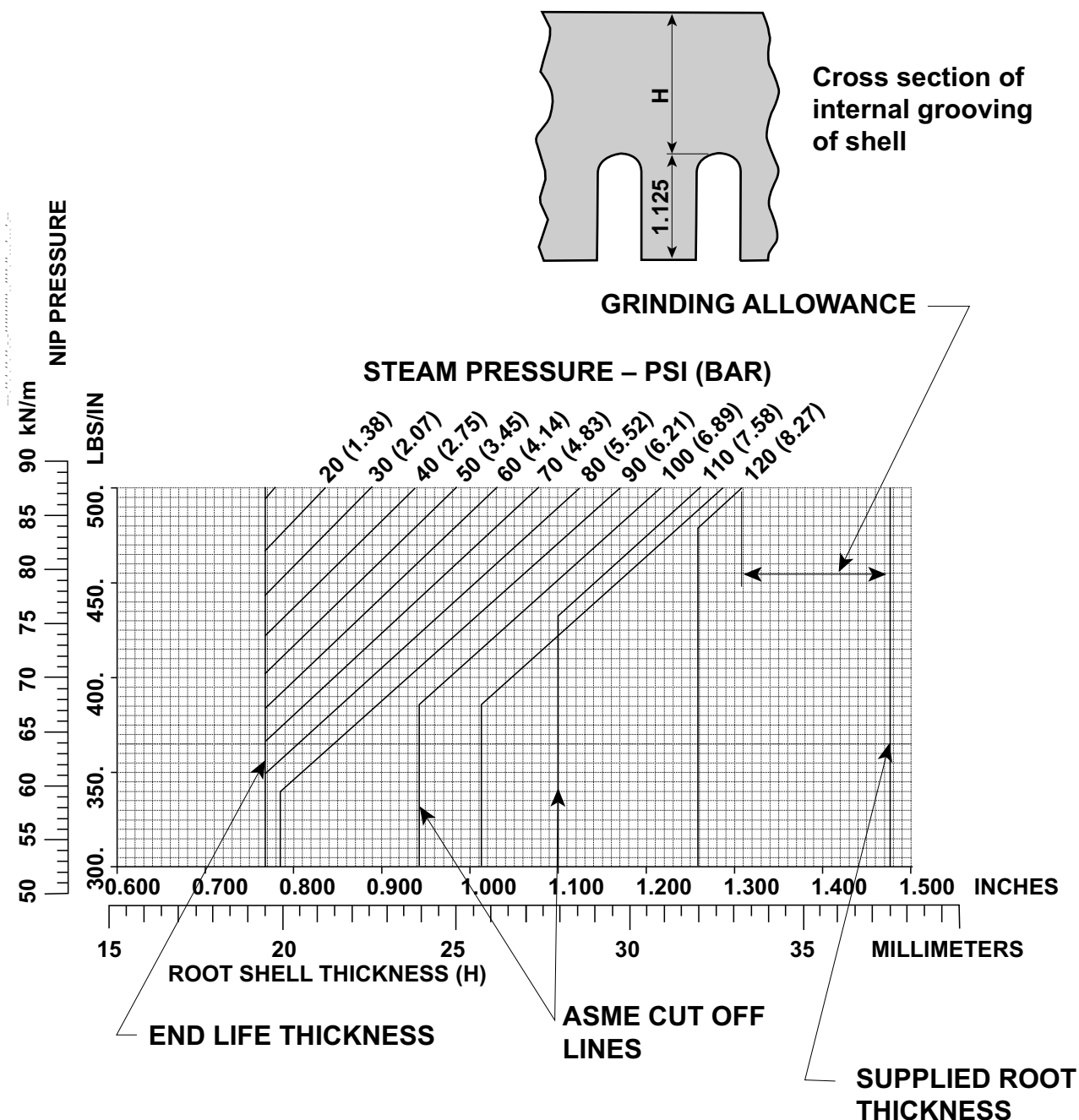
INSTALLATION OF YANKEE DRYERS (ROTATING CAST-IRON PRESSURE VESSELS) WITH FINISHED SHELL OUTER SURFACES

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, fi
- 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 8 to 23 ft. (2.4 to 7 m), widths from 8 to 28 ft. (2.4 to 8.5 m), pressurized and heated with steam up to 160 psi (1,100 kPa), and rotated at speeds up to 7,000 ft/min (2,135 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.

FIGURE S1.1
A TYPICAL MANUFACTURER'S "DE-RATE CURVE"

NOTE: There are several safe operating pressures for a given shell thickness.



S1.2 ASSESSMENT OF INSTALLATION

- e) 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.

- f) 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)⁷ due to pressing the wet web onto the dryer. Overload protection is usually provided by a control valve that limits the pneumatic or hydraulic forces on the roll loading arms such that the resultant nip load does not exceed the allowable operating nip load.
- g) 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.
- h) 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.
- i) Section VIII, Division 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.
- j) 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 NBIC Part 1, Figure S1.1).
- k) 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

⁷ Pressure roll load, line load, and nip load are terms that are used interchangeably to refer to the interaction between the pressure roll(s) and the Yankee dryer. It is called “nip” load because the pressure roll is rubber-covered and is pressed up against the Yankee with enough force to create a nip (or pinch) that forces the paper into line contact between the rolls and provides some mechanical dewatering. The paper then sticks onto the Yankee surface and follows the Yankee dryer for thermal dewatering by the steam-heated Yankee surface. This “nip load” is called a “line load” because the units are load (force) per length of line contact. The units are pounds per linear inch (PLI) and kilonewtons per meter (kN/m).

allowable working temperature (MAWT), then temperature sensors should be installed to monitor and record the Yankee dryer shell temperature during the hood testing; and

- 4) Impact load from improperly installed rolls, wires, nuts, dropped wrenches, etc., that may travel through the pressure roll nip causing external impact loads on the Yankee dryer shell.
- l) 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 NBIC Part 2 and Part 3.

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 and dictates the maximum allowable operating parameters as shell thickness is reduced (see NBIC Part 1, 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-retaining 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 by 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 surface 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 ASME Section VIII, Division 1, The maximum allowable stress for cast iron is specified in UCI-23 and UG-22 of the ASME Code.
- b) ASME 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 ASME 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 ensure 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.

S1.6 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 fl 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. 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.

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 NBIC Part 1, S2.3, 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 introducing boiler pressure into the low-pressure system:
 - 1) the failure of the pressure-reducing valve so that it remains wide open; and
 - 2) the possibility of the bypass valve being open.

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

- 1) steam fl

$$W = AKC$$

where,

A = internal area in sq. in. (sq. mm) of the inlet pipe size of the pressure-reducing valve (see NBIC Part 1, S2.5)

K = flow coefficient for the pressure-reducing valve (see NBIC Part 1, S2.4)

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

- 2) steam flow, W in lbs/hr (kg/hr) through the by-pass valve

$$W = A_1 K_1 C_1$$

where,

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

K₁ = fl

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

S2.4 STEAM FLOW WHEN FLOW COEFFICIENTS ARE NOT KNOWN

- a) It is possible that the fl 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 K₁.

The formulas in S2.3 then become:

W = 1/3 AC for the capacity through the pressure-reducing valve; and

W = 1/2 A₁ C₁ 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 NBIC Part 1, Table S2.5.

TABLE S2.3-a

CAPACITY OF SATURATED STEAM, IN IB./HR., PER SQ. IN. OF PIPE AREA

Outlet Pressure, psi	Pressure-reducing valve inlet pressure, psi												
	1,500	1,450	1,400	1,350	1,300	1,250	1,200	1,150	1,100	1,050	1,000	950	900
1,000	76,560	72,970	69,170	64,950	60,540	55,570	49,930	43,930	35,230	25,500	.....	.....	.....
950	77,430	74,180	70,760	63,100	63,100	58,770	53,920	48,610	42,380	34,890	24,910	.....	.....
900	77,750	74,810	71,720	68,340	64,870	61,040	56,820	52,260	47,050	41,050	33,490	23,960	.....
850	77,830	74,950	72,160	69,130	66,020	62,610	58,900	54,930	50,480	45,470	39,660	29,080	23,190
800		75,070	72,330	69,490	66,700	63,680	60,390	56,910	53,060	48,800	43,980	38,340	31,610
750				69,610	66,880	64,270	61,260	58,200	54,840	51,170	47,080	42,420	37,110
700					66,900	64,270	61,520	58,820	55,870	52,670	49,170	45,230	40,860
650							61,550	58,860	56,260	53,480	50,440	47,070	43,400
600								58,980	56,270	53,660	51,020	48,470	45,010
550										53,810	51,040	48,470	45,800
500													45,850
450													45,870
400													
350													
300													
250													
200													
175													
150													
110													
100													
85													
75													
60													
50													
40													
30													
25													
15													
10													
5													
Where capacities are not shown for inlet and outlet conditio													

TABLE S2.3M-a

CAPACITY OF SATURATED STEAM, IN KG/HR., PER SQ. MM OF PIPE AREA

Outlet Pressure, psi	Pressure-reducing valve inlet pressure, psi												
	850	800	750	700	650	600	550	500	450	400	350	300	250
1,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
950	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
900	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
800	22,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
750	30,600	21,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
700	35,730	29,420	21,020	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
650	39,200	34,250	28,260	20,190	.....	.....	.....	.....	.....	.....	.....	.....	.....
600	41,500	37,470	32,800	27,090	19,480	.....	.....	.....	.....	.....	.....	.....	.....
550	42,480	39,850	35,730	31,310	25,940	18,620	.....	.....	.....	.....	.....	.....	.....
500	43,330	40,530	37,610	33,880	29,760	24,630	17,720	.....	.....	.....	.....	.....	.....
450	43,330	40,730	38,150	35,260	31,980	28,080	23,290	16,680	.....	.....	.....	.....	.....
400	.....	40,760	38,220	35,680	33,050	29,980	26,380	21,870	15,760	.....	.....	.....	.....
350	.....	.....	.....	.....	33,120	30,690	27,910	24,570	20,460	14,790	.....	.....	.....
300	.....	.....	.....	.....	33,240	.....	28,140	25,610	22,620	18,860	13,630	.....	.....
250	.....	.....	.....	.....	.....	.....	28,150	25,650	23,200	21,000	17,100	10,800	.....
200	.....	.....	.....	.....	.....	.....	.....	.....	.....	21,350	18,250	15,350	10,900
175	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,250	16,000	12,600
150	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,250	16,200	13,400
110	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,780	.....	13,600
100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,600
85	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,600
75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,600
60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,600
50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,630
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Where capacities are not shown for inlet and outlet conditio

Where capacities are not shown for inlet and outlet conditio

TABLE S2.3-b

CAPACITY OF SATURATED STEAM, IN IB./HR., PER SQ. IN. OF PIPE AREA

Outlet Pressure, MPa	Pressure-reducing valve inlet pressure, MPa															
	10.25	10.00	9.75	9.5	9.25	9.00	8.75	8.5	8.25	8.00	7.75	7.50	7.25	7.00	6.75	6.50
6.75	53.44	51.68	49.82	47.85	45.77	43.63	41.28	38.73	36.01	33.09	29.47	25.37	20.89	.....	.....	6.25
6.50	53.87	52.23	50.52	48.69	46.79	44.83	42.69	40.40	37.95	35.30	32.33	29.02	25.31	20.46	.....	6.50
6.25	54.07	52.55	50.96	49.27	47.51	45.71	43.75	41.67	39.46	37.08	34.46	31.59	28.43	24.45	19.36	6.75
6.00	54.15	52.67	51.19	49.62	47.99	46.33	44.53	42.63	40.62	38.74	36.12	33.59	30.83	27.53	23.13	7.00
5.75	54.19	52.74	51.32	49.85	48.33	45.80	45.14	43.40	41.56	39.62	37.51	35.25	32.82	30.04	26.20	7.25
5.50	54.20	52.78	49.97	49.610	48.53	47.11	45.60	44.00	42.32	40.55	38.56	36.63	34.48	32.05	29.37	7.50
5.25	.....	.....	.....	50.00	48.60	47.20	45.82	44.35	42.78	41.17	39.44	37.62	35.68	33.52	31.16	7.75
5.00	.....	.....	.....	50.01	48.62	47.23	45.89	44.49	43.02	41.55	39.98	38.33	36.57	34.64	32.56	8.00
4.75	.....	.....	.....	.....	.....	47.24	.....	44.52	43.13	41.75	40.31	38.81	37.22	35.50	33.64	8.25
4.50	.....	.....	.....	.....	.....	.....	.....	44.53	43.14	41.77	40.43	39.08	37.63	36.07	34.41	8.5
4.25	.....	.....	.....	.....	.....	.....	.....	.....	43.15	41.82	40.46	39.10	37.74	36.33	34.90	8.75
4.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	41.84	40.48	39.12	37.82	36.45	35.12	9.00
3.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	39.14	37.88	36.48	35.13	9.25
3.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.5
3.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.75
3.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.00

Where capacities are not shown for inlet and outlet conditio

TABLE S2.3M-b

CAPACITY OF SATURATED STEAM, IN KG/HR. PER MM² OF PIPE AREA

Outlet Pressure, MPa	Pressure-reducing valve inlet pressure, MPa															
	6.00	5.75	5.50	5.25	5.00	4.75	4.50	4.25	4.00	3.75	3.50	3.25	3.00	2.75	2.50	2.25
5.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5.50	18.66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5.25	22.24	17.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5.00	24.96	21.60	17.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.75	27.06	24.31	21.18	17.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.50	28.64	26.30	23.70	20.58	16.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.25	29.71	27.67	25.44	22.83	19.75	15.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4.00	30.49	28.74	26.86	24.59	22.06	19.18	15.75	.....	.....	.....	.....	.....	.....	.....	.....	.....
3.75	30.99	29.49	27.95	25.92	23.77	21.42	18.76	15.23	.....	.....	.....	.....	.....	.....	.....	.....
3.50	31.15	29.77	28.32	26.74	24.90	22.87	20.68	17.93	14.24	.....	.....	.....	.....	.....	.....	.....
3.25	31.18	29.86	28.49	27.10	25.53	23.81	21.95	19.73	17.12	13.72	.....	.....	.....	.....	.....	.....
3.00	31.19	29.88	28.56	27.25	25.86	24.40	22.82	20.98	18.90	16.51	13.46	.....	.....	.....	.....	.....
2.75	.....	.....	28.58	27.28	25.98	24.68	23.34	21.79	20.09	18.19	15.90	12.98	.....	.....	.....	.....
2.50	.....	.....	.....	.....	.....	.....	23.37	22.05	20.62	19.04	17.19	14.94	11.83	.....	.....	.....
2.25	.....	.....	.....	.....	.....	.....	23.42	22.15	20.83	19.45	17.94	16.18	14.11	11.59	.....	.....
2.00	.....	.....	.....	.....	.....	.....	23.46	22.17	20.87	19.57	18.28	16.85	15.26	13.48	10.95	.....
1.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	19.58	18.30	17.03	15.79	14.59	12.54	9.55
1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17.05	15.90	14.84	12.12	10.46
1.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.92	14.95	12.98	11.75
1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.96	13.44	12.19
0.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.97	13.60	12.30
0.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.66	12.35
0.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Where capacities are not shown for inlet and outlet condition

TABLE S2.3-c

CAPACITY OF SATURATED STEAM. IN./HR. PER IN² OF THE PIPE AREA

Outlet pres., psi	Pressure-Reducing Valve Inlet Pressure											
	200	175	150	125	100	85	75	60	50	40	30	25
1,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
950	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
900	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
650	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
600	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
450	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
350	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
175	7,250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
150	9,540	6,750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
125	10,800	8,780	6,220	.....	.....	.....	.....	.....	.....	.....	.....	.....
110	11,000	9,460	7,420	4,550	.....	.....	.....	.....	.....	.....	.....	.....
100	11,000	9,760	7,970	5,630	.....	.....	.....	.....	.....	.....	.....	.....
85	11,000	.....	8,480	6,640	4,070	.....	.....	.....	.....	.....	.....	.....
75	11,000	.....	.....	7,050	4,980	3,150	.....	.....	.....	.....	.....	.....
60	11,000	.....	.....	7,200	5,750	4,540	3,520	.....	.....	.....	.....	.....
50	11,000	.....	.....	.....	5,920	5,000	4,230	2,680	.....	.....	.....	.....
40	11,000	.....	.....	.....	.....	5,140	4,630	3,480	2,470	.....	.....	.....
30	11,050	.....	.....	.....	.....	.....	.....	3,860	3,140	2,210	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	.....	3,340	2,580	1,485	.....
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,830	2,320	1,800
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,060
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Where capacities are not shown for inlet and outlet conditio												

TABLE S2.3M-c

CAPACITY OF SATURATED STEAM, IN KG/HR., PER MM² OF PIPE AREA

Outlet Pressure, kPa	Pressure-reducing valve inlet pressure, kPa										
	1,500.00	1,250.00	1,000.00	900.00	800.00	700.00	600.00	500.00	400.00	300.00	200.00
1,250.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1,000.00	7.78	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
900.00	8.15	6.25	.....	.....	.....	.....	.....	.....	.....	.....	.....
800.00	8.34	6.77	4.29	.....	.....	.....	.....	.....	.....	.....	.....
700.00	8.38	7.06	5.21	4.22	.....	.....	.....	.....	.....	.....	.....
600.00	8.38	7.08	5.65	4.87	3.82	.....	.....	.....	.....	.....	.....
500.00	8.38	.....	5.77	5.19	4.48	3.68	.....	.....	.....	.....	.....
400.00	8.38	.....	5.78	5.26	4.71	4.13	3.37	.....	.....	.....	.....
300.00	8.38	.....	.....	.....	4.74	4.22	3.66	3.01	.....	.....	.....
200.00	8.41	.....	.....	.....	.....	.....	3.69	3.71	2.62	1.83	.....
100.00	.....	.....	.....	.....	.....	.....	.....	.....	2.64	2.12	1.56
80.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.58
60.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.60
40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Where capacities are not shown for inlet and outlet conditio											

Where capacities are not shown for inlet and outlet conditio

TABLE S2.5
PIPE DATA

(15)

Nominal Pipe Size, Unitless (US Customary)	Nominal Pipe Size, Unitless (SI Metric)	Average Outside Diameter (D)	Average Outside Diameter (D)	Nominal Wall Thickness Standard Weight Pipe (t)	Nominal Wall Thickness Standard Weight Pipe (t)	Approximate Internal Area (Note 1)	Approximate Internal Area (Note 1)
ASME B36.10M							
Unitless	Unitless	in.	mm	in.	mm	in ²	mm ²
NPS 3/8	DN 10	0.675	17.1	0.091	2.31	0.191	122
NPS 1/2	DN 15	0.840	21.3	0.109	2.77	0.304	195
NPS 3/4	DN 20	1.050	26.7	0.113	2.87	0.533	345
NPS 1	DN 25	1.315	33.4	0.133	3.38	0.864	557
NPS 1-1/4	DN 32	1.660	42.2	0.140	3.56	1.496	967
NPS 1-1/2	DN 40	1.900	48.3	0.145	3.68	2.036	1,316
NPS 2	DN 50	2.375	60.3	0.154	3.91	3.356	2,163
NPS 2-1/2	DN 65	2.875	73.0	0.203	5.16	4.788	3,086
NPS 3	DN 80	3.500	88.9	0.216	5.49	7.393	4,769
NPS 3-1/2	DN 90	4.000	101.6	0.226	5.74	9.887	6,379
NPS 4	DN 100	4.500	114.3	0.237	6.02	12.73	8,213
NPS 5	DN 125	5.563	141.3	0.258	6.55	20.00	12,908
NPS 6	DN 150	6.625	168.3	0.280	7.11	28.89	18,646
NPS 8	DN 200	8.625	219.1	0.332	8.18	49.78	32,283
NPS 10	DN 250	10.750	273.0	0.365	9.27	78.85	50,854
NPS 12	DN 300	12.750	323.8	0.375	9.53	113.1	72,937

Note 1:

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.

Where: D = outside diameter of the pipe and t = nominal wall of the pipe

(15)

$$Are = \frac{\pi(D - 2t)^2}{4}$$

SUPPLEMENT 3

INSTALLATION OF LIQUID CARBON DIOXIDE STORAGE VESSELS

S3.1 SCOPE

This supplement provides requirements for the installation of Liquid Carbon Dioxide Storage Vessels (LCDSVs), fill boxes, fill systems, swimming pool PH control systems, and other fill in place systems storing 1,000 lbs (454 kg) or less of liquid CO₂.

S3.2 GENERAL REQUIREMENTS STORAGE TANK LOCATION

LCDSVs should be installed in an unenclosed area whenever possible. LCDSVs that do not meet all criteria for an unenclosed area shall be considered an enclosed area installation. An unenclosed area:

- c) Shall be outdoors;
- d) Shall be above grade; and
- e) Shall not obstruct more than three sides of the perimeter with supports and walls. At least 25% of the perimeter area as calculated from the maximum height of the storage container shall be open to atmosphere and openings shall be in direct conveyance with ground level.

S3.2.1 GENERAL REQUIREMENTS (ENCLOSED AND UNENCLOSED AREAS)

- a) LCDSVs shall not be located within 10 feet (3,050 mm) of elevators, unprotected platform ledges, or other areas where falling would result in dropping distances exceeding half the container height.
- b) LCDSVs shall be installed with sufficient clearance for filling, operation, maintenance, inspection, and replacement.
- c) Orientation of nozzles and attachments shall be such that sufficient clearance between the nozzles, attachments, and the surrounding structures is maintained during the installation, the attachment of associated piping, and operation.
- d) LCDSVs shall not be installed on roofs.
- e) LCDSVs shall be safely supported. Vessel supports, foundations, and settings shall be in accordance with jurisdictional requirements, manufacturer recommendations and/or other industry standards as applicable. The weight of the vessel when full of liquid carbon dioxide 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. Vessel foundations or floors in multistory buildings must be capable of supporting the full system weight and in accordance with building codes.
- f) LCDSVs shall not be installed within 36 in. (915 mm) of electrical panels.
- g) LCDSVs installed outdoors in areas in the vicinity of vehicular traffic shall be guarded to prevent accidental impact by vehicles. The guards or bollards shall be installed in accordance with local building codes or to a national recognized standard when no local building code exists.
- h) LCDSVs shall be equipped with isolation valves in accordance with paragraph NBIC Part 1, S3.6.

S3.2.2 UNENCLOSED AREA LCDSV INSTALLATIONS

If LCDSVs are installed outdoors and exposed to the elements, appropriate additional protection may be provided as necessary based on the general weather conditions and temperatures that the tank may be exposed to. Some possible issues include:

- a) Exposure to high solar heating loads will increase the net evaporation rate and will decrease hold times in low CO₂ usage applications. The vessel may be covered or shade provided to help reduce the solar load and increase the time needed to reach the relief valve setting in low use applications.
- b) If supply line is not UV resistant then the supply line should be protected via conduit or appropriate covering.

S3.2.3 ENCLOSED AREA LCDSV INSTALLATIONS

- a) Permanent LCDSV installations with remote fill connections:
 - 1) Shall be equipped with a gas detection system installed in accordance with NBIC Part 1, S3.4;
 - 2) Shall have signage posted in accordance with NBIC Part 1, S3.5; and
 - 3) Shall be equipped with fill boxes; fill lines and safety relief/vent valve circuits installed in accordance with NBIC Part 1, S3.6.
- b) Portable LCDSV installations with no permanent remote fill connection: **Warning: LCDSVs shall not be filled indoors or in enclosed areas under any circumstances. Tanks must always be moved to the outside to an unenclosed, free airflow**
 - 1) Shall be equipped with a gas detection system installed in accordance with NBIC Part 1, S3.4;
 - 2) Shall have signage posted in accordance with NBIC Part 1, S3.5;
 - 3) Shall have a safety relief/vent valve circuit connected at all times except when the tank is being removed for filling. Connects may be fitted with quick disconnect fittings meeting the requirements of NBIC Part 1, S3.6; and
 - 4) Shall be provided with a pathway that provides a smooth rolling surface to the outdoor, unenclosed fi

S3.3 FILLBOX LOCATION / SAFETY RELIEF/VENT VALVE CIRCUIT TERMINATION

Fill boxes and/or vent valve terminations shall be installed above grade, outdoors in an unenclosed, free airflow area. The fill connection shall be located so not to impede means of egress or the operation of sidewalk cellar entrance doors, including during the delivery process and shall be:

- 1) At least 36 in. (915 mm) from any door or operable windows;
- 2) At least 36 in. (915 mm) above grade;
- 3) Shall not be located within 10 ft. (31 m) from side to side at the same level or below, from any air intakes; and
- 4) Shall not be located within 10 ft. (31 m) from stairwells that go below grade.

S3.4 GAS DETECTION SYSTEMS

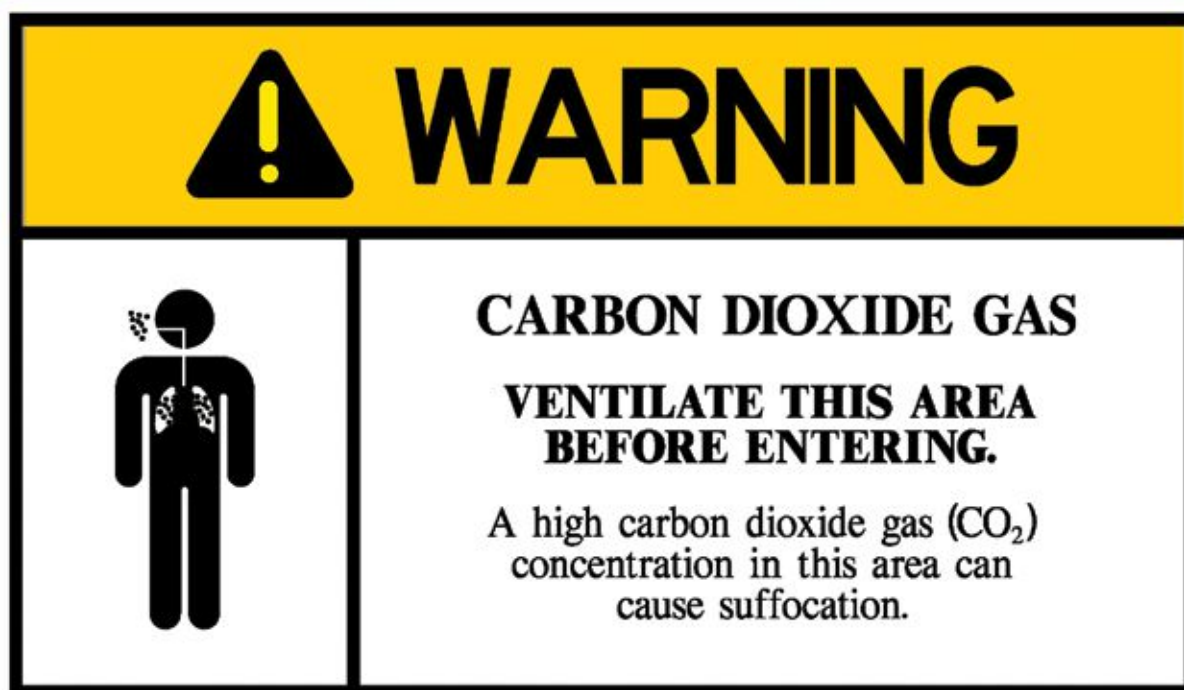
- (15) Rooms or areas where carbon dioxide storage vessel(s) are located indoors or in enclosed or below grade outdoor locations shall be provided with a gas detection and alarm system for general area monitoring that

is capable of detecting and notifying building occupants of a CO₂ gas release. Alarms will be designed to activate a low level pre-alarm at 5,000 ppm concentration of CO₂ and a full high alarm at 30,000 ppm concentration of CO₂ which is the NIOSH & ACGIH 15 minute Short Term Exposure Limit for CO₂. These systems are not designed for employee personal exposure monitoring. Gas detection systems shall be installed and tested in accordance with manufacturer's installation instructions and the following requirements:

- a) Activation of the gas detection system shall activate an audible alarm within the room or area in which the carbon dioxide storage vessel is located.
- b) Audible alarms shall also be placed at the entrance(s) to the room or area where the carbon dioxide storage vessel and/or fill box is located to notify anyone who might try to enter the area of a potential problem.

S3.5 SIGNAGE

FIGURE S3.5
CO₂ WARNING SIGN



Warning signs shall be posted at the entrance to the building, room, enclosure, or enclosed area where the container is located. The warning sign shall be at least 8 in. (200 mm) wide and 6 in. (150 mm) high. The wording shall be concise and easy to read and the upper portion of the sign must be orange as shown in figure NBIC Part 1, S3.5. The size of the lettering must be as large as possible for the intended viewing distance and in accordance with jurisdictional requirements. When no jurisdictional requirements exist, the minimum letter height shall be in accordance with NEMA American National Standard for Environmental and Facility Safety Signs (ANSI Z535.2). The warning sign shall be as shown in Figure S3.5. (15)

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

- a) Carbon Dioxide Monitors for general area monitoring (not employee personal exposure monitoring) are provided in this area. These monitors are set to alarm at 5,000 ppm for the low level alarm and at 30,000 ppm for high level alarm.
- b) Low Level Alarm (5,000 ppm) – Provide appropriate cross ventilation to the area. Personnel may enter area for short periods of time (not to exceed 15 minutes at a time) in order to identify and repair potential leaks.
- c) High Level Alarm (30,000 ppm) – Personnel should evacuate the area and nobody should enter the affected area without proper self-contained breathing apparatus until the area is adequately ventilated and the concentration of CO₂ is reduced below the high alarm limit.

S3.6 VALVES, PIPING, TUBING, AND FITTINGS

- a) **Materials** – Materials selected for valves, piping, tubing, hoses, and fittings shall meet following requirements:
 - 1) Components must be compatible for use with CO₂ in the phase (gas, or liquid in the applicable circuit) it encounters in the system.
 - 2) Components shall be rated for the operational temperatures and pressures encountered in the applicable circuit of the system.
 - 3) Shall be stainless steel, copper, brass, or plastic/polymer materials rated for CO₂.
 - 4) Only fittings and connections recommended by the manufacturer shall be used for all hoses, tubes, and piping.
 - 5) All valves and fittings used on the LCDSV shall be rated for the maximum allowable working pressure stamped on the tank.
 - 6) All piping, hoses, and tubing used in the LCDSV system shall be rated for the working pressure of the applicable circuit in the system and have a burst pressure rating of at least four times the maximum allowable working pressure of the piping, hose, or tubing.
- b) **Relief Valves** – Each LCDSV shall have at least one ASME/NB stamped & certified pressure setting at or below the MAWP of the tank. The relief valve shall be suitable for the temperatures and flows experienced during relief valve operation. The minimum relief valve capacity shall be designated by the manufacturer. Additional relief valves that do not require ASME stamps may be added per recommendations in Compressed Gas Association pamphlet, CGA S-1.3 Pressure Relief Device Standards Part 3, Stationary Storage Containers for Compressed Gases. Discharge lines from the relief valves shall be sized in accordance with tables NBIC Part 1, S3.6-a and S3.6-b.

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

Caution: Companies and/or individuals filling or refilling LCDSVs shall be responsible for utilizing fill equipment that is acceptable to the manufacturer to prevent over pressurization of the vessel.

- c) **Isolation Valves** – Each LCDSV shall have an isolation valve installed on the fill line and tank discharge, or gas supply line in accordance with the following requirements:
 - 1) Isolation valves shall be located on the tank or at an accessible point as near to the storage tank as possible.
 - 2) All valves shall be designed or marked to indicate clearly whether they are open or closed.
 - 3) All valves shall be capable of being locked or tagged in the closed position for servicing.

4) Gas Supply and Liquid CO₂ Fill Valves shall be clearly marked for easy identification.

- d) **Safety Relief/Vent Lines** – Safety relief/vent lines shall be as short and straight as possible with a continuous routing to an unenclosed area outside the building and installed in accordance with the manufacturer's instructions. The vent line(s) shall be a continuous run from the vessel pressure relief device vent piping to the outside vent line discharge fitting. Mechanical joints in metallic piping and tubing shall be visible and inspectable. Any splices in plastic or polymeric tubing shall be done within three feet of the vessel and must be visible and inspectable. These lines shall be free of physical defects such as cracking or kinking and all connections shall be securely fastened to the LCDSV and the fill box. All safety relief/vent lines shall be protected to prevent penetration by nail, projectile, or other foreign object when routed through a wall, floor, or ceiling. The minimum size and length of the lines shall be in accordance with NBIC Part 1, Tables S3.6-a and S3.6-b. Fittings or other connections may result in a localized reduction in diameter have been factored into the lengths given by the NBIC Part 1, Tables S3.6-a and S3.6-b. (15)

Note: Due to the design of the LCDSV, the discharge line may be smaller in diameter than the relief valve outlet size but shall not be smaller than that shown in NBIC Part 1, Tables S3.6-a and S3.6-b.

S3.6.1 SYSTEM DESCRIPTION

The Liquid Carbon Dioxide Beverage systems include the Liquid Carbon Dioxide Storage Vessel or LCDSV (tank) and associated sub-system circuits - Liquid CO₂ fill circuit, and associated sub-system circuits and pressure relief / vent line circuit. The LCDSVs are vacuum insulated pressure vessels, constructed of stainless steel, with Super Insulation wrapping between the inner pressure vessel and the outer vacuum jacket. (See Figure S3.6.1-a) These pressure vessels are typically designed for a maximum allowable working pressure (MAWP) of either 300 psig (2,068 kPa) or 283 psig (1,951 kPa). The LCDSV come equipped with an ASME/NB certified "UV" Primary Relief Valve (PRV) set at or below the MAWP of the vessel. Additionally, as recommended by the Compressed Gas Association pamphlet CGA S-1.3, (PRESSURE RELIEF DEVICE STANDARDS PART 3 - STATIONARY STORAGE CONTAINERS FOR COMPRESSED GASSES) a secondary relief valve may be installed. This secondary relief valve is beyond the scope of ASME Section VIII, Division 1 and is not required to be ASME/NB stamped and certified. This additional PRV is typically rated no higher than 1.5 times the vessel MAWP.

Operating conditions of the system, components, and inner pressure vessel can vary causing temperatures and pressures to range from 90 psig (-56°F) to 300 psig (+2°F) {620 kPa (-49°C) to 2,068 kPa (-16°C)}. Below about 60 psig (413 kPa) in the tank, liquid CO₂ begins changing to solid phase (dry ice). If the tank becomes completely depressurized to 0 psig, temperatures inside the tank could reach -109°F (-78°C), (solid dry ice). When liquid CO₂ turns to solid dry ice in a completely depressurized tank, all CO₂ gas flow in the system ceases and the tank becomes nonfunctional.

See the attached CO₂ Phase Diagram NBIC Part 1; Figure S3.6.1-b, showing the typical operating range of these systems. Components external to the LCDSV inner tank pressure vessel may encounter pressures and temperatures between 90 psig, and -56°F to 300 psig and +2°F, respectively {between 620 kPa, and -49°C to 2,068 kPa and -16°C, respectively}. Typical operating pressures and temperatures vary in each of the associated sub-system circuits. (See NBIC Part 1, Table S3.6.1-b)

TABLE S3.6.1

TYPICAL OPERATING PRESSURES & TEMPERATURES OF LCDSV SYSTEMS

System Component	Operati	
Storage Vessel (tank internal conditions)	90 – 300 psig	-56°F to +2°F
Liquid CO ₂ Fill Line	150 – 300 psig	-34°F to +2°F
Pressure Relief Gas Vent Line	0 – 120 psig	Ambient to -50°F

FIGURE S3.6.1-a

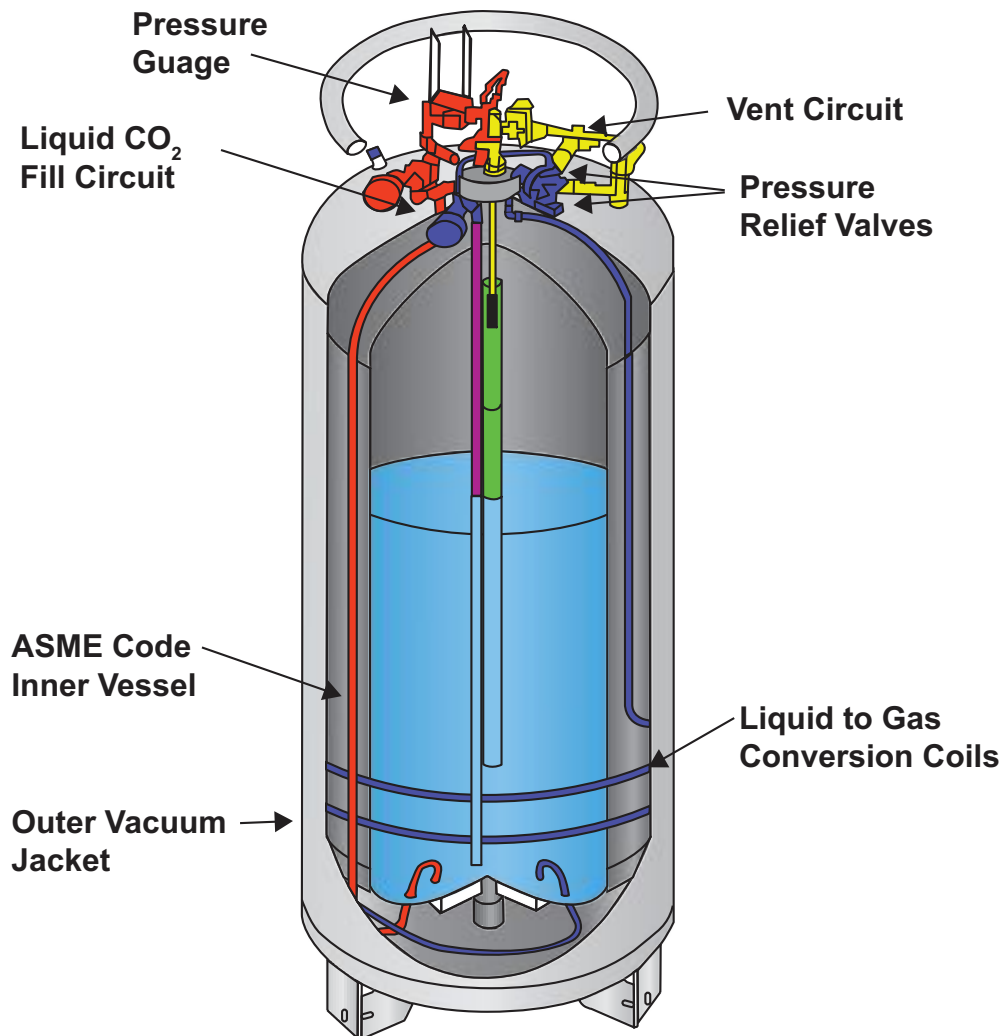


FIGURE 3.6.1-b
CO₂ PHASE DIAGRAM

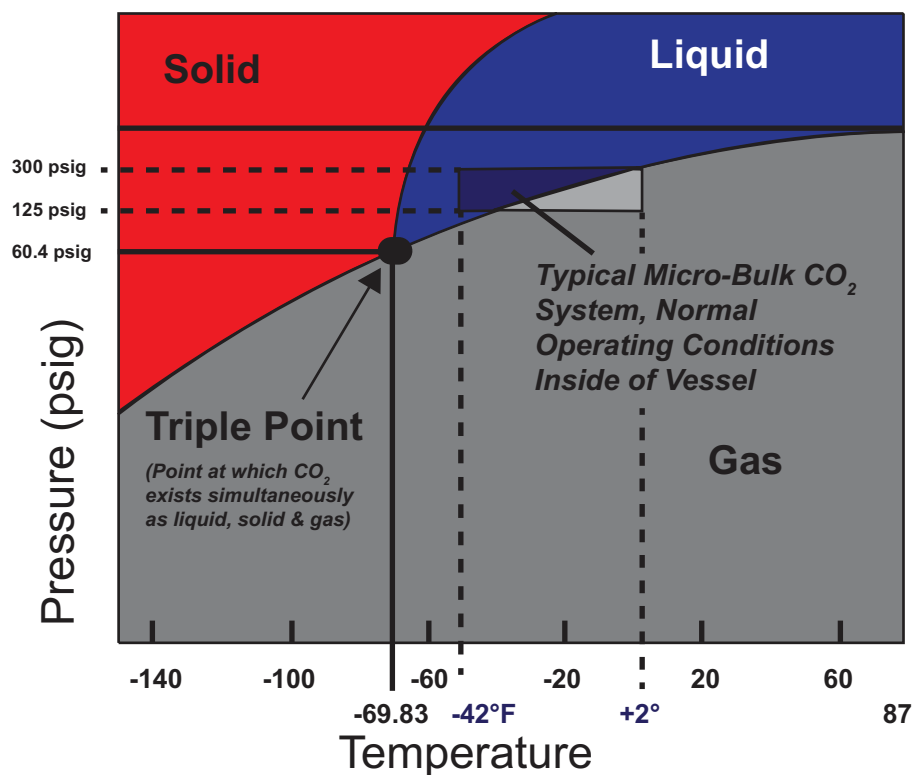


TABLE S3.6-a
MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (METALLIC)

Tank Size (Pounds)	Fire Flow Rate Requirements (Pounds per Minute)	Maximum length of 3/8 inch ID Metallic Tube Allowed	Maximum length of 1/2 inch ID Metallic Tube Allowed
Less than 500	2.60 maximum	80 feet	100 feet
500 - 750	3.85 maximum	55 feet	100 feet
Over 750 – 1,000	5.51 maximum	18 feet	100 feet

TABLE S3.6-b**MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (PLASTIC/POLYMER)**

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

TABLE S3.6M-a**METRIC MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (METALLIC)**

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

TABLE S3.6M-b**METRIC MINIMUM LCDSV SYSTEM RELIEF / VENT LINE REQUIREMENTS (PLASTIC/POLYMER)**

Tank Size (kg)	Fire Flow Rate Requirements (kg per Minute)	Maximum length of 10 mm ID plastic/polymer Tube Allowed	Maximum length of 13 mm ID plastic/polymer Tube Allowed
Less than 227	1.80 maximum	30.5 m	30.5 m
227 - 340	1.75 maximum	30.5 m	30.5 m
Over 340 - 454	2.50 maximum	N/A see 13 mm	30.5 m

Note:

Due to the design of the LCDSV, the discharge line may be smaller in diameter than the relief valve outlet size but shall not be smaller than that shown in tables NBIC Part 1, S3.6-a and -b.

SUPPLEMENT 4**INSTALLATION OF BIOMASS (WOOD/SOLID FUEL) FIRED BOILERS****S4.1 SCOPE**

This supplement provides requirements for the installation of biomass (wood/solid fuel) fired boilers as defined. (15)

S4.2 PURPOSE

- a) The purpose of these rules is to establish minimum requirements for the installation of biomass boilers. (15)
- b) It should be recognized that many of the requirements included in these rules must be considered in the design of the boiler 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 the behalf of the owner-user.
- c) This supplement provides requirements for the installation and control of boilers which use biomass as a major fuel component and will address the differences that occur when solid fuels, such as biomass, are being used. Thus the primary thrust of this section will be directed toward the control of the fuel handling and distribution systems.
- d) Fuels will vary widely depending upon source, moisture content, particle size, and distribution; however, once the fuel has been established, the owner-user should adhere to the original specification as closely as possible in order to minimize handling, combustion, and emissions problems.
- e) Additionally, the emissions control equipment is designed around the initial fuel specification. Any changes in fuel fired will impact on the performance of the various elements of the emissions control system.
- f) Biomass boilers and boiler rooms require additional considerations than traditionally fueled boilers that may include:
- 1) Transportation of the fuel from a storage facility to a metering device within the equipment room;
 - 2) Transportation of the metered fuel to the boiler for distribution to a combustion system whether it be a grate upon which the combustion takes place, a bubbling fluidized bed, circulating fluidized bed or suspension burner;
 - 3) In grate based combustion systems combustion air is typically divided into an underfire air system and an overfire air system, each of which must be closely controlled in order to produce clean, efficient combustion;
 - 4) Induced draft fans to overcome the pressure drop of the emissions control equipment;
 - 5) A fly ash or carbons recycle system, to return unburned carbon to the combustion zone; and
 - 6) An ash removal system, to move ash from the boiler and emissions control equipment to suitable cooling and storage area.

S4.3 DETERMINATION OF ALLOWABLE OPERATING PARAMETERS

The allowable operating parameters of the combustion side shall be installed in accordance with jurisdictional and environments requirements, manufacturer's recommendations, and/or industrial standards, as applicable. (15)

S4.4 GENERAL REQUIREMENTS

- (15) a) Power boilers utilizing biomass as the primary fuel source shall meet the requirements of NBIC Part 1, Section 2 and this supplement.
- b) Steam heating, hot water heating, and hot water supply boilers utilizing biomass as the primary fuel source shall meet the requirements of NBIC Part 1, Section 3 and this supplement.

S4.5 FUEL SYSTEM REQUIREMENTS AND CONTROLS

- (15) a) Fuel Transport Systems shall address preserving fuel particle size distribution, fire prevention, and the suppression of fires or explosions. In a single installation, various types of fuel transportation systems may co-exist. The most common systems are:
- 1) Conveyor systems – In these systems fuel is dropped onto a moving belt, bucket elevator, drag link conveyor, or a screw or auger mechanism. Speed of the conveyor may be varied to meet fuel demand.
 - 2) Lean phase pneumatic systems – In these systems fuel is dropped into a moving airstream, mixes with the air, and travels through a pipe at a velocity of approximately 5,000 ft/min (1,525 m/min). Air pressures are in the region of 25 inches (635 mm) water column.
 - 3) Dense phase pneumatic systems – An intermittent or batch feed system, in which fuel is dropped through a valve (dome valve) into a pressure vessel. When the vessel is filled, the valve is closed, air at a pressure between 30 to 100 psig (200 to 700 kPa) is admitted and the fuel leaves the vessel in the form of a “slug”. The sequence then repeats. (Note that these systems are also used for ash handling.)
- b) Fuel Transport Solid Fuel Metering Systems vary depending upon the fuel used and the particle size distribution. These metering systems include but are not limited to:
- 1) Variable speed augers
 - a. Variable speed, helically flighted, augers can be located in the bottom of a fuel metering bin. Alternatively, they could be a part of a retort type stoker. The auger dimensions, flighting, and speed range are selected on the basis of fuel being burned, its size range, heating value, and required boiler turndown range. The metered fuel typically is then dropped into the throat of a venturi (or in some cases a plain pipe) through which the fuel transport air flows to carry the fuel into the boiler combustion zone, for distribution on a grate, upon which the burning of the fuel takes place.
 - 2) Variable speed air-lock valves
 - a. This valve is basically a rotating slotted cylinder, operating within an outer cylinder, suitably sealed to prevent leakage. Rotational speed and slot dimensions can be varied to accommodate changes in fuel flow rate. The fuel passing through the valve, typically, is deposited onto a moving grate type stoker.
 - 3) Variable stroke rams
 - a. This is another device that can be located on the bottom of a metering bin, is typically used on smaller units, and is essentially a batch feed mechanism. The stroke of the ram is adjusted to set fuel fl

S4.6 COMBUSTION REQUIREMENTS

a) Overfire Air/Underfir

When solid fuels are burned on a grate, rather than in fluidized bed units or in suspension, it is normal practice to introduce some of the combustion air under the grate, or bed, and the remainder over the bed. In many cases fuel transport air becomes a part of the over-the-bed combustion air. The proportioning of the overfire to underfire airflow rates is dependent upon several factors, such as fuel particle size, fuel density, burn rate and volatiles. In general the objective is to get as complete a burn on the grate as possible, without creating large quantities of particulate emissions, and then using the overfire air to complete burning of the volatile and small particulate matter, leaving the fuel bed.

(15)

b) Loss of combustion air from either the underfire or overfire source shall cause shutoff of the fuel supply and a lockout condition. The control system shall be capable of maintaining the correct relationship between underfire air and overfire air, over the complete firing range of the boiler, while promoting complete burning with minimum particulate emissions.

c) Programming Controls

Programming controls may be relay based, or on more current units, programmable logic controller (PLC) based. Interactive graphics displays may also be incorporated into the system. Access to PLC based controls and interactive graphic displays shall be limited to qualified individuals and password protected. PLC functions shall be confined to the normal boiler operating logic, covering startup, interlocks, and normal shutdown sequences. PLC logic shall not interfere with, or over-ride safety controls, which cause boiler safety shutdown when activated. The PLC logic shall comply with the requirements of NFPA-85.

d) Pre-fi

In addition to the Safety Controls defined in NBIC Part 2, Sections S4.5, S4.6 a), and S4.6 b), prove that the following air handling fans are operating properly shall be required.

- 1) Induced draft fans,
- 2) Fuel transport fans,
- 3) Underfi
- 4) Carbon, or flyash, re-injection fans.

In cases where variable speed drives are used on fans, the combustion system manufacturer's instructions shall be followed in terms of the allowable upper and lower limits of the power supply frequency (Hz).

e) Pre-purging

Pre-purging the boiler and its venting system shall be required. Unless defined otherwise by the manufacturer of the fuel burning equipment, the pre-purge may be achieved by operating the induced draft fan prior to starting the remaining fans in the installation.

Purge air volume shall be set during commissioning by the combustion system manufacturer, or the manufacturer's representative, in accordance with applicable codes or standards and shall not be capable of being reset by operating personnel.

f) Ignition Systems

Solid fuel ignition systems and/or methods can vary from the placement of manually ignited, oil soaked rags on the fuel bed, to gas or oil fired pilot burners or lances but in all cases shall be in accordance the manufacturer's recommendations.

g) Firing Rate Control and Fuel/Air Ratio Control

The control system shall be capable of maintaining the desired air to fuel ratio over the entire firing range of the boiler, while promoting clean, stable combustion.

h) Re-injection Systems

In installations where fly ash is re-injected from a multi-cyclone collector into the combustion zone for carbon re-burn; precautions should be taken to ensure that plugging of the reinjection pipe work does not occur. Consideration should be given to installing cleanouts in the pipe work.

i) Shutdown and Post Purge

Unless the boiler manufacturer's instructions state otherwise, the fuel supply shall be terminated at shutdown, and the overfire air should remain on until the fuel bed is burned out, and the residue cooled.

SUPPLEMENT 5

INSTALLATION OF THERMAL FLUID HEATERS

S5.1 SCOPE

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

(15)

S5.2 DEFINITION

Thermal fluid: a fluid (other than water) that is chemically stable over a large temperature range and is specifically designed for use as a heat transfer medium.

(15)

Thermal fluid heater: a closed loop liquid phase heater (flooded pressure vessel) in which the heat transfer media is heated but no vaporization takes place within the vessel. Depending on the fluid selection and operating parameters, systems may be open or closed to the atmosphere. Closed systems may be pressurized with an inert gas blanket.

Thermal fluid vaporizer: a heater in which the thermal fluid is vaporized within the pressure vessel.

S5.3 GENERAL REQUIREMENTS

S5.3.1 SUPPORTS, FOUNDATIONS, AND SETTINGS

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

(15)

S5.3.2 STRUCTURAL STEEL

- a) If the thermal fluid heater is supported by structural steel work, the steel supporting members shall be so located or insulated that the heat from the furnace will not affect its strength.
- b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.

(15)

S5.3.3 SETTINGS

The thermal fluid heater shall be installed on a flat, level, noncombustible surface preferably of concrete to protect against any fire hazard. A 4 in. (100 mm) containment curb or 2 in. (25 mm), seal welded drip lip around the thermal fluid heater equipment skid shall be provided.

(15)

S5.3.4 CLEARANCES

- a) Thermal fluid heater installations shall allow for normal operation, maintenance, and inspections. There shall be at least 18 in. (460 mm) of clearance on each side of the thermal fluid heater to enable access for maintenance and/or inspection activities. Thermal fluid heaters operated in battery shall not be installed closer than 18 in. (460 mm) from each other. The front or rear of any thermal fluid heater shall not be located nearer than 36 in. (915 mm) from any wall or structure.

(15)

- b) Vertical heaters shall have at least 60 in. (1,520 mm) clearance from the top of the heater or as recommended by the heater manufacturer.
- c) Heaters with a bottom opening used for inspection or maintenance shall have at least 18 in. (460 mm) of unobstructed clearance.
- d) **NOTE:** Alternative clearances in accordance with the manufacturer's recommendation are subject to acceptance by the Jurisdiction.

S5.4 THERMAL FLUID HEATER ROOM REQUIREMENTS

S5.4.1 EXIT

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

S5.4.2 LADDERS AND RUNWAYS

- (15) a) All walkways, runways and platforms shall be:
- 1) Of metal construction;
 - 2) Provided between or over the top of heaters that are more than 8 ft. (2.4 m) above the operating floor;
 - 3) Constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);
 - 4) Of bolted, welded, or riveted construction; and
 - 5) Equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe-board.
- b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.
- c) Ladders that serve as a means of access to walkways, runways, or platforms shall:
- 1) Be of metal construction and not less than 18 in. (460 mm) wide;
 - 2) Have rungs that extend through the side members and are permanently secured;
 - 3) Have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;
 - 4) Have a clearance of not less than 6½ in. (165 mm) from the back of rungs to the nearest permanent object; and
 - 5) Have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.
- d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8m) in length.

S5.5 SYSTEM REQUIREMENTS

S5.5.1 THERMAL LIQUIDS (HEAT TRANSFER FLUIDS) (15)

It is extremely important that the proper heat transfer fluid be selected by competent personnel knowledgeable of the system. Heat transfer fluid (15)

- a) Resist deterioration at the temperatures involved to ensure long, useful life and a clean system.
- b) Possess good heat transfer characteristics.
- c) Have low vapor pressures at operating temperatures to permit operation at moderate pressures. Note: processes requiring thermal fluid temperatures higher than 650°F (340°C) will require the use of specialty fluids with high vapor pressures [e.g. 150 psi (1,030 kPa)]. These fluids also tend to have special environmental, safety, and health considerations.
- d) Have low viscosities to decrease pumping losses (due to pipe friction) and the power required for circulation.
- e) Be suitable for outside temperatures involved to prevent freeze up unless a means of heat trace has been implemented.
- f) Meet environmental regulations.

The heat transfer fluid must be kept clean and in proper condition. Tests of the fluid shall be conducted per the fluid manufacturer's recommendations by approved laboratories. Any heat transfer fluid that is added must be clean and of the proper specification.

S5.5.2 EXPANSION

The expansion tank shall have sufficient volume to handle the required expansion of the total system thermal liquid at the required operating temperature. (15)

The expansion tank should be sized so that when the thermal liquid in the system is cold, the tank will be one quarter full or as recommended by the manufacturer. When the system is up to operating temperature, the level of fluid in the expansion tank shall not exceed the manufacturer's recommendation. A high expansion tank liquid level alarm may be used for indication of high liquid level in the expansion tank(s). An expansion tank low level switch (or similar device) shall be used to ensure the appropriate minimum level of fluid in the tank per the manufacturer's recommendation. Tripping of this switch should shut down the pump and burner. The activation of this switch should activate an audible alarm and/or light. All expansion tank vents and drains shall be piped to a safe catchment or per the manufacturer's recommendations.

If the expansion tank is to be pressurized with an inert gas, pressure relief shall be provided in accordance with the code of construction used for the expansion vessel. When a safety relief valve is used, it shall be piped to a safe catchment.

S5.5.3 CONNECTION

The circulating pump shall be piped to the thermal fluid heater per the manufacturer's recommendations. The expansion tank should be installed at an elevation above all piping when possible. If the tank is not at the highest elevation, an inert gas blanket shall be used to pressurize the system to overcome the weight of the fluid. (15)

- a) Vented – The expansion tank shall accommodate the Net Positive Suction Head (NPSH) requirements of the circulating pump to provide a NPSH for the circulating pump. For non-pressurized tanks, a vent

connection (open to the atmosphere) is part of the design and should be piped to a safe catchment with no valve in the piping.

- b) Pressurized – The expansion tank may be pressurized with nitrogen or other inert gas as recommended by the fl
pressure may be adjusted to meet the Net Positive Suction Head requirement of the circulating pump. Compressed air is not recommended as it oxidizes the thermal fluid. Carbon dioxide is not recommended as it dissolves into the fluid and can create cavitation or other problems in the system.

S5.5.4 CIRCULATING PUMP

- (15) It is essential that the pump selection be made by competent personnel that are knowledgeable to the requirements of the specific system. Special attention to hot and cold alignment requirements and pump cooling requirements must be considered. The circulating pump must:
 - a) Provide the required fluid flow across the heater tube surface.
 - b) Handle the Total System Head.
 - c) Be specifically designed to handle the thermal fluid at the high temperatures as well as the viscosity requirements of cold start conditions. The pump should be rated for the maximum operating temperature of the fluid. A strainer should be located in each pump suction piping. Globe valves or other throttling valves should be considered in the pump discharge piping to throttle the pump if necessary to prevent it from running out on its curve. Dual pumps are often installed to provide 100% redundancy in the case of a pump failure. A fl

S5.5.5 PIPING AND VALVES

- (15) Carbon steel pipe such as SA-53 or SA-106 is preferred for the entire piping system. Seamless pipe should be used for thermal fluid piping. Copper, copper alloys, brass, bronze, aluminum, or cast iron should not be used as they are incompatible with most thermal fluids. All joints and connections NPS 1 (DN 25) and over (within the flow circuit) should be welded or flanged. Full penetration welds shall be used in the piping. All flange gaskets shall be suitable for the operating temperature, pressure, and fluid used. Special attention shall be given to the expansion of the piping due to the high temperatures involved. Valves shall be of steel material compatible for the thermal fluid and temperatures and shall be flanged or weld type manufactured from cast or forged steel or ductile iron. Valve internals and gland seals shall be made from materials suitable for use with high temperature fluids and compatible with the specific fluid utilized in the system. When 2-way valves are utilized in the piping system, a back pressure regulating valve or automatic bypass valve shall be incorporated to ensure the proper flow through the heater at all times regardless of control valve position. If 3-way valves are used, balancing valves should be included.

Design of piping supports should be in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards as applicable. Thermal insulation used on the pipes and equipment should be selected for the intended purpose and for compatibility with the fluid. Where there is the potential for fluid system leaks (flanged joints, etc.), the thermal insulation selected should be non-absorbent. Laminated foam glass or cellular glass (nonabsorbent, closed cell) insulation are examples of suitable insulation.

S5.5.6 FUEL

- (15) Fuel systems, whether firing on oil, gas, or other substances, shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or other industry standards, as applicable.

S5.5.7 ELECTRICAL

- a) All wiring for controls, heat generating apparatus, and other appurtenances necessary for the operation of the thermal fluid heater(s) 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 equipment room door and marked for easy identification. Consideration should also be given to the type and location of the switch to safeguard against tampering.
- c) A disconnecting means capable of being locked in the open position shall be installed at an accessible location at the heater so that the heater can be disconnected from all sources of potential. This disconnecting means shall be an integral part of the heater or adjacent to it.
- d) If the equipment 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 equipment room, there shall be a shutdown switch located at each door of egress. 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. For power burners with detached auxiliaries, only the fuel input supply to the fi
- e) Controls for Heat Generating Apparatus
 - 1) Oil and gas-fired and electrically heated thermal fluid heaters shall be equipped with suitable primary (flame safeguard) safety controls, safety limit switches and controls, and burners or electric elements 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. Thermal fluid heater shall have:
 - a. Expansion tank low level switch, liquid level switch (or similar device) interlocked with the circulating pump operation to confirm minimum level in the expansion tank when the system is cold. This interlock prevents pump cavitation. The function of this device shall prevent burner and pump operation if the liquid level is not adequate.
 - b. Thermal fluid temperature operation control. This temperature actuated control shall shut down the fuel supply when the system reaches a preset operation temperature. This requirement does not preclude the use of additional operation control devices when required.
 - c. High temperature limit safety switch located on the thermal fluid heater outlet. This limit shall prevent the fluid temperature from exceeding the maximum allowable temperature of the specific fluid. The high temperature limit safety switch set point should be set no higher than the maximum temperature specified by the fluid manufacturer, heater designer, or downstream process limits, whichever is lowest. Functioning of this control shall cause a safety shutdown and lockout. The manual reset may be incorporated in the temperature limit control. Where a reset device is separate from the temperature limit control, a means shall be provided to indicate actuation of the temperature sensing element. Each limit and operating control shall have its own sensing element and operating switch.
 - d. Primary fl
 - main fuel shut off valve and shut off pilot fuel upon loss of flame at the point of supervision. The function of this control shall cause a safety shutdown and lockout.
 - e. Power burners and mechanical draft atmospheric burners shall provide for the preignition purging of the combustion chamber and flue passes. The purge shall provide no fewer than four air changes or greater as specified by the manufacturer.

- f. Proof of flow rates and film temperatures through the heater. A low flow condition can cause overheating, degradation of the fluid or heater coil or tube failure. Activation of this interlock shall cause a safety shutdown of the burner and pump. One or more interlocks shall be provided to prove minimum flow through the heater at all operating conditions.
- 3) In accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or other industry standards, as applicable, Thermal fluid heaters may also have:
- a. A high stack temperature switch interlock – in the event of a high stack temperature (indication of improper combustion or cracked coil) this device shall shut off the burner and circulating pump and cause a lockout condition.
 - b. An inert gas smothering system (steam or CO₂) – this system is used to quench combustion in the event of a cracked heater coil or tube. The gas smothering system should be installed per local codes and requirements. A typical system may include two stack limit switches, an alarm and valve to allow inert gas to enter the combustion chamber. One stack limit is set at a value above the typical stack temperature for the equipment [e.g. 1,000. °F (540°C)] and the second is set at 100 °F (40°C) above the first. If the limit is tripped, the pump and burner will shut down. If the second limit is tripped, the inert gas shall enter the combustion chamber to quench the flame.
 - c. A high inlet pressure switch – this normally closed switch senses pressure at the heater inlet and its setpoint is determined based on the system design pressure when the system is cold. Activation of this switch indicates a restriction in flow and should shutdown the burner and pump and cause a lockout condition.
 - d. A low inlet pressure switch – this normally open switch senses pressure at the heater inlet and its setpoint is determined based on system pressure when the system is operating at temperature. Activation of this switch indicates a restriction in flow and should shutdown the burner and pump and cause a lockout condition.
 - e. A high outlet pressure switch – this normally closed switch senses pressure at the heater outlet and its setpoint is determined based on the system pressures when the system is at operating temperature. Activation of this switch indicates a restriction in flow and should shutdown the burner and pump and cause a lockout condition. Note: the setpoint of this switch should be lower than the safety relief valve setting.
- 4) These devices shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.

S5.5.8 VENTILATION AND COMBUSTION AIR

- (15) a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room and sufficient to maintain ambient temperatures as recommended by the heater manufacturer. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans.

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

- b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2,000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The heater equipment room air supply openings shall be kept clear at all times.
- c) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all thermal fluid heaters located in the equipment room. Additional capacity may be required for any other fuel burning equipment in the equipment room. Pressure in the room should be consistently neutral.
- d) When power ventilators or fans are used to supply combustion air they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.
- e) The size of openings specified by the Jurisdiction are used. -
- f) Care should be taken to ensure that thermal fluid lines are not routed across combustion air openings, where freezing may occur in cold climates.

S5.5.9 LIGHTING

The equipment room should be well lit and it should have an emergency light source for use in case of power failure. (15)

S5.5.10 EMERGENCY VALVES AND CONTROLS

All emergency shutoff 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. (15)

S5.6 DISCHARGE REQUIREMENTS

S5.6.1 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. (15)

S5.6.2 DRAINS

A suitable low point drain fitted with a stop valve shall be provided in the heater or connecting piping to allow the heat transfer media to be drained out of the pressure vessel and/or piping when necessary. The valve may either be locked in the closed position or a blank flange can be installed downstream of the valve. The valve should never be opened when there is temperature on the system.

S5.6.3 AIR VENT

A manual air vent valve should be installed on the high point of the system piping. This valve is typically used when filling or draining the system. The valve should never be opened when there is temperature on the system or when a pressurized system is utilized. (15)

S5.7 OVERPRESSURE PROTECTION**S5.7.1 GENERAL**

- (15) Thermal fl
construction.

S5.7.2 PRESSURE RELIEF DEVICES

- (15) Thermal fluid heaters shall be equipped with one or more pressure relief devices unless the option for overpressure protection by system design is utilized (when permitted by the original code of construction). When pressure relief devices are used, the following shall apply:
- a) Pressure relief valve(s) shall be of a totally enclosed type and shall not have a lifting lever.
 - b) Rupture disks may be installed upstream or downstream of the pressure relief valve(s) in accordance with the original code of construction.
 - c) Pressure relief valves and rupture disks shall be in accordance with the code of construction and designed for liquid, vapor, or combination service as required for the specific installation, service fluids, and overpressure conditions.
 - d) The inlet connection to the valve shall be not less than NPS ½ (DN 15).

S5.7.3 LOCATION

- (15) a) Pressure relief devices shall be connected to the heater in accordance with the original code of construction.

S5.7.4 CAPACITY

- (15) a) The pressure relief device(s) shall have sufficient capacity to prevent the pressure vessel from exceeding the maximum pressure specified in the vessel code of construction.

S5.7.5 SET PRESSURE

- (15) a) When a single relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure.
- b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure needs to be set at or below the maximum allowable working pressure. The set pressure of the additional relief devices shall be such that the pressure cannot exceed the maximum pressure permitted by the code of construction.

S5.7.6 INSTALLATION

- (15) a) When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet. The size of the discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity or adversely affect the operation of the attached pressure vessel relief devices. Discharge piping shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

- b) The cross sectional area of the piping between the heater and the relief device shall be sized either to avoid restricting the flow to the pressure relief devices connected to it.
- c) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting the flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it.
- d) Unless permitted by the code of construction, there shall be no intervening stop valve between the vessel and its pressure relief device(s), or between the pressure relief device and the point of discharge.
- e) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location, such as a catchment tank, for the disposal of flow.
- f) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with low point or valve body drains to prevent liquid from collecting in the discharge side of a pressure relief device. Drain piping shall discharge to a safe location for the disposal of the fluids being relieved.

S5.8 TESTING AND ACCEPTANCE

S5.8.1 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 thermal fluid system. Where possible, an inspection of the interior of the thermal fluid heater and its appurtenances shall be made for the presence of foreign debris prior to making the final flow test. (15)
- b) Safe operation should be verified by a person familiar with heater system operations for all heaters and connected appurtenances and all pressure piping connecting them to the appurtenances and all piping.
- c) 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).
- d) Washers shall only be used when specified.

S5.8.2 PRESSURE TEST

Prior to initial operation, the completed thermal fluid heater system, including pressure piping, pumps, stop valves, etc., shall be pressure tested in accordance with the manufacturer's recommendations. Hydrostatic testing of the system is not recommended due to possible contamination of the system. All pressure testing should be witnessed by an Inspector. (15)

S5.8.3 NONDESTRUCTIVE EXAMINATION

Thermal fluid heater components and subcomponents shall be nondestructively examined as required by the governing code of construction. (15)

S5.8.4 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 test. (15)

S5.8.5 FINAL ACCEPTANCE

- (15) A thermal fluid heater may not be placed into service until its installation has been inspected and accepted by the appropriate jurisdictional authorities.

S5.8.6 INSTALLATION REPORT

- (15) a) Upon completion, inspection, and acceptance of the installation, the installer should complete and certify the *Boiler Installation Report I-1*. See 1.4.5.1.
- b) The *Boiler Installation Report* should be submitted as follows:
- 1) One copy to the Owner; and
 - 2) One copy to the Jurisdiction, if required.

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. Whichever 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.).

7.2 EQUIVALENT RATIONALE

The rationale taken to convert metric units and US customary units involves knowing the difference between a *soft* conversion and a *hard* conversion. A soft conversion is an exact conversion. A hard conversion is simply performing a soft conversion and then rounding off within a range of intended precision. When values specified in the NBIC are intended to be approximate values, a hard conversion is provided. If an exact value is needed to maintain safety or required based on using good engineering judgment, then a soft conversion will be used. In general, approximate accuracy is acceptable for most repairs or alterations performed using the requirements of the NBIC. Therefore, within the NBIC, metric equivalent units are primarily hard conversions.

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 specific
- 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; and
- 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 NBIC Part 1, 2, 3, Tables 7.4-a through 7.4-j.

TABLE 7.4-a
SOFT CONVERSION FACTORS (US X FACTOR = METRIC)

US Customary	Metric	Factor
in.	mm	25.4
ft.	m	0.3048
in. ²	mm ²	645.16
ft ²	m ²	0.09290304
in. ³	mm ³	16,387.064
ft ³	m ³	0.02831685
US gal.	m ³	0.003785412
US gal.	liters	3.785412
psi	MPa	0.0068948
psi	kPa	6.894757
ft-lb	J	1.355818
°F	°C	5/9 x (°F–32)
R	K	5/9
lbm	kg	0.4535924
lbf	N	4.448222
in.-lb	N-mm	112.98484
ft.-lb	N-m	1.3558181
ksiVin	MPaVm	1.0988434
Btu/hr	W	0.2930711
lb/ft ³	kg/m ³	16.018463
in.-wc	kPa	0.249089

Note:
The actual pressure corresponding to the height of a vertical column of fluid is a function of the 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 (gn = 9.80665 N/kg) and a density of water equal to 1,000 kg/m³. 7.4-a through 7.4-j.

Temperature shall be converted to within 1°C as shown in NBIC Part 1, 2, 3, Table 7.4-b.

TABLE 7.4-b
TEMPERATURE EQUIVALENTS

Temperature °F	Temperature °C
60	16
70	21
100	38
120	49
350	177
400	204
450	232
800	427
1,150	621

Fractions of an inch shall be converted according to NBIC Part 1, 2, 3, Table 7.4-c. Even increments of inches are in even multiples of 25 mm. For example, 40 inches is equivalent to 1,000 mm. Intermediate values may be interpolated rather than converting and rounding to the nearest mm.

TABLE 7.4-c
US FRACTIONS/METRIC EQUIVALENTS

Inches	Millimeters
1/32	0.8
3/64	1.2
1/16	1.5
3/32	2.5
1/8	3
5/32	4
3/16	5
7/32	5.5
1/4	6
5/16	8
3/8	10
7/16	11
1/2	13
9/16	14
5/8	16
11/16	17
3/4	19
7/8	22
1	25

For nominal pipe sizes, the following relationships were used as shown in NBIC Parts 1, 2 or 3, Table 7.4-d.

TABLE 7.4-d
PIPE SIZES/EQUIVALENT

US Customary Practi	
NPS 1/8	DN 6
NPS 1/4	DN 8
NPS 3/8	DN 10
NPS 1/2	DN 15
NPS 3/4	DN 20
NPS 1	DN 25
NPS 1-1/4	DN 32
NPS 1-1/2	DN 40
NPS 2	DN 50
NPS 2-1/2	DN 65
NPS 3	DN 80
NPS 3-1/2	DN 90
NPS 4	DN 100
NPS 5	DN125
NPS 6	DN 150
NPS 8	DN 200
NPS 10	DN 250
NPS 12	DN 300
NPS 14	DN 350
NPS 16	DN 400
NPS 18	DN 450
NPS 20	DN 500
NPS 22	DN 550
NPS 24	DN 600
NPS 26	DN 650
NPS 28	DN 700
NPS 30	DN 750
NPS 32	DN 800
NPS 34	DN 850
NPS 36	DN 900
NPS 38	DN 950
NPS 40	DN 1000
NPS 42	DN 1050
NPS 44	DN 1100
NPS 46	DN 1150
NPS 48	DN 1200
NPS 50	DN 1250
NPS 52	DN 1300
NPS 54	DN 1350
NPS 56	DN 1400
NPS 58	DN 1450
NPS 60	DN 1500

Areas in square inches (in^2) were converted to square mm (mm^2) and areas in square feet (ft^2) were converted to square meters (m^2). See examples in NBIC Parts 1, 2 or 3, Tables 7.4-e and 7.4-f.

TABLE 7.4-e

Area (US Customary)	Area (Metric)
3 in^2	650 mm^2
6 in^2	3,900 mm^2
10 in^2	6,500 mm^2

TABLE 7.4-f

Area (US Customary)	Area (Metric)
5 ft^2	0.46 m^2

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

TABLE 7.4-g

Volume (US Customary)	Volume (Metric)
1 in^3	16,000 mm^3
6 in^3	96,000 mm^3
10 in^3	160,000 mm^3

TABLE 7.4-h

Volume (US Customary)	Volume (Metric)
5 ft^3	0.14 m^3

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-i. (Note that 14.7 psi converts to 101 kPa, while 15 psi converts to 100 kPa. While this may seem at fi

TABLE 7.4-i
PRESSURE/EQUIVALENTS

Pressure (US Customary)	Pressure (Metric)
0.5 psi	3 kPa
2 psi	15 kPa
3 psi	20 kPa
10 psi	70 kPa
15 psi	100 kPa
30 psi	200 kPa
50 psi	350 kPa
100 psi	700 kPa
150 psi	1.03 MPa
200 psi	1.38 MPa
250 psi	1.72 MPa
300 psi	2.10 MPa
350 psi	2.40 MPa
400 psi	2.8 MPa
500 psi	3.45 MPa
600 psi	4.14 MPa
1,200 psi	8.27 MPa
1,500 psi	10.34 MPa

TABLE 7.4-j

Strength (US Customary)	Strength (Metric)
95,000 psi	655 MPa

Material properties that are expressed in psi or ksi (e.g., allowable stress, yield and tensile strength, elastic modulus) were generally converted to MPa to three significant figures. See example in NBIC Parts 1, 2 or 3, Table 7.4-h.

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, propriety 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. Provide a copy of the specific
- 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 criteria:

- 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.

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 defi

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

Alteration — A change in the item described on the original Manufacturer's Data Report which affects the pressure containing capability of the pressure-retaining item. (See NBIC Part 3, 3.4.3, *Examples of Alteration*) 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.

Appliance — A piece of equipment that includes all controls, safety devices, piping, fittings, and vessel(s) within a common frame or enclosure that is listed and labeled by a nationally recognized testing agency for its intended use.

ASME — The American Society of Mechanical Engineers.

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 (AIA)

Inservice: An Authorized Inspection Agency is either:

- a) a jurisdictional authority as defi
- b) an entity that is accredited by the National Board meeting NB-369, *Accreditation of Authorized Inspection Agencies Performing Inservice Inspection Activities*; NB-371, *Accreditation of Owner-User Inspection Organizations (OUIO)*; or NB-390, *Qualifications and duties for Federal Inspection Agencies (FIAs) Performing Inservice Inspection Activities*.

New Construction: An Authorized Inspection Agency is one that is accredited by the National Board meeting the qualifi *Criteria for Acceptance of Authorized Inspection Agencies for New Construction*.

Biomass — Fuels which result from biological sources requiring a relatively short time for replenishment: Wood and bagasse are typical examples.

(15) **Biomass Fired Boiler** — A boiler which fi

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.

SECTION 9

Boiler — A 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 also shall include the apparatus used to generate heat and all controls and safety devices associated with such apparatus or the closed vessel.

High-Temperature Water Boiler — A power 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).

Hot-Water Heating Boiler — A hot water boiler installed to operate at pressures not exceeding 160 psig (1,100 kPa) and/or temperatures not exceeding 250°F (121°C), at or near the boiler outlet.

Hot-Water Supply Boiler — A boiler that furnishes hot water to be used externally to itself at a pressure less than or equal to 160 psig (1,100 kPa gage) or a temperature less than or equal to 250°F (120°C) at or near the boiler outlet

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. The term power boiler includes fired units for vaporizing liquids other than water, but does not include fired process heaters and systems. (See also High-Temperature Water Boiler).

Steam Heating Boiler — A steam boiler installed to operate at pressures not exceeding 15 psig (100 kPa).

Carbons Recycle — See Flyash Recycle.

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

Confined Space — Work locations considered “confined” because their configurations hinder the activities of employees who must enter, work in and exit them. A confined space has limited or restricted means for entry or exit, and it is not designed for continuous employee occupancy. Confined spaces include, but are not limited to, underground vaults, tanks, storage bins, manholes, pits, silos, process vessels, and pipelines. Regulatory Organizations often use the term “permit-required confined space” (permit space) to describe a confined space that has one or more of the following characteristics: contains or has the potential to contain a hazardous atmosphere; contains a material that has the potential to engulf an entrant; has walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant; or contains any other recognized safety or health hazard, such as unguarded machinery, exposed live wires, or heat stress. Confined space entry requirements may differ in many locations and the Inspector is cautioned of the need to comply with local or site- specific confined space entry requirements.

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.

Conveyor System(s) — A fuel transport system utilized on biomass boilers that drops fuel onto a moving belt, bucket elevator, drag link conveyor, or a screw or auger mechanism. (The speed of the conveyor may be varied to meet fuel demand.) (15)

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.

- (15) **Dense Phase Pneumatic System(s)** — A batch feed transport system used on solid fuel fired boilers for both fuel delivery and/or ash removal. In this system the material to be transported is dropped through a valve in a pressure vessel. When the vessel is filled the valve closes and air at a pressure from 30 to 100 psig (200 to 700 kPa) is admitted and the material leaves the vessel in the form of a “slug”. The sequence then repeats.

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.

Emissions — The discharge of various Federal or State defined pollutants into the atmosphere during a given time period.

Emissions Control System — An arrangement of devices, usually in series, used to capture various air pollutants and thereby reduce the amount of these materials, or gases, being admitted to the surrounding atmosphere, below Federal or State defined standards.

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*

Fluidized Bed — A process in which a bed of granulated particles are maintained in a mobile suspension by an upward flow of air or gas.

Fluidized Bed (Bubbling) — A fluidized bed in which the fluidizing velocity is less than the terminal velocity of individual bed particles where part of the fluidizing gas passes through as bubbles.

Fluidized Bed (Circulating) — A fluidized bed in which the fluidizing velocity is greater than the terminal velocity of the individual bed particles.

Flyash — Suspended ash particles carried in the flue gas.

Flyash Collector — A device designed to remove flyash in the dry form from the flue gas.

Flyash Recycle — The reintroduction of flyash/unburned carbon from the flyash collector into the combustion zone, in order to complete the combustion of unburned fuel, thereby improving efficiency.

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

Fuel Transport Fan — A fan which generates airflow capable of moving fuel particles, in suspension, from a metering device to the combustion zone.

Grate — The surface on which fuel is supported and burned and through which air is passed for combustion.

Hydrostatic Test — A liquid pressure test which is conducted using water as the test medium.

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

Induced Draft Fan — A fan exhausting hot gases from the heat absorbing equipment.

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*.

Lean Phase Pneumatic System(s) — A fuel transport system utilized on biomass boilers that drops fuel into a moving airstream, mixes with the air, and travels through a pipe at a velocity in the region of 5,000 ft/min (1,525 m/min). Air pressures are in the region of 25 inches (635 mm) water column.

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.

Liquid Pressure Test — A pressure test using water or other incompressible fluid as a test medium.

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

Mechanical Assembly — The work necessary to establish or restore a pressure retaining boundary, under supplementary materials, whereby pressure-retaining capability is established through a mechanical, chemical, or physical interface, as defined under the rules of the NBIC.

Mechanical Repair Method — A method of repair, which restores a pressure retaining boundary to a safe and satisfactory operating condition, where the pressure retaining boundary is established by a method other than welding or brazing, as defined under the rules of the NBIC.

Metering Device — A method of controlling the amount of fuel, or air, flow.

“NR” Certifi — 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.

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

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.

Overfi — Air admitted to the furnace above the grate surface /fuel bed. Used to complete the combustion of fine particles, in suspension. Also aids in reducing NOx formation.

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.

Pneumatic Test — A pressure test which uses air or another compressible gas as the test medium.

Potable Water Heaters — A corrosion resistant appliance that includes the controls and safety devices to supply potable hot water at pressure not exceeding 160 psig (1,100 kPa) and temperature not in excess of 210°F (99°C).

Fired Storage Water Heater — A potable water heater in which water is heated by electricity, the combustion of solid, liquid, or gaseous fuels and stores water within the same appliance.

Indirect Fired Water Heater — A potable water heater in which water is heated by an internal coil or heat exchanger that receives its heat from an external source. Indirect fired water heaters provide water directly to the system or store water within the same appliance.

Circulating Water Heater — A potable water heater which furnishes water directly to the system or to a separate storage tank. Circulating water heaters may be either natural or forced flow.

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 — A test that is conducted using a flammable liquid or gas.

Pressure Vessel — A pressure vessel is a container other than a boiler or piping used for the containment of pressure.

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

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.

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

Re-rating — See alteration.

Safe Point of Discharge — A location that will not cause property damage, equipment damage, or create a health or safety threat to personnel in the event of discharge.

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.

(15) **Seal Weld** — Any weld designed primarily to provide a specific degree of tightness against leakage. A seal weld is not intended to provide structural integrity to a pressure retaining item.

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.

Suspension Burner — A combustion system in which the fuel is in the form of relatively small particles, Their buoyancy is maintained in the transport airstream and the fuel/air mixture flow stream, until combustion is completed.

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

Thermal Fluid Heater — A thermal fl the direct application of heat from a thermal energy source. Depending on the process heating requirements, the fluid may be vaporized with normal circulation but, more often, the fluid is heated and circulated by a pump.

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

Underfire Air — A method of introducing air beneath the grate surface/fuel bed.

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

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

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/ft (10 kPa/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.

PART 1, SECTION 10

INSTALLATION — NBIC APPROVED INTERPRETATIONS

10.1 SCOPE

- a) This section provides a list of all approved interpretations for previous editions and addenda of the NBIC. A complete list of interpretations including approved interpretations for this edition is provided on the National Board website.
- b) Each interpretation references the edition and addenda applicable to the committee response and approval. Use of interpretations, for other than the approved edition and addenda, may not be appropriate for reference.
- c) Technical inquiries (also known as “request for interpretation”) may be submitted to the NBIC committee to clarify the meaning or intent of existing rules to the NBIC. The requirements for submitting technical inquiries are described in NBIC Parts 1, 2, and 3 (Section 8), Preparation of Technical Inquiries to the NBIC Committee.

2013 INTERPRETATIONS

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13-04	2013	3	3.3.2 e)	Seal Welding of Inspecti
13-03	2011	3	3.3.2 d) 1)	Standard Threaded Fittin ASME VIII, Div. 1 Vessel
13-02	2011	3	5.7.5	Stamping Requirements for Alterations
13-01	2013	3	1.8.5 q)	Personnel Qualified IAW ANSI/ASME N45.2.23

2011 INTERPRETATIONS

Interpretation	Edition	Part	Secti	Subject
11-06	2011	3	3.2.5	Calculations / Start of Work
11-05	2011	2	5.2.2 – 5.2.3	Replacement of Stamped Data on Corrugator Rolls
11-04	2011	3	1.7	Application of “VR” Stamp
11-03	2011	2	2.5.8	Test Frequencies
11-02	2011	3	4.4.2 a)	Liquid Pressure Test Requirements
11-01	2011	3	3.3.2	Routine Repair Considerations

2007 INTERPRETATIONS

Interpretation	Edition	Addenda	Part	Section	Subject
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07-15	2007	2008	2	S2.10.6	Average Pitch
07-14	2007	2009	3	3.3.3	Replacement of Pressure Retaining Parts
07-13	2007	2009	All		The Original Code of Construction
07-12	2007	2009	3	3.4.3	Replacement of Heads with Different Types

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Interpretati		Addenda	Part	Section	Subject
07-11	2007	2010	3	3.2.2 a)	Replacement Parts
07-10	2007	2009	3	3.3.2–3.3.3	Routine Repairs
07-09	2007	2008	2	S2.9 b) & S2.11 b) 7) b)	Schedule 80 Pipe in External Piping
07-08	2007	2009	3	3.4.3 c)	Handhole Replacement with Flush Patch
07-07	2007	2009	3	3.3.4.3 e) & 3.3.2 d) 3)	Weld Buildup of Wasted Area / Routi
07-06	2007		3		Replacement Parts for Repairs and Alterati
07-05	2007	2008	1	2.9.5.1 c)	Change-Over Valve Permitted in ASME Code Case-2254 Use
07-04	2007		1	4.5.1 a)	Installati Holder
07-03	2007		3	2.5.3	Use of Alternati and P-No 5A Base Material
07-02	2007		3	1.6.2, 1.7.5.4, & 1.8.2	NBIC Manual Requirements for “R”, “VR”, and “NR” Stamp Holders
07-01	2004	2006		RB-8400 & RB- 8410	“Try Testing” of Pressure Relief Valves

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Interpretation	Edition	Addenda	Section	Subject
04-23	2004	2005	RC-1110, RC-2050(c), RC-3030(c), & RC-3031(e)	Jurisdictional Acceptance of NDE
04-22	2004		RC-1130	Inspector Verifi
04-21	2004	2005	RC-1130	Inspector Involvement in NDE in Lieu of Pressure Test
04-20	2004	2005	RC-2051(d) & RC- 3031(b)	Pneumati
04-19	2004	2005	RD-2020	Repair of Threaded Bolt Holes
04-18	2004	2005	RD-3010	Re-rati Original Code of Construction
04-17	2001	2003	RD-2020(c)	Procedures for Repairing Cracks and Crack Clas- sification
04-16	2004		RA-2370	“NR” Certi Replacement Program
04-15	2004		RD-2060	Utilizing a Flush Patch to Gain Access Window in Pressure Retaining Items
04-14	2004		RC-1000 & RC-3000	Replacement Safety Valves with Diff ities and Set Pressures than Boiler Data Report

2004 INTERPRETATIONS

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04-13	2004		RC-1020, RC-1030, Appendix 4, & RC-3022	Replacement of a Cast Iron Section
04-12	2001	2003	RD-1030, RC-1050(c)	Post Weld Heat Treatment of Parts
04-11	2001	2003	RC-1050(c), RC-2050, & RC-2051	Requirements for Testi
04-10	2004		RC-2031	Flush Patches in Pipes and Tubes NPS 5 or less
04-09	2004		RC-2031	Routi
04-08	2004		RE-1050	Fabricated Replacement Criti
04-07	2004		RE-1050	Source for Criti
04-06	2004		RC-1050(c), RC-2050, RC-2051, & RC-1110	Written Procedure Requirements for Non-Destructive Examinations
04-05	2001	2003	RC-1050(c) & RC-2050	"R" Stamp Holder Installati turer Supplied Parts
04-04	2004		RC-3022(b) & (d)	Re-rati Service/Removal of Insulation
04-03	2004		RC-3022(b) & (d)	Re-rati of Insulati
04-02	2004		RA-2213	"VR" Certi turer's Nameplate Capacity
04-01	2004		RD	Use of Welded Encapsulati Build Up or Flush Patch

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01-40	2001	2003	RC-2051(e), RC-3031(c), RC-2050, & RC-3030(c)	Use of VT when Pressure Test Is Not Practi - ble
01-39	2001	2003	RC-3051	Inspector Responsibiliti Witnessing Pressure Test
01-38	2001	2003	RD-3022(d)	Design Only "R" Stamp Holders Pressure Test- ing and Form R-2
01-37	2001	2003	RC-1140 & RC-3040	Construction Phase & Stamping when Re-rati- ing without Physical Changes
01-36	2001	2002	RC-1020(b)	Applicati - sure Retaining Items
01-35	2001	2002	RC-1040	Is Pre-Assembly of a Part Considered Fabrica- tion
01-34	2001	2002	RD-1060(h)(2)	Butt
01-34	2001	2002	RD-1040(i)(6)	Shielding Gas Dewpoint Temperature

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01-32	2001	2002	Introduction	Are Reference Codes and Standards Accept- able
01-31	2001	2002	RB-3238	Determinati Boilers and Pressure Vessels
01-30	2001	2002	RC-1050(c)	Fabricati Holder
01-29	2001	2002	RC-2070	Installati
01-28	2001	2002	RC-1040	Use of Material That Has Been Previously Inservice
01-27	2001	2002	RC-1090	Welding Using Welders Who Are Not Em- ployed by the "R" Stamp Holder
01-26	2001	2002	RB-3238(f)	Criteria for Determining Actual Thickness and Maximum Deterioration
01-25	2001		RC-3050	Documenti "R" Stamp Organizations
01-24	2001		RC-1110(a)	NDE of Tack Welds by Welders and Welder Operators
01-23	2001		RC-2031(a)(1)	Routine Repairs
01-22	2001		RC-2031	Routi
01-21	2001		Appendix 6, Part B	Alternati Weld Heat Treatment
01-20	2001		RC-2031(a)(1)	Routine Repairs
01-19	2001		RC-2031(a)(1)	Routine Repairs
01-18	2001		8-5000(b)	Repairs
01-17	2001		RC-3021	Calculations
01-16	2001		RC-3000	Alterations to ASME Section VIII, Div. 2 Vessels
01-15	2001		RC-2051	Pressure Test Repairs and Alterati Isolati Retaining Item
01-14	2001		RC-2082(b)	Repair Plan (Sec. VIII, Div. 2) AIA Acceptance
01-13	2001		RB-4010	Replacement of Stamped Data
01-12	2001		RA-2274	Use of Owner/User Personnel during Repairs of Pressure Relief Valves
01-11	2001		RC-3022	Re-rating Based on Joint Efficiency
01-10	1998	2000	RD-1000	Alternative Postweld Heat Treatment Methods
01-09	1998	2000	RC-2031(a)(1)	Routine Repairs

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01-07	1998	2000	RA-2030(a)	Owner-User Inspecti
01-06	1998	2000	RA-2010	Accreditati
01-05	1998	2000	RA-2330(n)	"NR" Program Audits
01-04	1998	2000	RC-2050, RC-3030, RA-2151(m)	Calibration of Pressure Gages
01-03	1998	2000	Appendix 4	Pressure Retaining Items
01-02	1998	1999	RC-2031(a)(3)	Weld Metal Build-Up
01-01	1998	1999	RA-2330(g)	Demonstration for an "NR" Certifi Authorization

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98-42	1998	1999	RC-2031, RD-2030(d)	Weld Buildup of Wasted Area of Boiler Tubes
98-41	1998		RA-2330(g)	Compliance with Part RA-2330(g)
98-40	1998		RD-2070	Replacement of Threaded Stays with Welded Stays
98-39	1998	1999	R-1 & R-2 Forms	Inspector Requirements
98-38	1998	1999	RC-3031(c)	NDE in Lieu of Pressure Test
98-37	1998	1999	RC-1050(a)	Material Requirements
98-36	1998	1999	RD-2050	Original Code of Construction
98-35	1998	1999	RB-4000	Restamping or Replacement of Nameplate
98-34	1995	1996	RC-3030	Examination and Testin
98-33	1998		RC-2051	Liquid Pressure Test of Repairs
98-32	1998		RC-3022	Re-rati
98-31	1998		RC-2031	Replacement of a Nozzle as Routi
98-30	1998		Appendix 6C	Example of Alterati ing
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98-28	1998		Appendix 6	Pressure Retaining Replacement Items
98-28	1998		RC-1050	Definition of New Replacement Parts
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98-27	1995	1996	RC-1050	Replacement Parts

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98-25	1998		RA-2262(b)(3)	Stamping on Repair Nameplate
98-24	1998		RA-2242(c)	“VR” Certi 1945
98-23	1995		Appendix 6, B-7	Head and Shell Thickness Limitati stalling Nozzles -
98-22	1998		RC-1010	Scope
98-21	1998		RA-2130(f)	Requirements for Applicants for “R” Certi Authorizati
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98-19	1998		RB-3237	Inspection Interval
98-18	1998		RC-2031(a)(1)	Routine Repairs
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98-16	1998		RA-3020	Prerequisites for Accreditation
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98-14	1998		RC-1050	Replacement Parts
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98-14			RC-3020	Design
98-13	1995	1996	RA-2151(r)	QC Manual Requirements
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98-11	1995	1996	RA-3050	Owner-User Program Accreditati tions -
98-10	1995		RC-1110	NDE Requirements for ASME Secti Repairs
98-09	1995		RB-3640	Inspecti
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98-07	1995	1996	RA-2330(d)	ASME Secti
98-06	1995	1996	RC-1090	Welding Non-Pressure Parts in a Pressure Retain- ing Item
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95-56	1995	1996	RA-2231(b)(1)	Acceptance of Code Cases 1923 & 1945
95-55	1995	1996	RB-3550	Operational Inspection
95-54	1995	1996	RC-2050	Pressure Testing
95-53	1995		RD-2031	Routine Repairs
95-52	1995	1996	RD-2060	Patches, Figure 8
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95-50	1995	1996	RC-2072 & RC-3052	R-3, R-4, & Manufacturer's Partial Data Report
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95-47	1995		RB-4020	Replacement Name Plates & Nati Numbers
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95-45	1995		Appendix 4	Repairs and Alterations
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95-43	1995		Appendix 5	Repairs
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95-40	1995		Appendix 5	Form R-2
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95-36	1995		RC-1020	Work Performed to a Code Other than the Original Code of Constructi
95-35	1992	1994	R-200	Welding of Tube Plugs
95-34	1995		Appendix 4	Inspector Responsibilities
95-33(a)	1992	1994	Appendix C-R, 4.0 (f)	Field Repairs in Other Shops Owned by the Cer- ti
95-33	1995		RC-2031(a)(2)	Non-Load Bearing Attachments
95-32	1995		RC-2050	Pressure Testing
95-31	1995		RC-2031	Waiving the Inprocess Involvement of the In- spector
95-30	1995		Data Report Forms	API-510 Reporti
95-29	1995		RC-1070	Non Nati tors
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95-23	1995		RC-1010	Documentation of Repairs to Non-Symbol Stamped Cargo Vessels
95-22	1995		RC-3020 & RC-3021	Reclassifi
95-21	1995		Appendix 4	Repairs to PWHT Vessels Without Subsequent PWHT
95-20	1995		Foreword	Use of Earlier Edition and Addenda
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95-18	1992	1994	Appendix C-NR & NR- 1000	Scope and Applicability
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94-1	1989		Chapter III	Repair of Valves Covered by B31.1
93-6	1992		Chapter III	Re-rating by Performing Radiography & Recalculating Joint Efficiency
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Z



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