

COMMITTEE CORRESPONDENCE

COMMITTEE: PRD

TO: PRD

FROM: Robin Hough
NBIC Secretary

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SUBJECT: Letter Ballot NB11-0401 PRD

DATE: May 24, 2012

Gentlemen:

Letter Ballot NB11-0401 PRD has now closed. The ballot passed. The voting results are:

6	Approved
0	Disapproved
0	Abstain
0	Not Voting
5	Not Returned

This document will now be discussed at NBIC Committee meetings in July.

Thanks,

Robin Hough
NBIC Committee Secretary

Ballot Votes NB11-0401

<u>Name</u>	<u>Email</u>	<u>Votes</u>	<u>Vote Date</u>
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Ballot Comments

<u>Name</u>	<u>Document</u>	<u>Comment</u>	<u>Date Created</u>
Alton Cox	NBIC Part 4 draft 4-12-1 comments.doc	with comments.	05/23/2012
R. W. Donalson		I approve but would like a chance to review again once the open editorial items have all been addressed.	05/23/2012
Frank Hart		will provide written documents for discussion at meeting.	05/22/2012

SC-PRD ITEM NB11-0401, Draft 4-25-12 -- Alton Cox comments

Open Issues:

1. Editorial items
 - A. Renumbering needs to be checked
 - B. All cross references need to be checked/updated
 - C. Index not complete
 - D. Several tables did not import correctly

Organizational Comments:

1. Part 3 supplement 7 has been changed to main body text, and rearranged for flow
2. Administrative requirements moved after general repair requirements

Editorial/ other comments

1. Safety valve and safety relief valve changed to "pressure relief valve" where appropriate
2. "mounted" changed to "installed" in numerous locations
3. Organic fluid heater pressure relief requirements expanded based upon Section I of ASME Code
4. Does not include NBIC changes that have been approved by the committee but not yet published

Key:

Italics indicate new material written for this draft

~~Strikethrough~~ indicates deleted material

(Parenthetical notes are for information only, and are not to be included in publications)

Document: NBIC Part 4 draft4-12.doc

NBIC PART 4

PRESSURE RELIEF DEVICES

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INTRODUCTION

This Part of the NBIC addresses requirements for the installation, in-service inspection, and repair of pressure relief devices used for the overpressure protection of pressure retaining items (PRI).

(NOTE: Include Forward, Committee member Information, copyright information, introduction (up to XVIII), table of contents (All as part of Introduction)
Also include information on jurisdictional oversight. Part 1, Par 1.1 through 1.4.4
Glossary, Interpretations, Index to be at end of document)

National Board Inspection Code 2013 Edition

Date of Issue — July 31, 2013

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

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

^RNR

^RR

[®]

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

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

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Foreword

The National Board of Boiler and Pressure Vessel Inspectors is an organization comprised of Chief Inspectors for the states, cities, and territories of the United States and provinces and territories of Canada. It is organized for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity in post-construction activities of pressure-retaining items, thereby 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 postconstruction activities involving safety of pressure-retaining items. This restructuring provides for future expansion, transparency, and uniformity, ultimately improving public safety. The NBIC Committee's function is to establish rules of safety governing post-construction activities for the installation, inspection and repair and alteration of pressure-retaining items, and to interpret these rules when questions arise regarding their intent. In formulating the rules, the NBIC Committee considers the needs and concerns of individuals and organizations involved in the safety of pressure-retaining items. The objective of the rules is to afford reasonably certain protection of life and property, so as to give a reasonably long, safe period of usefulness. Advancements in design and material and the evidence of experience are recognized.

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

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

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

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 postconstruction activities that will be as safe as otherwise provided by the rules in the original Code of Construction.

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

construction, inspection, testing, and documentation.

There are instances where the NBIC serves to warn against pitfalls; but the Code is not a handbook, and cannot substitute for education, experience, and sound engineering judgment. It is intended that this Edition of the NBIC not be retroactive. Unless the Jurisdiction imposes the use of an earlier edition, the latest effective edition is the governing document.

Introduction

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

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

Scope

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

- Installation
- Inspection
- Repairs and Alterations

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

The words 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.
- *Part 4, Pressure Relief Devices – This part provides information and guidance on the installation, inservice inspection and repair of pressure relief devices.*

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

Text Identification and Numbering

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

Paragraphs under sections or subsections shall be designated with small letters in parenthesis (e.g., a), b), c)) and further subdivided using numbers in parenthesis (e.g., 1), 2), 3)).

Subdivisions of paragraphs beyond this point will be designated using a hierarchical sequence of letters and numbers followed by a dot.

Example:

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

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

Supplements

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

Interpretations

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

Jurisdictional Precedence

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

Units of Measurement

Both 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 Supplement 6, Parts 2 and 3, Continued Service and Inspection of 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 programs, 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 “R” and NR” repair organizations. Requirements for “VR” repair organizations are included in Part 4.

The National Board also administers and accredits four specific inspection agency programs as shown below:

New Construction

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

Inservice

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

Owner-User

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

Federal Government

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

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

The National Board of Boiler and Pressure Vessel Inspectors

1055 Crupper Avenue

Columbus, OH 43229-1183

Phone — 614.888.8320

Fax — 614.847.1828

Web site — www.nationalboard.org

Certificates of Authorization for Accreditation Programs

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

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

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

All charts, graphs, tables, and other criteria that have been reprinted from the *ASME Boiler and Pressure Vessel Code*, Sections I, IV, VIII, and X are used with the permission of the American Society of Mechanical Engineers. All Rights Reserved.

INSTALLATION of Pressure Relief Devices

(previously in Part 1)

1.0 Installation of Pressure Relief Devices

The correct selection of appropriate pressure relief devices (PRDs) and the proper installation of those devices are critical to the safe operation of pressure retaining Items. Following are requirements for the installation of pressure relief devices for protection of different types of pressurized equipment. See NBIC Part 1 for general installation requirements. **Different types of pressurized equipment conflicts with TOC**

1.1.1 ~~2.9.4~~ Pressure Relief Devices — Definitions

- a) *Pressure Relief Device: A device designed to prevent pressure or vacuum from exceeding a predetermined value in a pressure by the transfer of fluid during emergency or abnormal conditions.*
- b) *Pressure Relief Valve (PRV): A pressure relief device designed to actuate on inlet static pressure and reclose after normal conditions have been restored.*
- c) *Safety valve: A pressure relief valve characterized by rapid opening and normally used to relieve compressible fluids.*
- d) *Safety relief valve: A pressure relief valve characterized by rapid opening or by gradual opening that is generally proportional to the increase in pressure. It can be used for compressible or incompressible fluids.*
- e) *Relief valve; A pressure relief valve characterized by gradual opening that is generally proportional to the increase in pressure. It is normally used for incompressible fluids.*
- f) *Pilot operated pressure relief valve: A pressure relief valve in which the disk is held closed by system pressure, and the holding pressure is controlled by a pilot valves actuated by system pressure.*

1.1.1.1 ~~4.4~~ Additional DEFINITIONS RELATING TO PRESSURE RELIEF DEVICES

Unless otherwise specified in these rules and procedures, the definitions relating to pressure relief devices in Section 2 of ASME PTC25-2008 shall apply.

1.1 ~~2.9~~ Pressure Relief Valves For Boilers

See NBIC Part 1, par. 2.2 for the boilers covered under this section.

1.1.2 General requirements

- a) Safety valves, safety relief valves or pilot operated pressure relief valves designed to relieve steam shall be used for steam service.
- b) Safety relief valves are valves designed to relieve either steam or water, depending on the application.
- c) ~~Safety and safety-relief~~ *Pressure 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, pressure 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~~ *pressure relief* valves with an inlet connection greater than NPS 3 (DN 80) used for pressure greater than 15 psig (1003-kPa), shall have a flanged inlet connection or a welding-end inlet connection. The dimensions of flanges subjected to boiler pressure shall conform to the applicable standards.
- g) When a 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.

1.1.1.1 ~~2.9.4.4~~ Number

At least one National Board capacity certified ~~pressure safety or safety-relief~~ valve shall be installed on the boiler. If the boiler has more than 500 sq. ft. (46 sq. m.) of heating surface, or if an electric boiler has a

power input of more than 3.76 million BTU/hr (1100 kW), two or more National Board capacity certified pressure ~~safety or safety~~ relief valves shall be installed.

1.1.1.2 ~~2.9.1.2~~ Location

- a) Pressure ~~Safety or safety~~ relief valves shall be placed on, or as close as physically possible, to the boiler proper.
- b) Pressure ~~Safety or safety~~ relief valves shall not be placed on the feedline.
- c) Pressure ~~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.

1.1.1.3 ~~2.9.1.3~~ Capacity

- a) The pressure-relieving valve capacity for each boiler shall be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6% above the highest pressure at which any valve is set and in no case to more than 6% above the maximum allowable working pressure of the boiler.
- b) The minimum relieving capacity for other than electric boilers and forced-flow steam generators with no fixed steam line and waterline shall be estimated for the boiler and waterwall heating surfaces as given in Table 1.1.1.3 ~~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 pressure ~~safety or safety~~ relief valves on a high temperature water boiler shall be determined by dividing the maximum output in Btu at the boiler nozzle obtained by the firing of any fuel for which the unit is designed by one thousand.
- d) The minimum pressure ~~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 pressure ~~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 1.1.1.3 ~~2.9.1.3~~ - Minimum Pounds of steam per hour per square foot of Heating Surface
lb steam/hr/sq.ft (kg/hr/sq m)**

| | Firetube Boilers | Watertube Boilers |
|------------------------------------|-------------------------|--------------------------|
| Boiler heating surface | | |
| Hand-fired | 5 (24) | 6(29) |
| stoker-fired | 7 (34) | 8 (39) |
| oil, gas, or pulverized fuel-fired | 8 (39) | 10 (49) |
| Waterwall heating surface | | |
| hand-fired | 8 (39) | 8 (39) |
| stoker-fired | 10 (49) | 12 (59) |
| oil, gas, or pulverized fuel-fired | 14 (68) | 16 (78) |
| Copper-finned watertubes | | |
| hand-fired | | 4 (20) |
| stoker-fired | | 5 (24) |
| oil, gas, or pulverized fuel-fired | | 6 (29) |

NOTES:

- When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/cu.ft.(7.5MJ/cu. m), the minimum relieving capacity should be based on the values given for hand-fired boilers above.
- The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tubesheets, and the projected area of headers need to be considered, except that for vertical firetube steam boilers, only that portion of the tube surface up to the middle gage cock is to be computed.
- For firetube boiler units exceeding 8000 Btu/ft.2 (9085 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 1000 Btu/ft.2 (1136 J/cm.2) above 8000 Btu/ft.2 (9085 J/cm.2) For units less than 7000 Btu/ft.2 (7950 J/cm.2), the factor from the table will be decreased by 1 (7950 J/cm.2).
- For watertube boiler units exceeding 16000 Btu/ft.2 (18170 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 1000 Btu/ft.2 (1136 J/cm.2) above 16000 Btu/ft.2 (18170 J/cm.2). For units with less than 15000 Btu/ft.2 (17034 J/cm.2), the factor in the table will be decreased by 1 (4.88) for every 1000 Btu/ft.2 (1136 J/cm.2) below 15000 Btu/ft.2 (17034 J/cm.2).

1.1.1.4 2.9.1.4 Set Pressure

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

1.1.2 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, pressure relief ~~safety~~ valves may be provided in accordance with the above paragraphs identified in 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 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 actuated 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 fixed steamline and waterline:
 - 1) The power-actuated pressure-relieving valve shall also receive a control impulse to open when the maximum allowable working pressure of the component, having the lowest pressure level upstream to the stop valve, is exceeded.
 - 2) The spring-loaded safety valve shall be located to provide overpressure protection for the component having the lowest working pressure.
 - 3) A reliable pressure-recording device shall always be in service and records kept to provide evidence of conformity to the above requirements.

1.1.3 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 pressure safety relief valve or valves, on the boiler, as distinct from the superheater, is at least 75% of the aggregate capacity required.
- c) Every independently fired superheater that may be shut off from the boiler and permit the superheater to become a fired pressure vessel shall have one or more safety valves having a discharge capacity equal to six pounds of steam per hr/sq. ft. (29 kg per hr per sq. m) of superheater surface measured on the side exposed to the hot gases.
- d) Every safety valve used on a superheater discharging superheated steam at a temperature over 450°F (230°C) shall have a casing, including the base, body, bonnet, and spindle constructed of steel, steel alloy, or equivalent heat-resistant material. The valve shall have a flanged inlet connection or a welding-end inlet connection. The seat and disk shall be constructed of suitable heat-erosive and corrosive-resistant material, and the spring fully exposed outside of the valve casing so that it is protected from contact with the escaping steam.

1.1.4 2.9.4 ECONOMIZERS

An economizer that may not be isolated from a boiler does not require a pressure 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 pressure relief valve. Discharge capacity, rated in lbs/hr (kg/hr), of the pressure safety relief valve or valves shall be calculated from the maximum expected heat absorption rate in Btu/hr (Joules/hr) of the economizer, and will be determined from manufacturer data, divided by 1000. The pressure relief valve shall be located as close as possible to the economizer outlet.

1.1.5 2.9.5 Pressure-Reducing Valves

- a) Where pressure-reducing valves are used, one or more pressure ~~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 pressure ~~safety or safety~~ relief valves shall be located as close as possible to the pressure reducing valve.
- c) Capacity of the pressure ~~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 pressure ~~safety or safety~~ relief valves or meets the requirements of the high pressure system.
- e) See Supplement XX1 (*check x-ref*) for additional information on the calculation of the required capacity of pressure relief valves installed after pressure-reducing valves.

1.1.6 2.9.6 Installation Mounting and Discharge Requirements

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

opening for inlet of steam shall be 1/4 in. (6 mm). If pressure relief valves are attached to a separate steam drum or dome, the opening between the boiler proper and the steam drum or dome shall be not less than 10 times the total area of the safety valve inlet.

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

c) The opening or connection between the boiler and the pressure relief valve shall have at least the area of the valve inlet. No valve of any description should be placed between the pressure relief valves and the boiler, nor on the discharge pipe between the pressure relief valves and the atmosphere. When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet or of the total of the areas of the valve outlets, discharging thereinto and shall be as short and straight as possible and arranged to avoid undue stresses on the valve or valves.

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

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

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

g) All pressure relief valves shall be piped to a safe point of discharge so located or piped as to be carried clear from running boards or platforms. Ample provision for gravity drain shall be made in the discharge pipe at or near each pressure relief valve, and where water or condensation may collect. Each valve shall have an open gravity drain through the casing below the level of the valve seat. For iron- and steel bodied valves exceeding NPS 2 (DN 50), the drain hole shall be tapped not less than NPS 3/8 (DN 10).

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

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

1.1.6.1 2.3.4 SUPPORTS, FOUNDATIONS, AND SETTINGS

Each boiler *pressure relief valve* 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 *reaction forces* ~~the weight of water during a hydrostatic test~~) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable. (adapted from Part 1, 2.3.1)

1.1.7 2-2.12.7 Pressure Relief Valves for Thermal Fluid Heaters

f. Pressure Relief Valves — Pressure relief valves shall be a closed bonnet design with no manual lift lever. A valve body drain is not required.

The pressure relief discharge should be connected to a closed, vented storage tank or blowdown tank with solid piping (no drip pan elbow, or other air gap). When outdoor discharge is used, the following should be considered for discharge piping at the point of discharge:

1. Both thermal and chemical reactions (personnel hazard)
2. Combustible materials (fire hazard)
3. Surface drains (pollution and fire hazard)
4. Loop seal or rain cap on the discharge (keep both air and water out of the system)
5. Drip leg near device (prevent liquid collection)
6. Heat tracing for systems using high freeze point fluids (prevent blockage)

(The following was developed based upon ASME Code Section I, Part PVG)

7. A suitable condenser that will condense all the vapors discharged from the pressure relief valve may be used in lieu of piping the vapors to the atmosphere.

8. In order to minimize the loss by leakage of material through the pressure relief valve, a rupture disk may be installed between the pressure relief valve and the vaporizer, provided the following requirements are met.

8.1 The cross-sectional area of the connection to a vaporizer shall be not less than the required relief area of the rupture disk.

8.2 The maximum pressure of the range for which the disk is designed to rupture does not exceed the opening pressure for which the pressure relief valve is set or the maximum allowable working pressure of the vessel.

8.3 The opening provided through the rupture disk, after breakage, is sufficient to permit a flow equal to the capacity of the attached valve, and there is no chance of interference with the proper functioning of the valve, but in no case shall this area be less than the inlet area of the valve.

8.4 The space between a rupture disk and the valve should be provided with a pressure gage, try cock, free vent, or a suitable telltale indicator. This arrangement permits the detection of disk rupture or leakage.

8.5 Pressure relief valve discharge capacity shall be determined from the following equation:

$$W = CKAP \sqrt{M/T}$$

Where

A = discharge area of pressure relief valve

C = constant for vapor that is a function of the ratio of Specific Heats $k = c_p/c_v$.

Note: Where k is not known, $k = 1.001$.

K = coefficient of discharge for the valve design

M = molecular weight

P = (set pressure \times 1.03) + Atmosphere Pressure

T = absolute temperature at inlet, $^{\circ}\text{F} + 460$ ($^{\circ}\text{C} + 273$)

W = flow of vapor

The required minimum pressure relief valve relieving capacity shall be determined from the following equation:

$$W = C \times H \times 0.75/h$$

where

C = maximum total weight or volume of fuel burned per hour, lb (kg) or ft³ (m³)

H = heat of combustion of fuel, Btu/lb (J/kg) or Btu/ft³ (J/m³)

h = latent heat of heat transfer fluid at relieving pressure, Btu/lb (J/kg)

W = weight of organic fluid vapor generated per hour

The sum of the pressure relief valve capacities marked on the valves shall be equal to or greater than W.

1.2 3.9 Pressure Relief Valves for Steam Heating Boilers, Hot-Water heating boilers, Hot water supply Boilers and Potable Hot Water Heaters

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

1.2.1 3.9.1 Pressure Relief Safety-Valve Requirements — general

The following general requirements pertain to the installation of mounting, and connecting pressure relief safety valves on heating boilers.

1.2.1.1 3.9.1.1 Installation of Mounting Pressure Relief Safety and Safety-Relief Valves for Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers

1.2.1.1.1 3.9.1.1.1 Permissible Installation Mounting

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

They shall be connected directly to a tapped or flanged opening in the boiler, to a fitting connected to the boiler by a short nipple, to a Y-base, or to a valveless header connecting steam or water outlets on the

same boiler. Coil or header type boilers shall have the safety valve or safety relief valve located on the steam or hot water outlet end. Safety valves and safety relief valves shall be installed with their spindles vertical. The opening or connection between the boiler and any safety valve or safety relief valve shall have at least the area of the valve inlet.

1.2.1.1.2 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 (DN100), two or more valves having the required combined capacity shall be used. When two or more valves are used on a boiler, they may be single, directly attached, or *installed mounted* on a Y-base.

1.2.1.2 3.9.1.2 Threaded Connections

A threaded connection may be used for attaching a valve.

1.2.1.3 3.9.1.3 Prohibited Installations Mountings

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

1.2.1.4 3.9.1.4 Use of Shutoff Valves Prohibited

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

1.2.1.5 3.9.1.5 Pressure Relief ~~Safety and Safety Relief~~ Valve Discharge Piping

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

1.2.1.6 3.9.1.6 Temperature and Pressure Safety Relief Valves

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

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

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

c) When the temperature and pressure safety relief valve is *installed mounted* directly on the boiler with no more than 4 in. (100 mm) maximum interconnecting piping, the valve ~~may should~~ be installed in the horizontal position with the outlet pointed down.

1.2.2 3.9.2 Safety Valve Requirements for Steam Heating Boilers

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

b) Each steam boiler shall have one or more National Board capacity certified safety valves of the spring pop type adjusted and sealed to discharge at a pressure not to exceed 15 psig (100 kPa).

c) No safety valve for a steam boiler shall be smaller than NPS 1/2 (DN 15). No safety valve shall be larger than NPS 4 (DN 100). The inlet opening shall have an inside diameter equal to, or greater than, the seat diameter.

d) The minimum valve capacity in pounds (kilograms) per hour shall be the greater of that determined by dividing the maximum Btu (Watts) output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1000 Btu/lb (645 W/hr/kg), or shall be determined on the basis of the pounds (kilograms) of steam generated per hour per square foot (square meter) of boiler heating surface as given in Table 3.9.2. For cast-iron boilers, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirement of 3.9.2(e) shall be met.

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

f) When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with 3.9.2(e). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

1.2.3 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 (414kPa), 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 (4.4kW) should be equipped with a rated safety relief valve of NPS 1/2 (DN 15).

f) The required relieving capacity, in pounds per hour (kg/hr), of the pressure relieving device or devices on a boiler shall be the greater of that determined by dividing the maximum output in Btu (Watts) at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1000 Btu/lb (645 w/kg), or shall be determined on the basis of pounds (kilograms) of steam generated per hour per square foot (square meter) of boiler heating surface as given in Table

3.9.2. For cast-iron boilers, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirements of 3.9.3(h) shall be met. When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and shall be in accordance with 3.9.3(h). The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

h) Safety relief valve capacity for each boiler with a single safety relief valve shall be such that, with the fuel burning equipment installed and operated at maximum capacity, the pressure cannot rise more than 10% above the maximum allowable working pressure. When more than one safety relief valve is used, the over pressure shall be limited to 10% above the set pressure of the highest set valve allowed by 3.9.3(b).

1.2.4 3.9.4 Safety Relief Valve Requirements for Potable Water Heaters

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

b) The pressure setting shall be less than or equal to the maximum allowable working pressure of the water heater. However, if any of the other components in the hot-water supply system (such as valves,

pumps, expansion or storage tanks, or piping) have a lesser working pressure rating than the water heater, the pressure setting for the safety relief valve(s) shall be based upon the component with the lowest maximum allowable working pressure rating. If more than one safety relief valve is used, the additional valve(s) may be set within a range not to exceed 10% over the set pressure of the first valve.

c) The required relieving capacity in Btu/hr (W) of the safety relief valve shall not be less than the maximum allowable input unless the water heater is marked with the rated burner input capacity of the water heater on the casing in a readily visible location, in which case the rated burner input capacity may be used as a basis for sizing the safety relief valves. The relieving capacity for electric water heaters shall be 3500 Btu/hr (1.0 kW) per kW of input. In every case, the following requirements shall be met. Safety relief valve capacity for each water heater shall be such that with the fuel burning equipment installed and operating 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.

1.2.4.1 ~~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.

1.2.4.2 ~~3.9.4.2~~ Permissible *Installations* 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 *installed* ~~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 *install* ~~mount~~ the safety valve shall be of nominal pipe size less than that of the valve inlet.

1.2.4.3 ~~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 installed ~~mounted~~ on a Y-base.

1.2.4.4 ~~3.9.4.4~~ Threaded Connections

A threaded connection may be used for attaching a *pressure relief* valve.

1.2.4.5 ~~3.9.4.5~~ Prohibited *Installations* Mountings

Pressure 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.

1.2.4.6 ~~3.9.4.6~~ Use of Shutoff Valves Prohibited

No shutoff *valve* 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.

1.2.4.7 ~~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.

1.2.5 ~~3.9.5~~ Pressure Relief Safety and Safety-Relief Valves for Tanks and Heat Exchangers

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

1.2.5.2 ~~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 *Part 1, paragraph 3.2, Definitions*, the heat exchanger shall be equipped with one or more National Board capacity certified *pressure 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.

1.2.5.3 ~~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 *Part 1, paragraph 3.2, Definitions*, the heat exchanger shall be equipped with one or more National Board capacity certified *pressure relief 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 *Part 1, Section 2 or Section 4 of this Part*.

1.3 Pressure Vessel Pressure Relief Devices

See Part 1, par. 4.1 for the scope of pressure vessels covered by these requirements..

All pressure vessels shall be protected by pressure relief devices in accordance with the following requirements.

1.3.1 ~~4.5.1~~ Device Requirements

a) Pressure relief devices are to be manufactured in accordance with a national or international standard and shall be certified for capacity (or resistance to flow for rupture disk devices) by the National Board.

b) Dead weight or weighted lever pressure relief valves shall not be used.

c) An unfired steam boiler shall be equipped with pressure relief valves as required in Section 2 of this Part. (See 2.9).

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

1.3.2 ~~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.

1.3.3 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 4.5.6 e) 2) (CHECK PAR. X-REF).
- b) Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or in the piping system connected to the vapor space.
- c) Pressure relief devices intended for use in liquid service shall be connected below the normal liquid line. *The liquid level during upset conditions shall be considered.*

1.3.4 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 ~~may should~~ be considered as one unit when determining capacity requirements.
- d) Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid overpressure in case of internal failure.
- e) When a non-reclosing device is installed between a pressure relief valve and the pressure vessel, the reduction in capacity due to installation of the non-reclosing device shall be determined in accordance with the code of construction by use of a National Board certified Combination Capacity Factor (CCF). For rupture disks, if a certified combination capacity factor is not available, the capacity of the pressure relief valve shall be multiplied by 0.9 and this value used as the capacity of the combination installation.
- f) The owner shall document the basis for selection of the pressure relief devices used, including capacity, and have such calculations available for review by the Jurisdiction.

1.3.5 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.

1.3.6 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.
- b) A non-reclosing device installed between a pressure vessel and a pressure relief valve shall meet the requirements of 4.5.6(a) (check cross reference here).
- c) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device.
- d) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of 4.5.6(a).
- e) There shall be no intervening stop valves between the vessel and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge, except under the following conditions:

- 1) When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity; or,
- 2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a pressure vessel and its pressure relief device should be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station.
- 3) A full area stop valve should also be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked and sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed.
- 4) A pressure vessel in a system where the pressure originates from an outside source should 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.
- h) Pressure relief devices shall be installed so they are readily accessible for inspection, repair, or replacement.
- i) *Pressure vessel pressure relief devices and discharge piping shall be safely support. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal movement), and loadings (including reaction forces during device operation the weight of water during a hydrostatic test) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable. (Based upon Part 1, 4.3.1.)*

1.4 5.3 Piping System Pressure Relief Devices

See NBIC Part 1, par. X.x for the piping systems covered under this section.

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

1.4.1 5.3.4 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.

1.4.2 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.

1.4.3 5.3.3 Location

Pressure relief devices, except those covered by Sections 1.1 through 1.3-2 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 5.3.6 e).

check cross reference

1.4.4 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 in the original code of construction.

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

c) The owner shall document the basis for selection of the pressure relief devices used, including capacity, and have such calculations available for review by the Jurisdiction, when required.

1.4.5 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.

1.4.6 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 5.3.6(a). **check cross reference**

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 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; or,

- 2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a piping system and its pressure relief device ~~should~~ *may* be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station.
- 3) A full area stop valve may be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed.
- 4) A piping system where the pressure originates from an outside source should have a stop valve between the system and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of pressure.
- f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.
- g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device.
- h) The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping.
- l) Pressure relief devices shall be installed so they are accessible for inspection, repair, or replacement.

In-Service Inspection (previously in Part 2)

2.0 2.5 In-Service Inspection of Pressure Relief Devices

Once a pressure relief device is installed on a piece of pressurized equipment or system, it must be periodically inspected and tested to assure that the pressure relieving function can still be relied upon. The inspection of pressure relief devices is often coordinated with the inspection of the system. See NBIC Part 2 for in service inspection requirements and procedures for other portions of the equipment not discussed below.

2.1 2.5.1 Scope

- a) The most important appurtenances on any pressurized system are the pressure relief devices provided for overpressure protection of that system. These are devices such as safety valves, safety relief valves, pilot valves, and rupture disks or other nonreclosing devices that are called upon to operate and reduce an overpressure condition.
- b) These devices are not designed or intended to control the pressure in the system during normal operation. Instead, they are intended to function when normal operating controls fail or abnormal system conditions are encountered.
- c) Periodic inspection and maintenance of these important safety devices is critical to ensure their continued functioning and to provide assurance that they will be available when called upon to operate. See 2.5.8 (CHECK X-REF) for recommended testing frequency for PRDs.
- d) Inspection areas of concern include:
 - 1) correct set pressure; (matching of set pressure to MAWP)
 - 2) safety considerations; (is something missing here? Need information on respecting pressure, noise, heat etc)
 - 3) device data;
 - 4) condition of the device;
 - 5) condition of the installation; and
 - 6) testing and operational inspection.

2.1.1 2.5.2 Pressure Relief Device Data

- a) Nameplate marking or stamping of the device should be compared to stamping on the protected pressure-retaining item.
For a single device, the set pressure shall be no higher than the maximum allowable working pressure (MAWP) marked on the protected pressure-retaining item or system.
- b) If multiple devices are provided, the difference between set pressures shall not exceed that permitted by the original code of construction. The set pressure of additional devices may exceed the MAWP, as permitted by the original Code of Construction.
- c) Verify nameplate capacity and, if possible, compare to system capacity requirements.
- d) Check identification on seals and ensure they match nameplates or other identification (repair or reset nameplate) on the valve or device.

2.1.2 2.5.3 Device conditions

- a) Check for evidence that the valve or device is leaking or not sealing properly. Evidence of leakage through pressure-relief valves may indicate that the system is being operated at a pressure that is too close to the valve's set pressure. (See Part 2, Supplement 2 & for guidance on the pressure differential between the pressure relief valve set pressure and system operating pressure.)
- b) Seals for adjustments shall ~~should~~ be intact and show no evidence of tampering.
- c) Connecting bolting should be tight and all bolts intact.
- d) The valve or device should be examined for deposits or material buildup.
- e) Evidence of rust or corrosion should be checked.
- f) Check for damaged or misapplied parts.
- g) If a drain hole is visible, ensure it is not clogged with debris or deposits.
- h) Check for test gags left in place after pressure testing of the unit.

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

2.1.3 2.5.4 Installation Condition

- a) Inspect inlet piping and ensure it meets the requirements of the original Code of Construction. For pressure relief valves, check that the inlet pipe size is not smaller than the device inlet size.
- b) Inspect discharge piping and ensure it meets the original Code of Construction. Check that the discharge pipe size is not smaller than the device outlet size.
- c) Check that the valve drain piping is open.
- d) Check drainage of discharge piping.
- e) Check that inlet and discharge piping are not binding or placing excessive stress on the valve body, which can lead to distortion of the valve body and leakage or malfunction.
- f) Check the condition and adequacy of piping supports. Discharge piping should be supported independent of the device itself.
- g) Check for possible hazards to personnel from the valve discharge or discharge pipe.
- h) Check that there are no intervening isolation valves between the pressure source and the valve inlet or between the valve outlet and its point of discharge. (Isolation valves may be permitted in some pressure vessel service. See Part 1, 5.3.6 e.), and jurisdictional requirements. Isolation valves are not permitted for power boilers, heating boilers, or water heaters.)
- i) A change-over valve, which is used to install two pressure relief devices on a single vessel location for the purpose of switching from one device to a spare device, is not considered a block valve if it is arranged such that there is no intermediate position that will isolate both pressure relief devices from the protected system. Change-over valves should be carefully evaluated to ensure they do not have excessive pressure drop that could affect the pressure relief device operation or capacity. These devices are commonly used in pressure vessel service. They may also be used in some boiler applications. It is recommended that the Jurisdiction be contacted to determine their acceptability on boiler applications.

2.1.4 2.5.5 Additional Inspection Requirements

Following are additional items that should be considered for the specified types of installations or services.

2.1.4.1 2.5.5.1 BOILERS

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

2.1.4.2 2.5.5.2 PRESSURE VESSELS AND PIPING

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

2.1.4.3 2.5.5.3 RUPTURE DISKS

- a) Rupture disks or other non-reclosing devices may be used as sole relieving devices or in combination with safety relief valves to protect pressure vessels.
- b) The selection of the correct rupture disk device for the intended service is critical to obtaining acceptable disk performance. Different disk designs are intended for constant pressure, varying pressure, or pulsating pressure. Some designs include features that make them suitable for back pressure and/or internal vacuum in the pressure vessel.
- c) The margin between the operating pressure and the burst pressure is an important factor in obtaining acceptable performance and service life of the disk. Flat and prebulged solid metal disks are typically used with an operating pressure that is no more than 60% to 70% of the burst pressure. Other designs are available that increase the operating pressure to as much as 90% of the burst pressure. Disks that have been exposed to pressures above the normal operating pressure for which they are designed are subject to fatigue or creep and may fail at unexpectedly low pressures. Disks used in cyclic service are also subject to fatigue and may require a greater operating margin or selection of a device suitable for such service.
- d) The disk material is also critical to obtaining acceptable service life from the disk. Disks are available in a variety of materials and coatings, and materials that are unaffected by the process fluid should be used. Disks that experience corrosion may fail and open at an unexpectedly low pressure.
- e) Disk designs must also be properly selected for the fluid state. Some disk types are not suitable for use in liquid service. Some disks may have a different flow resistance when used in liquid service, which may affect the sizing of the disk.
- f) Information from the rupture disk manufacturer, including catalog data and installation instructions, should be consulted when selecting a disk for a particular service.
- g) For rupture disks and other non-reclosing devices, the following additional items should be considered during inspections.
 - 1) The rupture disk nameplate information, including stamped burst pressure and coincident temperature, should be checked to ensure it is compatible with the intended service. The coincident temperature on the rupture disk shall be the expected temperature of the disk when the disk is expected to burst and will usually be related to the process temperature, not the temperature on the pressure vessel nameplate.
 - 2) Markings indicating direction of flow should be carefully checked to ensure they are correct. Some rupture disks when installed in the incorrect position may burst well above the stamped pressure.
 - 3) The marked burst pressure for a rupture disk installed at the inlet of a safety relief valve shall be equal to or less than the safety relief valve set pressure. A marked burst pressure of 90% to 100% of the safety relief valve set pressure is recommended. A disk with a non-fragmenting design that cannot affect the safety relief valve shall be used.

Note: If the safety relief valve set pressure is less than the vessel MAWP, the marked burst pressure may be higher than the valve set pressure, but no higher than the MAWP.

- 4) Check that the space between a rupture disk and a safety relief valve is supplied with a pressure gage, try cock, or telltale indicator to indicate signs of leakage through the rupture disk. The safety relief valve shall be inspected and the leaking disk shall be replaced if leakage through the disk is observed.
- 5) If a rupture disk is used on a valve outlet, the valve design must be of a type not influenced by back pressure due to leakage through the valve. Otherwise, for nontoxic and non-hazardous fluids, the space between the valve and the rupture disk shall be vented or drained to prevent the accumulation of pressure.
- 6) For rupture disks installed on the valve inlet, the installation should be reviewed to ensure that the combination rules of the original Code of Construction have been applied. A reduction in the valve capacity up to 10% is expected when used in combination with a non-reclosing device.
- 7) The frequency of inspection for rupture disks and other non-reclosing devices is greatly dependent on the nature of the contents and operation of the system and only general recommendations can be given. Inspection frequency should be based on previous inspection history. If devices have been found to be leaking, defective, or damaged by system contents during inspection, intervals should be shortened until acceptable inspection results are obtained. With this in mind, the inspection frequency guidelines specified in 2.5.8 are suggested for similar services.
- 8) Rupture disks are often used to isolate pressure relief valves from services where fouling or plugging of the valve inlet occurs. This tendency should be considered in establishing the inspection frequency.

9) Since these devices are for one time use, a visual inspection is the only inspection that can be performed. Rupture disks that are installed using a specified bolting torque procedure cannot be reused after inspection and must be replaced.

10) It is recommended that all rupture disks be periodically replaced to prevent unintended failure while in service due to deterioration of the device.

Rupture disks should be carefully checked for damage prior to installation and handled by the disk edges, if possible. Any damage to the surface of the ruptured disk can affect the burst pressure.

~~2.5.6 Packaging, Shipping and Transportation of Pressure Relief Devices~~ (moved to Supplement 4 for repair procedures and combined with similar text)

2.1.5 ~~2.5.7~~ Testing and Operational Inspection of Pressure Relief Devices

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

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

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

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

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

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

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

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

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

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

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

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

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

Note: Valves being tested after a repair must be tested on steam except as permitted by Part 3, *Repairs and Alterations*, Section 4.5.2 (CHECK X-REF).

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