Ballot Comments

Name	Document	Comment	Date Created	Is Active
Raymond Snyder		I agree with Venus Newton and others ,I do not agree in this separating these references from Parts1,2or3.	05/25/2012	☑ True
Raymond Snyder		I agree with Venus Newton and others ,I do not agree in this separating these references from Parts1,2or3.	05/25/2012	☑ True
Raymond Snyder		I agree with Venus Newton and others ,I do not agree in this separating these references from Parts1,2or3.	05/25/2012	☑ True
Donald Patten		I think that in removing the PRD information from Part 1 will leave a void. I would assume that a reference for installation of PRD's in Part 1 directing you to Part 4 would be appropriate.	05/23/2012	☑ True
Gary Scribner		I also feel that the basic installation requirements for PRD's should be at least duplicated in section one so that an installer understands the basic requirements for the vessel being installed.	05/23/2012	☑ True
Joseph Ball		Any requirements concerning discharge piping from pressure relief devices were intended to be moved to part 4 so inlet piping, device requirements themselves, and discharge piping are all together in one location.	05/23/2012	☑ True
Geoffrey Halley		While I am in general agreement with a separate PRV section, I wonder if it is wise to separate the vent pipework from the installation section.	05/21/2012	☑ True
Stanley Konopacki		No comments at this time	05/10/2012	☑ True
Michael Richards		No comments.	05/02/2012	☑ True
Joseph Ball		Not a member. Voting to activate ability to respond to comments	05/01/2012	☐ False
Joseph Ball		Dear Mr. Tyndall, I appreciate (and anticipated) some comments like this. Development of a stand alone PRD document was authorized by the executive committee because it represents manufacturing and repair industries that are usually separate from boiler/pressure vessel manufacturing and repair, although other NBIC users (such as Users and Inspectors) probably look at the use of a PRD along with	05/01/2012	☑ True

	the rest of the unit being protected. A final resolution of your comment will ultimately come from the NBIC committee after consideration of the comments received during this balloting. Thank you for your comment and concerns. J. Ball		
Harold Tyndall	I like the ability to go to one part of the NB Code to see what I need. If I am looking at Section I Power Boilers, I want to find all I need to know in once section. If we break out PRDs, what will be next	04/26/2012	☑ True

Ballot Comments NB11-0401 INSP

Name	Document	Comment	Date Created	Is Active
Bob Reetz		I agree with Venus Newton and others. I do not believe that separating all references to PRD's from Parts I and 2 and 3 and creating a new Part 4 will enhance anything. I recommend leaving the references just where they are at present. As an inspector, it just complicates matters to have to jump back and forth between NBIC sections to understand an issue. For these reasons, this action to remove PRD references from each Part of the NBIC does not have my approval.	05/23/2012	☑ True
Jim Riley		Speaking for owner-users we support PRD related items moving to a new Part 4. Our owner-user agencies keep all current NBIC parts in electronic form with all other industry and regulatory codes. Easy access search using PDF format. Inspectors are fluent with electronic access and rely on it for most recent information. Good summary by Joe Ball.	05/23/2012	☑ True
Mark Horbaczewski		However, I agreed with Dave Parish more work has to be done so we are consistent with the other sections. I believe that a new item for business may have to be opened and get committee members to go over these changes thoroughly.	05/23/2012	☑ True
Venus Newton		I don't agree with the whole idea of removing the PRD's	05/23/2012	☑ True

		from Part 2, because now in order to perform a complete inspection of a pressure retaining item a field inspector has yet one more Code book to go to. It's just adding to the confusion of performing an inservice inspection.		
Joseph Ball	56c03783-d093-4c71-858e-b17acdbf5a7c.docx	See attached document	05/23/2012	☑ True
Joseph Ball		Thanks to David Parrish for the detailed review. Material in Supplements was kept in those documents considering the users want the information for these particular types of equipment in one place, and those supplements were written in that fashion. See the attachment for more detailed responses.	05/23/2012	☑ True
Joseph Ball		Please see response to Mr. Parrish. Thank you.	05/23/2012	☐ False
Timothy Barker		I agree with Mr. Parrish's comments. I like the idea but there are many areas that were missed with the changeover and a lot of areas referencing Safety Valves where it should be PRD's.	05/04/2012	☑ True
Dave Parrish	NBIC PART 2 with Part 4 removed dkpComments.docx	There is general agreement within FM Global with the objective to consolidate OPD guidance into a specific part. There is, however, concern about redundancy in each PART and across all four PARTS. Currently, there are some inconsistencies resulting from duplications of text. The proposed PART 4 does reduce some of	05/04/2012	☑ True

	the redundancy and inconsistency, but further effort is needed. Attached is a quick review of proposed PART 2 INSPECTION to demonstrate how improvement can be accomplished.		
John Richardson	The changes appear to be in order.	04/27/2012	☑ True

Dave Parrish Comments

NBIC PART 2 with Part 4 removed.docx

(NOTE: All general pressure relief device information that will be moved to part 4 is shown as strike through text. Detail PRD information in supplements has *not* been moved, examples: DOT, historic boilers)
4-25-12

Organization
The NBIC is organized into three ***four*** 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

2.2 Boilers 20
2.2.1 Scope 20
2.2.2 Service Conditions 20
2.2.3 Pre-Inspection Activities 20
2.2.4 Condition of Boiler Room or Boiler Location 20
2.2.5 External Inspection 21
2.2.6 Internal Inspection 21
2.2.7 Evidence of Leakage 22
2.2.8 Boiler Corrosion Considerations 22
2.2.9 Waterside Deposits 22
2.2.10 Inspection of Boiler Piping, Parts, and Appurtenances 23
2.2.10.1 Boiler Piping 23
2.2.10.3 Flanged or Other Connections 23
2.2.10.4 Miscellaneous 23
2.2.10.4 Gages 23
2.2.10.5 Pressure Relief Devices 24
2.2.10.6 Controls 24
2.2.11 Records Review 25
2.2.12 Description and Concerns of Specific Types of Boilers 25
2.2.12.1 Cast-Iron Boilers 25
2.2.12.2 Firetube Boilers 26
2.2.12.3 Watertube Boilers 28

2.2.12.4 Electric Boilers 29
2.2.12.5 Fired Coil Water Heaters 29
2.2.12.6 Fired Storage Water Heaters 30
2.2.12.7 Thermal Fluid Heaters 30
2.2.12.8 Waste Heat Boilers 32
2.2.12.9 Kraft or Sulfate Black Liquor Recovery Boilers 33
2.3 Pressure Vessels 35
2.3.1 Scope 35
2.3.2 Service Conditions 35
2.3.3 External Inspection 36
2.3.4 Internal Inspection 37
2.3.5 Inspection of Pressure Vessel Parts and Appurtenances 38
2.3.5.1 Gages 38
2.3.5.2 Safety Devices 38
2.3.5.3 Controls/Devices 38
2.3.5.4 Records Review 38
2.3.6 Description and Concerns of Specific Types of Pressure Vessels 39
2.3.6.1 Deaerators 39
2.3.6.2 Compressed Air Vessels 40
2.3.6.3 Expansion Tanks 40
2.3.6.4 Liquid Ammonia Vessels 41
2.3.6.5 Inspection of Pressure Vessels with Quick-Actuating Closures 45
2.4 Piping and Piping Systems 47
2.4.1 Scope 47
2.4.2 Service Conditions 47
2.4.3 Assessment of Piping Design 47
2.4.4 External Inspection of Piping 47
2.4.5 Internal Inspection of Piping 48
2.4.6 Evidence of Leakage 48
2.4.7 Provisions for Expansion and Support 48

2.4.8 Inspection of Gages, Safety Devices, and Controls 49
2.4.8.1 Gages 49
2.4.8.2 Safety Devices 49
2.4.8.3 Quick-Disconnect Coupling 49
~~2.5 Pressure Relief Devices ..... 49~~
~~2.5.1 Scope ..... 49~~
~~2.5.2 Pressure Relief Device Data ..... 50~~
~~2.5.3 Inservice Inspection Requirements for Pressure Relief Devices Conditions ..... 50~~
~~2.5.4 Inservice Inspection Requirements for Pressure Relief Devices Installation Condition ..... 51~~
~~2.5.5 Additional Inspection Requirements ..... 51~~
~~2.5.5.1 Boilers ..... 51~~
~~2.5.5.2 Pressure Vessels and Piping ..... 52~~
~~2.5.5.3 Rupture Disks ..... 52~~
~~2.5.6 Packaging, Shipping and Transportation ..... 54~~
~~2.5.7 Testing and Operational Inspection of Pressure Relief Devices ..... 54~~
~~2.5.8 Recommended Inspection and Test Frequencies for Pressure Relief Devices ..... 56~~
Section 3 Corrosion and Failure Mechanisms 59
3.1 Scope 60
3.2 General 60
3.3 Corrosion 60
3.3.1 Macroscopic Corrosion Environments 60
3.3.2 Microscopic Corrosion Environments 62
4
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION
2011
3.3.3 Control of Corrosion 62
3.3.3.1 Process Variables 62
3.3.3.2 Protection 63
3.3.3.3 Material Selection 63
3.3.3.4 Coatings 63
3.3.3.5 Engineering Design 64
3.3.3.6 Conclusion 64
3.4 Failure Mechanisms 64
3.4.1 Fatigue 65
3.4.2 Creep 65
3.4.3 Temperature Effects 65
3.4.4 Hydrogen Embrittlement 65
3.4.5 High Temperature Hydrogen Attack 66
3.4.6 Hydrogen Damage 66
3.4.7 Bulges and Blisters 67
3.4.8 Overheating 67
3.4.9 Cracks 67
Section 4 Examinations, Test Methods, and Evaluations 69
4.1 Scope 70
4.2 Nondestructive Examination Methods (NDE) 70
4.2.1 Visual 70
4.2.2 Magnetic Particle 70
4.2.3 Liquid Penetrant 71
4.2.4 Ultrasonic 71
4.2.5 Radiography 71
4.2.6 Eddy Current 72
4.2.7 Metallographic 72

Supplement 1 Steam Locomotive Firetube Boiler Inspection and Storage 108
S1.1 Scope 108
S1.2 Special Jurisdictional Requirements 109
S1.3 Federal Railroad Administration (FRA) 109
S1.4 Locomotive Firetube Boiler Inspection 109
S1.4.1 Inspection Methods 109
S1.4.2 Inspection Zones 110
S1.4.2.1 Riveted Seams and Rivet Heads 110
S1.4.2.2 Welded and Riveted Repairs 112
S1.4.2.3 Boiler Shell Course 112
S1.4.2.4 Dome and Dome Lid 112
S1.4.2.5 Mudring 113
S1.4.2.6 Flue Sheets 113
S1.4.2.7 Flanged Sheets 114
S1.4.2.8 Stayed Sheets 114
S1.4.2.9 Staybolts 115
S1.4.2.10 Flexible Staybolts and Sleeves 115
S1.4.2.11 Girder Stay and Crown Bars 116
S1.4.2.12 Sling Stays 117
S1.4.2.13 Crown Stays and Expansion Stays 118
S1.4.2.14 Diagonal and Gusset Braces 119
S1.4.2.15 Flues 119
S1.4.2.16 Superheater Units and Header 120

S1.4.2.17 Arch Tubes, Water Bar Tubes, and Circulators 120
S1.4.2.18 Thermic Syphons 121
S1.4.2.19 Firebox Refractory 121
S1.4.2.20 Dry Pipe 121
S1.4.2.21 Throttle and Throttle Valve 122
S1.4.2.22 Screw-Type Washout Plugs, Holes, and Sleeves 122
S1.4.2.23 Handhole Washout Doors 122
S1.4.2.24 Threaded and Welded Attachment Studs 123
S1.4.2.25 Fusible Plugs 123
S1.4.2.26 Water Glass, Water Column, and Gage Cocks 124
S1.4.2.27 Steam Pressure Gage 124
S1.4.2.28 Boiler Fittings and Piping 125
S1.4.2.29 Boiler Attachment Brackets 125
S1.4.2.30 Fire Door 125
S1.4.2.31 Grates and Grate Operating Mechanism 126
S1.4.2.32 Smokebox 126
S1.4.2.33 Smokebox Steam Pipes 126
S1.4.2.34 Ash Pan and Fire Pan 127
S1.4.3 Method of Checking Height of Water Gage Glass 127
S1.4.3.1 Water Height Measurement Method 127
S1.4.3.2 Flexible Spirit Level Method 129
S1.5 Guidelines for Steam Locomotive Storage 130
S1.5.1 Storage Methods 130
S1.5.2 Wet Storage Method 130
S1.5.3 Dry Storage Method 131
S1.5.4 Recommended General Preservation Procedures 131
S1.5.5 Use of Compressed Air to Drain Locomotive Components 134
S1.5.6 Return to Service 135
S1.6 Safety Valves ..... 136[dkp1]

S1.6 Tables and Figures..... 136
Supplement 2 Historical Boilers..... 137
S2.1 Scope..... 137
S2.2 Introduction..... 137
S2.3 Responsibilities..... 137
S2.4 General Inspection Requirements 137
S2.4.1 Pre-Inspection Requirements 138
S2.4.2 Post-Inspection Activities 138
S2.4.3 Boiler Operators..... 138
S2.4.4 Examinations and Tests 139
S2.4.4.1 Nondestructive Examination Methods..... 139
S2.4.4.2 Testing Methods..... 139
S2.5 Specific Examination and Test Methods 139
S2.5.1 Specific Examination Methods 139
S2.5.2 Visual Examination..... 140
S2.5.2.1 Preparation for Visual Inspection..... 140
S2.5.2.2 Visual Examination Requirements..... 140
S2.5.3 Ultrasonic Examination..... 141
S2.5.4 Liquid Penetrant Examination..... 141
S2.5.5 Magnetic Particle Examination..... 141
S2.6 Specific Testing Methods 141
S2.6.1 Hydrostatic Pressure Testing..... 141
S2.6.2 Ultrasonic Thickness Testing..... 141
S2.7 Inspections..... 142
S2.7.1 Inservice Inspections..... 142
S2.7.2 Inservice Inspection Documentation..... 143
S2.7.3 Inspection Intervals..... 143
S2.7.3.1 Initial Inspection..... 143
7
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION
2011
S2.7.3.2 Subsequent Inspections..... 143
S2.8 Safety Devices — General Requirements..... 144
S2.8.1 Safety Valves..... 144[dkp2]
S2.8.2 Gage Glass..... 145
S2.8.3 Try-Cocks..... 145
S2.8.4 Fusible Plug..... 145
S2.8.5 Pressure Gage..... 146
S2.9 Appurtenances – Piping, Fittings, and Valves..... 146
S2.9.1 Piping, Fittings, and Valve Replacements..... 147
S2.10 Maximum Allowable Working Pressure (MAWP)..... 147
S2.10.1 Strength..... 147
S2.10.2 Rivets..... 148
S2.10.3 Cylindrical Components 148
S2.10.4 Stayed Surfaces 167
S2.10.4.1 Staybolts 167
S2.10.5 Construction Code..... 172
S2.10.6 Nomenclature..... 172
S2.10.7 Limitations..... 173
S2.11 Boiler Inspection Guideline..... 173
S2.12 Initial Boiler Certification Report Form 179
S2.13 Guidelines for Historical Boiler Storage..... 179
S2.13.1 Storage Methods..... 179
S2.13.1.1 Wet Storage Method..... 180
S2.13.1.2 Dry Storage Method..... 180

S2.13.2 Recommended General Preservation Procedures..... 181
S2.13.3 Use of Compressed Air to Drain Historical Boiler Components..... 183
S2.13.4 Return to Service..... 183
S2.14 Safety Procedures..... 184
S2.14.1 Experience..... 184
S2.14.2 Stopping Engine in an Emergency..... 185
S2.14.3 Water Glass Breakage..... 185
S2.14.4 Runaway Engine and Governor Over Speed..... 186
S2.14.5 Killing a Fire..... 186
S2.14.6 Injector Problems..... 187
S2.14.7 Foaming or Priming Boiler..... 188
S2.14.8 Handhole Gasket Blows Out..... 188
S2.14.9 Tube Burst..... 189
S2.14.10 Leaking Valves..... 189
S2.14.11 Broken Pipes..... 189
S2.14.12 Safety Valve Problems..... 190
S2.14.13 Safety Valve Opens But Will Not Close..... 190
S2.14.14 Leaking Pipe Plugs..... 190
S2.14.15 Melted Grates..... 190
S2.15 Tables and Figures..... 190
Supplement 3 Inspection of Graphite Pressure Equipment 195
S3.1 Scope 195
S3.2 Application 195
S3.3 Operations 195
S3.4 Inservice Inspection 195
Supplement 4 Inspection of Fiber-Reinforced Thermosetting Plastic Pressure Equipment..... 197
S4.1 Scope 197
S4.2 Inservice Inspection 197
S4.3 General 197
S4.4 Visual Examination 198
S4.5 Inspector Qualifications 199
8
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION
2011
S4.6 Assessment of Installation 199
S4.6.1 Preparation 200
S4.6.2 Leakage 200
S4.6.3 Tools 200
S4.7 External Inspection 200
S4.7.1 Insulation or Other Coverings 200
S4.7.2 Exposed Surfaces 201
S4.7.3 Structural Attachments 201
S4.8 Internal Inspection 201
S4.8.1 General 201
S4.8.2 Specific Areas of Concern 202
S4.9 Inspection Frequency 202
S4.9.1 Newly Installed Equipment 202
S4.9.2 Previously Repaired or Altered Equipment 203
S4.10 Photographs of Typical Conditions 204
S4.11 Tables and Figures..... 219
Supplement 5 Inspection of Yankee Dryers (Rotating Cast-Iron Pressure Vessels) with Finished Shell Outer Surfaces 221
S5.1 Scope 221
S5.2 Assessment of Installation 221
S5.2.1 Determination of Allowable Operating Parameters..... 223

S5.2.2 Adjusting the Maximum Allowable Operating Parameters of the Yankee Dryer Due to a Reduction in Shell Thickness from Grinding or Machining..... 224
S5.2.3 Documentation of Shell Thickness and Adjusted Maximum Allowable Operating Parameters..... 224
S5.3 Causes of Deterioration and Damage 225
S5.3.1 Local Thinning 225
S5.3.2 Cracking 226
S5.3.2.1 Through Joints and Bolted Connections..... 226
S5.3.2.2 Through-Wall Leakage..... 226
S5.3.2.3 Impact From Objects Passing Through The Yankee/ Pressure Roll Nip..... 227
S5.3.2.4 Stress Magnification Around Drilled Holes..... 227
S5.3.2.5 Thermal Stress and/or Micro-Structural Change From Excessive Local Heating and Cooling..... 227
S5.3.2.6 Joint Interface Corrosion..... 227
S5.3.2.7 Stress-Corrosion Cracking of Structural Bolts..... 228
S5.3.3 Corrosion 228
S5.4 Inspections 228
S5.5 Nondestructive Examination..... 228
S5.6 Pressure Testing..... 229
S5.7 Tables and Figures..... 229
Supplement 6 Continued Service and Inspection of DOT Transport Tanks..... 230
S6.1 Scope 230
S6.2 Terminology 230
S6.3 Administration 230
S6.4 Inspection..... 230
S6.4.1 Scope..... 230
S6.4.2 General Requirements for Inspectors 231
S6.4.3 Registration of Inspectors..... 231
S6.4.4 Qualifications of Inspectors..... 231
S6.4.5 Codes of Construction..... 231
S6.4.6 Inspector Duties for Continued Service Inspections..... 231

S6.4.6.1 Inspector Duties for Continued Service Inspection of Cargo Tanks 232
S6.4.6.2 Inspector Duties for Continued Service Inspection of Portable Tanks 233
S6.4.6.3 Inspector Duties for Continued Service Inspectionsof Ton Tanks..... 233
S6.4.7 Continued Service, Inspection for DOT Transport Tanks Scope..... 233
S6.4.7.1 Administration..... 233
S6.4.7.2 Inspection and Test Required Frequencies..... 234
S6.4.7.3 External Visual and Pressure Tests..... 234
S6.4.7.4 Leak Tightness Testing of Transport Tanks..... 234
S6.4.7.4.1 Cargo Tanks..... 234
S6.4.7.4.2 Portable Tanks 235
S6.4.7.4.3 Ton Tanks..... 235
S6.4.7.4.4 Leak Tightness Testing of Valves..... 235
S6.4.7.4.4.1 Cargo Tanks..... 235
S6.4.7.4.4.2 Portable Tanks..... 235
S6.4.7.4.4.3 Ton Tanks..... 235
S6.4.7.5 Leak Tightness Testing of Safety Relief Devices..... 236 [dkp3]
S6.4.7.5.1 Cargo Tanks..... 236
S6.4.7.5.2 Portable Tanks..... 236
S6.4.7.5.3 Ton Tanks..... 237
S6.4.7.6 Testing of Miscellaneous Pressure Parts..... 237

S6.4.7.6.1 Cargo Tanks..... 237
S6.4.7.6.2 Portable Tank..... 237
S6.4.7.6.3 Ton Tanks..... 237
S6.4.7.7 Acceptance Criteria..... 238
S6.4.7.8 Inspection Report..... 238
S6.4.7.8.1 Cargo Tanks..... 238
S6.4.7.8.2 Portable Tanks..... 238
S6.4.7.8.3 Ton Tanks..... 238
S6.5 Stamping and Record Requirements for DOT Transport Tanks in Continued Service..... 238
S6.5.1 General..... 238
S6.5.2 Stamping..... 238
S6.5.3 Owner or User Required Records For Cargo Tanks..... 239
S6.5.3.1 Reporting Requirements by the Owner or User of Tests and Inspections of DOT Specification Cargo Tanks..... 241
S6.5.3.2 DOT Marking Requirements for Test and Inspections of DOT Specification Cargo Tanks..... 241
S6.5.4 Owner or User Required Records for Portable Tanks..... 242
S6.5.4.1 Reporting of Periodic and Intermediate Periodic Inspection and Tests of DOT Specification Portable Tanks..... 242
S6.5.4.2 Marking Requirements for Periodic and Intermediate Inspection and Test for IM or UN Portable Tanks..... 242
S6.5.4.3 DOT Marking Requirements for Periodic and Intermediate Inspection and Tests of DOT Specification 51, 56, 57, or 60 Portable Tanks..... 243
S6.5.5 Owner or User Required Reports for DOT Specification 106A and DOT 110A Ton Tanks..... 243
S6.5.5.1 Reporting of Inspection and Tests for DOT Specification 106A and DOT 110A Ton Tanks..... 243
S6.5.5.2 DOT Marking Requirements for Test and Inspection of DOT Specification 106A and 110A Ton Tanks..... 244
S6.6 Corrosion and Failure Mechanisms in Transport Tanks..... 244
S6.6.1 Scope..... 244
S6.6.2 General..... 245
S6.6.3 Internal and/or External Corrosion..... 245
10
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION
2011
S6.6.3.1 Types of Corrosion..... 245
S6.6.4 Failure Mechanisms..... 247
S6.7 Classification Boundaries..... 249
S6.8 Pressure, Temperature, and Capacity Requirements for Transport Tanks..... 249
S6.9 Reference to Other Codes and Standards..... 249
S6.10 Conclusion..... 250
S6.11 Personnel Safety and Inspection Activities..... 250
S6.12 Transport Tank Entry Requirements..... 251
S6.12.1 Pre-Inspection Activities..... 251
S6.12.2 Preparation for Internal Inspection..... 252
S6.12.3 Post-Inspection Activities..... 253
S6.13 Inspection and Tests of Cargo Tanks..... 253
S6.13.1 Visual External Inspection..... 253
S6.13.2 Inspection of Piping, Valves, and Manholes..... 256
S6.13.3 Inspection of Appurtenances and Structural Attachments..... 257
S6.13.4 Visual Internal Inspection..... 258
S6.13.5 Lining Inspections..... 259
S6.13.6 Pressure Tests..... 260

S6.16.5 Schedule of Inspections 292
S6.16.6 External Visual Inspection of Pressure Relief Devices 292
S6.16.7 Pressure Testing of Pressure Relief Valves 293
S6.16.8 Correction of Defects 294
S6.16.9 Inspection of Rupture Disks and Non-Reclosing Devices ..... 294[dkp4]
S6.17 Definitions 294
S6.18 Tables and Figures..... 302
Supplement 7 Inspection of Pressure Vessels in Liquefied Petroleum Gas (LPG) Service..... 303
S7.1 Scope 303
S7.2 Pre-Inspection Activities 303
S7.3 Inservice Inspection for Vessels in LP Gas Service 303
S7.3.1 Nondestructive Examination (NDE)..... 304
S7.4 External Inspection 304
S7.5 Internal Inspection 305
S7.6 Leaks 305
S7.7 Fire Damage 305
S7.8 Acceptance Criteria 305
S7.8.1 Cracks 306
S7.8.2 Dents 306
S7.8.3 Bulges 306
S7.8.4 Cuts or Gouges 307
S7.8.5 Corrosion 307
~~Supplement 8 Pressure Differential Between Safety or Safety Relief Valve Setting and Boiler or Pressure Vessel Operating Pressure..... 308~~
~~S8.1 Scope ..... 308~~
~~S8.2 Hot-Water Heating Boilers ..... 308~~
~~S8.3 Steam Heating Boilers ..... 308~~
~~S8.4 Power Boilers ..... 309~~
~~S8.5 Pressure Vessels ..... 309~~
Section 7 NBIC Policy for Metrication..... 311
7.1 General 312
7.2 Equivalent Rationale 312
7.3 Procedure for Conversion 312

7.4 Referencing Tables 313
Section 8 Preparation of Technical Inquiries to the *National Board Inspection Code* Committee..... 317
8.1 Introduction 318
8.2 Inquiry Format 318
8.3 Code Revisions or Additions 319
8.4 Code Interpretations 319
8.5 Submittals 320
Section 9 Glossary of Terms..... 321
9.1 Definitions..... 322
Section 10 NBIC Approved Interpretations..... 327
10.1 Scope..... 328
10.2 Index of Interpretations..... 328
10.3 Subject Index of Interpretations..... 331
Section 11 Index..... 335

INSPECTION – GENERAL REQUIREMENTS FOR INSERVICE INSPECTION OF PRESSURE-RETAINING ITEMS

PART 2, SECTION 1

outside the vessel at the point of entry while the Inspector is inside and shall monitor activity inside and outside and communicate with the Inspector as necessary. The attendant shall have a means of summoning rescue assistance, if needed, and to facilitate rescue procedures for all entrants without personally entering the vessel.

Note: If a vessel has not been properly prepared for an internal inspection, the Inspector shall decline to make the inspection.

1.5.4 POST-INSPECTION ACTIVITIES

a) During any inspections or tests of pressure-retaining items, the actual operating and maintenance practices should be noted by the Inspector and a determination made as to their acceptability.

b) Any defects or deficiencies in the condition, operating, and maintenance practices of the pressure-retaining item shall be discussed with the owner or user at the time of inspection and recommendations made for correction. Follow-up inspections should be performed as needed to determine if deficiencies have been corrected satisfactorily.

c) Documentation of inspection shall contain pertinent data such as description of item, classification, identification numbers, inspection intervals, date inspected, type of inspection, and test performed, and any other information required by the inspection agency, jurisdiction, and/or owner-user. The Inspector shall sign, date, and note any deficiencies, comments, or recommendations on the inspection report. The Inspector should retain and distribute copies of the inspection report, as required.

d) The form and format of the inspection report shall be as required by the Jurisdiction. Where no Jurisdiction exists, forms NB-5, NB-6, or NB-7 (see NBIC Part 2, 5.3) or any other form(s) required by the inspection agency or owner-user may be used as appropriate.

INSPECTION – DETAILED REQUIREMENTS FOR INSERVICE INSPECTION OF PRESSURE-RETAINING ITEMS

PART 2, SECTION 2

PART 2, SECTION 2
INSPECTION — DETAILED REQUIREMENTS FOR INSERVICE INSPECTION OF PRESSURE-RETAINING ITEMS

(FOLLOWING par. F. IS ALSO INCLUDED IN PART 4, but not deleted here for continuity of this section)

f. Pressure Relief Devices — pressure relief valves shall be a closed bonnet design with no manual lift lever. 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); and
6. Heat tracing for systems using high freeze point fluids (prevent blockage).

[dkp5]

2.5 PRESSURE RELIEF DEVICES: SEE NBIC PART 4 for the Inspection of Pressure Relief Devices[dkp6]

~~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 non-reclosing devices that are called upon to operate and reduce an overpressure condition.~~
~~b) These devices are not designed or intended to control the pressure in the system during normal operation. Instead, they are intended to function when normal operating controls fail or abnormal system conditions are encountered.~~
~~c) Periodic inspection and maintenance of these important safety devices is critical to ensure their continued functioning and availability when called upon to operate. See NBIC Part 2, 2.5.8 for recommended testing frequency for PRDs.~~
~~d) Inspection areas of concern include:~~
~~1) correct set pressure;~~
~~2) safety considerations;~~
~~3) device data;~~
~~50~~
~~NATIONAL BOARD INSPECTION CODE~~
~~SECTION 2 PART 2 — INSPECTION~~
~~2011~~

~~4) condition of the device;~~
~~5) condition of the installation; and~~
~~6) testing and operational inspection.~~

~~2.5.2 PRESSURE RELIEF DEVICE DATA~~

~~a) Nameplate marking or stamping of the device should be compared to stamping on the protected pressureretaining 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.~~

~~2.5.3 INSERVICE INSPECTION REQUIREMENTS FOR PRESSURE RELIEF 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 NBIC Part 2, Supplement 8.~~
~~b) Seals for adjustments should be intact and show no evidence of tampering.~~

c) Connecting bolting should be tight and all bolts intact.
d) The valve or device should be examined for deposits or material buildup.
e) Evidence of rust or corrosion should be checked.
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 gages left in place after pressure testing of the unit.
i) Bellows valves shall be checked to ensure the bonnet vent is open or piped to a safe location. The vent shall not be plugged since this will cause the valve set pressure to be high if the bellows develops a leak. Leakage noted from the vent indicates the bellows is damaged and will no longer protect the valve from the effects of back pressure.
51
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION SECTION 2
2011

2.5.4 INSERVICE INSPECTION REQUIREMENTS FOR PRESSURE RELIEF DEVICES 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 NBIC 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.

2.5.5 ADDITIONAL INSPECTION REQUIREMENTS

Additional items should be considered for the specified services.

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.
52
NATIONAL BOARD INSPECTION CODE
SECTION 2 PART 2 — INSPECTION
2011

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 not removed from the system. When this hot water evaporates in the discharge piping, calcium deposits may tend to form in the valve inlet and outlet.

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 cap-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.

2.5.5.3 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 pre-bulged 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 checked carefully 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 ruptured 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 NBIC Part 2, 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 replaced periodically to prevent unintended failure while in service due to deterioration of the device.
Rupture disks should be checked carefully 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.
54
NATIONAL BOARD INSPECTION CODE
SECTION 2 PART 2 — INSPECTION
2011

2.5.6 PACKAGING, SHIPPING AND TRANSPORTATION

a) The improper packaging, shipment, and transport of pressure relief devices can have detrimental effects on device operation. Pressure relief devices should be treated with the same precautions as instrumentation, with care taken to avoid rough handling or contamination prior to installation.
b) The following practices are recommended:
1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces except threaded and socket-weld valves up to 2 in. (50mm) may be securely packaged and cushioned during transport;
2) Valve inlet and outlet connection, drain connections, and bonnet vents should be protected during shipment and storage to avoid internal contamination of the valve. Ensure all covers and/or plugs are removed prior to installation;
3) The valve should not be picked up or carried using the lifting lever. Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored. These wires shall be removed before the valve is placed in service;
4) Pilot valve tubing should be protected during shipment and storage to avoid damage and/or breakage.

2.5.7 TESTING AND OPERATIONAL INSPECTION OF PRESSURE RELIEF DEVICES

a) Pressure relief valves must be tested periodically to ensure that they are free to operate and will operate in accordance with the requirements of the original Code of Construction. Testing should include device set or opening pressure, reclosing pressure, where applicable, and seat leakage evaluation. Tolerances specified for these operating requirements in the original Code of Construction shall be used to determine the acceptability of test results.
b) Testing may be accomplished by the owner on the unit where the valve is installed or at a qualified test facility. In many cases, testing on the unit may be impractical, especially if the service fluid is hazardous or toxic. Testing on the unit may involve the bypassing of operating controls and should only be performed by qualified individuals under carefully controlled conditions. It is recommended that a written procedure be available to conduct this testing.
1) The Inspector should ensure that calibrated equipment has been used to perform this test and the results should be documented by the owner.
2) If the testing was performed at a test facility, the record of this test should be reviewed to ensure the

valve meets the requirements of the original Code of Construction. Valves which have been in toxic, flammable, or other hazardous services shall be carefully decontaminated before being tested. In particular, the closed bonnet of valves in these services may contain fluids that are not easily removed or neutralized. If a test cannot be performed safely, the valve shall be disassembled, cleaned, and decontaminated, repaired, and reset.
3) If a valve has been removed for testing, the inlet and outlet connections should be checked for blockage by product buildup or corrosion.
55
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION SECTION 2
2011

e) Valves may be tested using lift assist devices when testing at full pressure may cause damage to the valve being tested, or it is impractical to test at full pressure due to system design considerations. Lift assist devices apply an auxiliary load to the valve spindle or stem, and using the measured inlet pressure, applied load and other valve data allow the set pressure to be calculated. If a lift assist device is used to determine valve set pressure, the conditions of NBIC Part 3, 4.5.3 shall be met. It should be noted that false set pressure readings may be obtained for valves which are leaking excessively or otherwise damaged.
d) If valves are not tested on the system using the system fluid, the following test mediums shall be used:
1) High pressure boiler safety 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 NBIC Part 3, 4.5.2.
e) As an alternative to a pressure test, the valve may be checked by the owner for freedom of operation by activating the test or "try" lever (manual check). For high pressure boiler and process valves, this test should be performed only at a pressure greater than 75% of the stamped set pressure of the valve or the lifting device may be damaged. This test will only indicate that the valve is free to operate and does not provide any information on the actual set pressure. All manual checks should be performed with some pressure under the valve in order to flush out debris from the seat that could cause leakage.
Note: The manual check at 75% or higher is based on lift lever design requirements for ASME Section I and VIII valves. Code design requirements for lifting levers for ASME Section IV valves require that the valve be capable of being lifted without pressure.
f) If a valve is found to be stuck closed, the system should immediately be taken out of service until the condition can be corrected, unless special provisions have been made to operate on a temporary basis (such as additional relief capacity provided by another valve).
g) If a pressure test indicates the valve does not open within the requirements of the original Code of Construction, but otherwise is in acceptable condition, minor adjustments (defined as no more than twice the permitted set pressure tolerance) shall be made by an organization accredited by the National Board to reset the valve to the correct opening pressure. All adjustments shall be resealed with a seal identifying the responsible organization and a tag shall be installed identifying the organization and the date of the adjustment.
h) If a major adjustment is needed, this may indicate the valve is in need of repair or has damaged or misapplied parts. Its condition should be investigated accordingly.
56
NATIONAL BOARD INSPECTION CODE
SECTION 2 PART 2 — INSPECTION
2011

i) Systems with multiple valves will require the lower set valves to be held closed to permit the higher set valves to be tested. A test clamp or "gag" should be used for this purpose. The spring compression screw shall not be tightened. It is recommended that the test clamps be applied in accordance with the valve

manufacturer's instructions when the valve is at or near the test temperature, and be applied hand tight only to avoid damage to the valve stem or spindle.
j) Upon completion of set pressure testing, all pressure relief valve gags shall be removed.

2.5.8 RECOMMENDED INSPECTION AND TEST FREQUENCIES FOR PRESSURE RELIEF DEVICES

a) Power Boilers
1) Pressure less than 400 psig (2.76 MPa): Manual check every 6 months; pressure test annually to verify nameplate set pressure or as determined by operating experience as verified by testing history.
2) Pressure greater than 400 psig (2.76 MPa): Pressure test to verify nameplate set pressure every three years or as determined by operating experience as verified by testing history.
3) Pressure tests should be performed prior to bringing the boiler down for planned internal inspection so needed repairs or adjustments can be made while the boiler is down.
b) High-Temperature Hot-Water Boilers
Pressure test annually to verify nameplate set pressure or as determined by operating experience as verified by testing history. For safety reasons, removal and testing on a steam test bench is recommended. Such testing will avoid damaging the safety valve by discharge of a steam-water mixture, which could occur if the valve is tested in place.
c) Low-Pressure Steam Heating Boilers
Manual check quarterly; pressure test annually prior to steam heating season to verify nameplate set pressure.
d) Hot-Water Heating Boilers
Manual check quarterly; pressure test annually prior to heating season to verify nameplate set pressure.
Note: The frequencies specified for the testing of pressure relief valves on boilers is primarily based on differences between high pressure boilers that are continuously manned, and lower pressure automatically controlled boilers that are not monitored by a boiler operator at all times. When any boiler experiences an overpressure condition such that the safety or safety relief valves actuate, the valves should be inspected for seat leakage and other damage as soon as possible and any deficiencies corrected.
e) Water Heaters
Manual check every two months. Due to the relatively low cost of safety valves for this service, it is recommended that a defective valve be replaced with a new valve if a repair or resetting is indicated.
f) Pressure Vessels and Piping
Frequency of test and inspection of pressure relief devices for pressure vessel and piping service is greatly dependent on the nature of the contents and operation of the system and only general recommendations can be given. Inspection frequency should be based on previous inspection history. If valves are found to be defective or damaged by system contents during inspection, intervals should be shortened until acceptable inspection results are obtained. Where test records and/or inspection history are not available, the following inspection and test frequencies are suggested:
57
NATIONAL BOARD INSPECTION CODE
PART 2 INSPECTION SECTION 2
2011

Service Inspection Frequency
Steam Annual
Air and Clean Dry Gases Every three years
Pressure relief valves in
combination with rupture
disks
Every five years
Propane, Refrigerant Every five years
All Others Per inspection history
g) Establishment of Inspection and Test Intervals
Where a recommended test frequency is not listed, the valve user and Inspector must determine and agree on a suitable interval for inspection and test. Some items to be considered in making this determination are:
1) Jurisdictional requirements;
2) Records of test data and inspections from similar processes and similar devices in operation at that

~~facility;~~
~~3) Recommendations from the device manufacturer. In particular, when the valve includes a non-metallic part such as a diaphragm, periodic replacement of those parts may be specified;~~
~~4) Operating history of the system. Systems with frequent upsets where a valve has actuated require more frequent inspection;~~
~~5) Results of visual inspection of the device and installation conditions. Signs of valve leakage, corrosion or damaged parts all indicate more frequent operational inspections;~~
~~6) Installation of a valve in a system with a common discharge header. Valves discharging into a common collection pipe may be affected by the discharge of other valves by the corrosion of parts in the outlet portion of the valve or the buildup of products discharged from those valves;~~
~~7) Ability to coordinate with planned system shutdowns. The shutdown of a system for other maintenance or inspection activities is an ideal time for the operational inspection and test of a pressure relief valve;~~
~~8) Critical nature of the system. Systems that are critical to plant operation or where the effects of the discharge of fluids from the system are particularly detrimental due to fire hazard, environmental damage, or toxicity concerns all call for more frequent inspection intervals to ensure devices are operating properly;~~
~~9) Where the effects of corrosion, blockage by system fluid, or ability of the valve to operate under given service conditions are unknown (such as in a new process or installation), a relatively short inspection interval, not to exceed one year or the first planned shutdown, whichever is shorter, shall be established. At that time the device shall be visually inspected and tested. If unacceptable test results are obtained, the inspection interval shall be reduced by 50% until suitable results are obtained.~~
~~h) Establishment of Service Intervals~~
~~1) The above intervals are guidelines for periodic inspection and testing. Typically if there are no adverse findings, a pressure relief valve would be placed back in service until the next inspection. Any unacceptable conditions that are found by the inspection shall be corrected immediately by repair or~~
~~58~~
~~NATIONAL BOARD INSPECTION CODE~~
~~SECTION 2 PART 2 — INSPECTION~~
~~2011~~

~~replacement of the device. Many users will maintain spare pressure relief devices so the process or system is not affected by excessive downtime.~~
~~2) Pressure relief valves are mechanical devices that require periodic preventive maintenance even though external inspection and test results indicate acceptable performance. There may be wear on internal parts, galling between sliding surfaces or internal corrosion, and fouling which will not be evident from an external inspection or test. Periodic re-establishment of seating surfaces and the replacement of soft goods such as o-rings and diaphragms are also well advised preventive maintenance activities that can prevent future problems. If the valve is serviced, a complete disassembly, internal inspection, and repair as necessary, such that the valve's condition and performance are restored to a like-new condition, should be done by an organization accredited by the National Board.~~
~~3) Service records with test results and findings should be maintained for all overpressure protection devices. A service interval of no more than three inspection intervals or ten years, whichever is less, is recommended to maintain device condition. Results of the internal inspection and maintenance findings can then be used to establish future service intervals.~~

INSPECTION – Corrosion and Failure Mechanisms

PART 2, SECTION 3

recommendations are followed. Extreme caution should be employed to ensure only enough force is applied to contain pressure. Excessive mechanical force applied to the spindle restraint may result in damage to the seat and/or spindle and may interfere with proper operation of the valve. The spindle restraint shall be removed following the test.
The organization that performs the liquid pressure test and applies a spindle restraint shall attach a metal tag that identifies the organization with the date the work was performed to the pressure relieving device. If the seal was broken, the organization shall reseal the adjustment housing with a seal that identifies the responsible

organization. The process shall be acceptable to the Jurisdiction where pressure-retaining items are installed.
[dkp7]
Metal temperature shall not be more than 120°F (49°C) unless the owner-user specifies the requirement for a higher test temperature. If the owner-user specifies a test temperature higher than 120°F (49°C), then precautions shall be taken to afford the Inspector close examination without risk of injury.
Hold-time for liquid pressure tests shall be for a minimum of 10 minutes prior to examination by the Inspector. Test pressure shall be maintained for the time necessary for the Inspector to conduct inspection.

4.3.1.3 PNEUMATIC PRESSURE TESTING

A pressure test using a compressible gas should not be considered due to potential hazard unless a liquid pressure test cannot be performed without damaging the pressure-retaining item or causing contamination of internal surfaces of the pressure-retaining item.
Concurrence of the owner and Inspector shall be obtained and the Jurisdiction, where required, prior to conducting a pneumatic test. The test pressure shall be the minimum required to verify leak tightness integrity but shall not exceed maximum pneumatic test pressure of the original code of construction. Precautionary requirements of the original code of construction shall be followed.
WARNING: Adequate safety precautions shall be taken to ensure personnel safety when a compressible gas is used due to volumetric expansion potential upon release of pressure test gas. Consideration shall be given to possible asphyxiation hazards.
Properly calibrated instrumentation shall be used to detect leakage of testing medium. Instrumentation selected shall be appropriate for the test medium. Instrumentation may detect changes in pressure or chemical concentrations and shall be sensitive enough to detect leakage.

4.4 METHODS TO ASSESS DAMAGE MECHANISMS AND INSPECTION FREQUENCY FOR PRESSURE-RETAINING ITEMS

[dkp8]
1) The anticipated length of time the locomotive will be stored;
2) Whether storage will be indoors or outdoors;
3) Anticipated weather conditions during the storage period;
4) The availability of climate-controlled storage;
5) Type of fuel used; and
6) Equipment available at the storage site.
b) Indoor storage can be categorized into two types: indoor with climate control, and indoor without climate control.
c) Outdoor storage can also be categorized into two types: outdoors during a warm time of year or in a geographic location where it can reasonably be expected to be above freezing during storage, and outdoors during a time period or in a geographic location where it can be expected that freezing temperatures will occur during storage.
d) Locomotive boilers may be stored using the "wet method" or the "dry method."
e) Before any method of storage, the boiler must be thoroughly washed out with mud and scale removed from the mudring, crownsheet, bottom of the barrel, and the top of the firing door.

S1.5.2 WET STORAGE METHOD

a) When utilizing the "wet storage method" the boiler is completely filled with treated water to exclude air.
Note: This method cannot be used if the locomotive is exposed to freezing weather during storage.
b) Chemicals may be added to the storage water to further inhibit corrosion. However, depending on the chemical used, the treated water may have to be disposed of as a hazardous waste to prevent chemical contamination of the surrounding property.

c) The procedure applies only to the sections of the boiler that contain water. The firebox interior, cylinders, piping, and auxiliary equipment of the locomotive still require draining, preservation, and dry storage.

S1.5.3 DRY STORAGE METHOD

a) When utilizing the "dry storage method" the boiler is completely emptied of water, dried out, and allowed to stand empty. Several variations of the "dry method" may be used. These include but are not limited to:
1) airtight storage with a moisture absorbent placed in trays in the boiler;

2) airtight storage with the boiler filled with inert gas to exclude oxygen; and
3) open air storage with the mudring washout plugs removed to enable air circulation for evaporation of formed moisture.
b) Each variation has positive and negative points that must be taken into account before use. If the boiler is filled with inert gas such as nitrogen, care must be taken because this method can result in asphyxiation of personnel if the gas escapes the boiler through a leaking valve or washout plug and enters a pit, sump, or enclosed room. In addition, the boiler must be completely vented to remove gas, then tested and declared gas-free before personnel may enter.
c) Although the use of dry storage with several washout plugs removed for air circulation is the most common method, there are some potential drawbacks. The boiler interior may be subject to moisture forming from condensation created from humidity changes in the ambient air. Small animals may take up residence inside if screens are not used to cover handholes and washouts.
d) Before storage, the boiler must be thoroughly washed out with mud and scale removed from the mudring, crownsheet, bottom of the barrel, and top of the firing door. Any mud or loose scale left in the boiler will retain moisture, leading to corrosion. After washing, water must be removed and the boiler dried before storage. A portable gas or electric heater placed in the firebox to aid evaporation and drying, along with a vacuum used to siphon water out via the lower washout plugs, is recommended.
Note: Use of the common railroad drying out procedure of building a small wood fire in the firebox is not recommended because of the danger of overheating the firebox sheets.
e) The typical railroad dry storage method required blow down of the boiler until empty while steam pressure registered on the gage and removal of the washout plugs while the shell plates were hot and there was no steam pressure. This allowed the heat remaining in the boiler plates to evaporate remaining water in the boiler. However, this method may result in staybolt damage from temperature change and requires extreme care, if used.
f) Oil should not be applied to the interior surfaces of the boiler because it is difficult to remove. Further, the oil must be removed before steaming or it will form scale and contribute to foaming.

S1.5.4 RECOMMENDED GENERAL PRESERVATION PROCEDURES

a) When the locomotive is under steam, inspect piping, fittings, and appliances for steam and water leaks that may introduce moisture into the lagging. Repair leaks as necessary and remove wet lagging. Wet lagging can accelerate corrosion of the boiler external surfaces, especially staybolt sleeves and caps.

b) Thoroughly wash the boiler and firebox and remove mud and scale from the mudring, crownsheet, bottom of the barrel, and top of the firing door. Any mud or loose scale left in the boiler will retain moisture, leading to corrosion. Wash out thermic siphons, arch tubes, and circulators.
c) To protect the boiler interior during storage, dry the boiler by using compressed air to blow out as much water as possible. A portable heater placed in the firebox to warm the boiler to 200°F (93°C), along with a vacuum used to siphon water out via the lower washout plugs, can aid evaporation and drying of any moisture that collects in low or impossible-to-drain locations without harming the sheets.
Caution: To prevent a buildup of steam pressure during the drying process, the steam dome cover or top washout plugs should be removed to enable the moisture to escape. In addition, the driving wheels should be blocked and the throttle and cylinder cocks should be opened to permit any steam that forms in the superheater units to escape.
d) Superheater units, by nature of design, can be difficult to drain and dry out. Typical methods include:
1) Pressurize the boiler with compressed air with the locomotive stationary and blocked in place. Using the throttle to regulate the airflow, allow the air to blow through the entire bank of superheater units and dry pipe and discharge into the cylinders. The cylinder cocks must be open.
2) Pressurize the boiler with compressed air and then operate the locomotive under air pressure over a short distance of track. The cylinder cocks should be opened during the initial operation to prevent damaging the cylinders by hydraulic lock.
3) If the air pressure draining procedure is not practical or cannot be accomplished correctly, the superheater units can be protected against trapped moisture by filling the entire superheater bundle with a standard antifreeze/water mixture or with diesel fuel.

Notes: The air pressure dry-out methods "1" or "2" may have to be performed several times to discharge all of the moisture. Refer to NBIC Part 2, S1.5.5, *Use of Compressed Air to Drain Locomotive Components*, for additional information on compressed air drying.
If the locomotive is operated under air pressure, the air brake system should be made operational to provide safe stopping or other steps taken to control and stop the locomotive.
e) After drying, it will be necessary to either vent the boiler or to place containers of desiccant inside the boiler through the dome cap to absorb any condensation that may occur during storage. Venting the boiler to allow air circulation is accomplished by leaving two or more of the lower washout plugs out and opening the vent valve on the top of the boiler. A vent line consisting of two 90° elbows and pipe nipples should be installed in the vent valve to locate the opening to the downward direction in order to keep rain or snow from entering the open valve.
f) If the locomotive will be stored outdoors, the following should be completed:
1) Inspect the boiler jacket and confirm it is tight with no gaps leading into the lagging or shell. Pay close attention to areas at shell openings such as for studs, safety valves, etc. Repair all gaps or damaged jacket sections as necessary. Consideration should be given to covering the entire locomotive and tender with a tarp. Otherwise, all jacket openings should be covered to prevent the entrance of rain or snow. Where necessary, apply a waterproof covering over the exposed or open sections;
2) The smokestack should be sealed by applying a wood and sheet rubber cover held in place by clamps or a through bolt;

3) The safety valves should either be covered or removed, with plugs or caps installed in the holes if the valves are removed;
4) The dynamo, air pump, and feedwater heater exhausts should also be covered;
5) Empty and clean the smokebox, front tubesheet, superheater units, steam pipes, and front end plates of all coal, ash, or burnt oil. This work is especially critical at the bottom section of the smokebox and front tubesheet rivet flange. The smokebox door should be sealed by applying a gasket or sealant and any other air openings in the smokebox sealed. The exhaust nozzle should be sealed by applying a wood and sheet rubber cover held in place by clamps;
6) The potential for corrosion of the smokebox interior can be further minimized by applying a coating of outdoor paint or primer. All inspection of the smokebox and front tubesheet must be accomplished before painting since it will cover up many types of defects. The coating will burn off quickly when the locomotive is returned to service;
7) Thoroughly clean the firebox sheets, flues, and superheater return bends of all ash and clinker.
8) On coal burners, empty and clean the grates and ash pan of all coal and ash completely. This work is especially critical at the sections between the grate bearers, the mudring rivets, and firebox sheets; and from the grate segment air openings. On oil burners, care should be taken to remove ash from between the flash wall refractory and the firebox sheets;
9) If the locomotive will be out of service for longer than 12 months, removal of the brick arch or flash wall refractory that extends above the mudring should be considered to prevent condensation and corrosion from occurring between the brick and the steel. Temporary removal of the brick arch or flash wall to permit application of a preservative to firebox sides, arch tubes, or siphons should be considered for shorter storage periods;
10) All appliances and piping that might contain water or condensation should be drained and blown dry using dry compressed air. This includes the air and equalizing reservoirs, dirt collectors, injectors, cylinders, stoker engine cylinders, dynamos, the steam and water sides of feedwater heaters and pumps, the steam side of air pumps, the steam side of lubricators, atomizers, oil tank heaters, gage siphons, tank hoses, and cab heater piping. A small quantity of valve oil should be sprayed into the valve chambers, cylinders and the steam side of all appliances to protect against corrosion. Refer to S1.5.5, *Use of Compressed Air To Drain Locomotive Components*, for details;
11) The cylinder castings, exhaust cavities, and steam lines must be drained of all moisture and blown dry. Typical methods include:
a. Pressurizing the boiler with compressed air, with the locomotive stationary and blocked in place.

Using the throttle to regulate the airflow, allow the air to blow through the dry pipe and discharge into the cylinders. The cylinder cocks must be open;
b. Pressurizing the boiler with compressed air, then operate the locomotive under air pressure over a short distance of track. The cylinder cocks should be opened during the initial operation to prevent damaging the cylinders by hydraulic lock;
Note: Methods "1" or "2" may have to be performed several times to discharge all of the moisture from the cylinders, and steam pipes. If the locomotive is operated under air pressure, the air brake system should be made operational to provide safe stopping or other steps taken to control and stop the locomotive.

c. Refer to NBIC Part 2, S1.5.5, *Use of Compressed Air to Drain Locomotive Components*, for additional information;
g) Drain and wash tender water spaces. The tank should be inspected afterward and any remaining water removed by siphon or vacuum. When dry, spray the water space with outdoor paint or a commercial rust preventative. Drain and dry tender tank hoses and clean screens;
h) On coal or wood burners, spray any exposed surfaces of the tender fuel space with outdoor paint or a commercial rust preventative. If the locomotive is to be stored outdoors for a long term, remove all coal and spray the surfaces as above or cover the coal space with a tarp or a roof;
i) On oil burners, drain and blow out all fuel lines, tank heater and blowback lines, and the burner itself. Drain sludge and water from the bottom of the fuel tank. Ensure that tank hatches are secure and the tank is vented to prevent condensation. Draining the oil tank is recommended if the fuel oil is known to lose its volatile content during storage;
j) After cleaning thoroughly, coat all side and main rods, cross heads, valve gear, guides, piston rods, brake pistons, feedwater pump pistons, and air pump pistons with water-resistant grease or a rust preventative. Grease should be applied to the junction of each axle and driving box and journal box to prevent water entering. Grease should be applied to junction of rod and pin in valve gear and rods to prevent water entering;
k) If the locomotive is moved after grease is applied, it will be necessary to reapply the coating to piston rods and guides;
Note: Heavy oil or unrefined oil such as any of the Bunker types (Bunker 6, etc.) should not be used for preservation of any components because the sulfur contained in it can accelerate corrosion. Standard motor oil or journal oil will not stick to and preserve wetted surfaces. All surfaces, to be so coated, must be dry. If moisture is a problem, steam cylinder oil should be applied.
l) Plain journal bearings should be inspected for water and repacked. Roller bearing boxes should have all moisture drained and the boxes filled with lubricant. Grease plugs should be screwed down so that the threads are not exposed;
m) If the locomotive is to be stored outdoors with questionable or no security, remove and store all cab gages, water glasses, lubricators, brass handles, seatboxes, and any other items that thieves or vandals might attack. Remove the whistle, bell, headlight and marker, and/or classification lights. Remove tools, radios, and spare parts. Secure wood or metal covers over all windows and doors, and board up the back of the cab. Secure all manholes on the top of the tender; and
n) Inspect stored locomotives regularly for signs of rust, corrosion, damage, deterioration, or vandalism and immediately take any corrective measures necessary.

S1.5.5 USE OF COMPRESSED AIR TO DRAIN LOCOMOTIVE COMPONENTS

a) The process of using air pressure to drain and empty auxiliary components such as the cylinders, superheater units, and piping completely of water offers several advantages over other methods.
b) The air compressor must be equipped with a suitable filter to enable it to supply oil-free air because the introduction of air that contains oil into the water/steam parts of the boiler and superheater will promote the formation of scale and water foaming when the locomotive is returned to service.

S1.6 SAFETY VALVES

The minimum safety valve capacity in pounds per hour (kilograms per hour) shall be calculated by multiplying the boiler heating surface area by the factor from the appropriate chart in NBIC Part 2, Table S1.6 (1 pound steam/hr/sq. ft = 4.88 kg steam/hr/sq meter).

Table S1.6
Minimum Pounds of Steam/hr./sq. ft. of Steam Heating Surface
Firebox Heating Surface
Type Factor
Hand-Fired 8
Stoker-Fired 10
Oil-Fired 14
Flue Heating Surface
Type Factor
Hand-Fired 5
Stoker-Fired 7
Oil-Fired 8
Superheater Heating Surface
Type Factor
Hand-Fired 5
Stoker-Fired 7
Oil-Fired 8[dkp9]

S2.8.1 SAFETY VALVES

a) The following requirements shall be verified acceptable when performing inspections of safety valves.
1) Set pressures of safety valves installed shall be verified by operation or certification acceptable to the Jurisdiction.
2) Safety valve(s) shall be National Board capacity certified.
3) Safety valve(s) shall be sealed by an ASME "V" Stamp Holder or National Board "VR" repair firm.
4) The required safety valve capacity in pounds per hour (kg per hour) shall be calculated by multiplying boiler heating surface area by the type of fuel factor used (see NBIC Part 2, Table S2.8.1 for fuel factors). Excessive safety valve capacity should be avoided. (Only heating surface area above the grates shall be used when calculating heating surface for safety valve required capacity.)
Note: An additional pressure relief valve may be used in conjunction with the above required ASME safety valve if set at a lower pressure, although no credit for relieving capacity may be used.
5) Safety valve(s) shall have a test lever.
6) No isolation valve of any description shall be placed between the required safety valve(s) and the boiler, or on the discharge pipe between the valve and the atmosphere.
7) The piping connection between the boiler and the safety valve shall not be less than the inlet size of the safety valve, and the discharge pipe, if used, shall not be reduced between the safety valve and the point of discharge.
b) To reduce cycling stress on the boiler, it is recommended that a safety valve with a blowdown between 2% and 4% be used. The blowdown, however, should never exceed 6%.
145
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION SECTION 6
2011

TABLE S2.8.1
Minimum Pounds of Steam per Hour per Square Foot of Heating Surface (1 lb. Steam/hr./sq. ft. [4.88 kg/hr./sq. m])
Boiler Heating Surface Firetube Boilers Watertube Boilers
Hand-Fired 5 6
Stoker-Fired 7 8
Power Burner 8 10
Hand-Fired Waterwall 8 8
Stoker Waterwall 10 12
Power Burner Waterwall 14 16
[dkp10]

S2.14.2 STOPPING ENGINE IN AN EMERGENCY

a) Know how to stop the engine suddenly. For example, if someone or something runs out in front of the engine or some problem happens with whatever its belted up to:
1) Close throttle.
2) Reverse valve quadrant position.
3) Open throttle for a moment (this will quickly stop your engine).
4) Close throttle.
5) Open cylinder cocks.
b) Steam traction engines do not have brakes, so this is a maneuver worth knowing and practicing. However, it should be practiced with the dome valve shut as this method of stopping the engine tends to be very hard on gears and castings. In regards to belt work, it is extremely important that total undivided attention is given to what it is belted up to. Be prepared to shut down quickly should something happen.
[dkp11]

S2.14.3 WATER GLASS BREAKAGE

Having a properly guarded water glass will prevent objects from coming in contact with the glass. However, water glasses do break. If the machine is operating when water glass breakage occurs:
a) Close throttle.
b) Set valve quadrant to neutral (middle notch).
c) Disengage clutch.
d) Close damper.
e) Locate bottom water glass valve and shut off.
1) The first four procedures will be difficult if the water glass is mounted back by the operator's platform.
2) The bottom water glass valve is essential to locate and close first. This valve is below the waterline and can take the water dangerously close to the crownsheet if water is allowed to escape unchecked. This is where having the automatic type gage valves would be most desirable. Most traction engines do not have automatic type gage valves. Caution must be exercised at this time because 300 degree F steam and water will be spraying in every direction! There will be an inability to see much of anything except a cloud of water vapor, use a shovel or a coat or something to deflect the spray to be able to find that lower valve.
f) Next, close the top gage valve; this one should just be blowing steam and obscuring visibility. There is no serious problem with steam being released because this valve is above the water line.

g) Next, use the try-cocks to determine water level of boiler. If bottom try-cock blows water, then inject water and replace water glass. However, if bottom try-cock does not blow water, and only blows steam, do not inject water and proceed to kill fire immediately. Do not move engine. Another method of determining the water level in the boiler other than using the try-cocks is to wet down a burlap sack and lay it on the barrel part of the boiler. Quickly pull it away and there will be a "sweat line" of where the actual water level is.

S2.14.4 RUNAWAY ENGINE AND GOVERNOR OVER SPEED

a) Probable causes: governor malfunction. Usually the governor belt either slips or breaks. Know the governor belt condition and keep its tension snug but not too tight. Also, packing nut could be too tight causing a binding on valve spindle; more often this will cause engine to not respond to load and usually will not "runaway."
b) What to do in a runaway situation: Never leave the operator's platform while engine is at governed speed. In the case of a runaway engine:
1) Quickly close the throttle;
2) Move forward/reverse lever to center of quadrant;
3) Open cylinder cocks;
4) Close dome valve;
5) Close damper and steam down (this is not a boiler emergency; once engine has stopped there should be no danger).
c) In the unlikely event the throttle was to jam in conjunction with governor malfunction:
1) Move forward/reverse lever to center of quadrant. This will stop the engine even though steam is still being sent to the valve chest;
2) Close the dome valve; this would be the same as closing the throttle. Steam flow would then be stopped and the engine should be safe;
3) Close damper and steam down.

[dkp12]

S2.14.5 KILLING A FIRE

This is an important procedure to know, should a low water situation ever occur.
a) Close all dampers. This will stop incoming air which supports fire. Capping the smokestack is an additional way of checking draft to fire. However, it will cause a lot of smoke to emit around fire door.
b) Shovel dry sand or dry earth on the fire; this should immediately cool the fire to a safe level. Have a pile of dry sand or dirt in or around the steam engine area should a situation occur. It is important to remember that when trying to extinguish a fire, never stir the fire; this will only intensify the fire's heat.
187
NATIONAL BOARD INSPECTION CODE
PART 2 — INSPECTION SECTION 6
2011

c) Close the fire door.
d) Close the dome valve.
e) Leave the engine alone. It is especially important not to move the engine as this could slosh water onto a possibly overheated crownsheet.

S2.14.6 INJECTOR PROBLEMS

Injector problems are the number one reason for boiler operation malfunctions. An injector can be a very sensitive device. The ability to identify the reasons why it's not working is the most important thing a steam engineer needs to know. The following are various problems and causes.
a) Failure to raise water from supply tank
1) Suction pipe clogged or tank supply valve turned off.
2) Leaks in suction pipe or hose, allowing air to enter above the level of water supply. A common problem when rubber or plastic hoses are used on suction side of injector.
3) Water supply too hot. Hot water will prevent injector from lifting water.
4) Obstruction in the lifting or combining tubes of the injector.
b) Injector lifts water but will not force it into the boiler.
1) Choked suction pipe or strainer/incomplete obstruction.
2) Supply valve not opened all the way.
3) Boiler valve closed.
4) Boiler check valve stuck closed.
5) Obstruction in delivery tube on injector.
6) Leaking injector overflow check valve.
7) Injector choked with lime.
c) Other injector problems.
1) Usually you have a hot injector because of improper operation. This is where a removable rubber hose

S2.14.12 SAFETY VALVE PROBLEMS

Testing of this critical safety device should be done each time the boiler is fired up. This is essential to ensure its continued safe operation. In the event the safety valve does not open at its preset pressure and trying to manually trip open valve lever is unsuccessful, close the damper and follow steam down procedure. After closing damper, start the injector. This will decrease the steam pressure. Under no circumstance should the blowdown valve be used to release pressure (blowing down will lower the water level considerably). Killing the fire should not be necessary; provided the water level is at a safe level and the steam pressure is dropping from running the injector. Do not continue to run engine, remove the valve and send to a certified shop for repair or replace the valve.

S2.14.13 SAFETY VALVE OPENS BUT WILL NOT CLOSE

This problem is more prevalent than valves that don't open. There is no immediate danger in a safety valve that won't close, the boiler is only losing steam. Try to manually open the valve a few times under pressure. This may seat the valve. Bringing your steam pressure down approximately 25 PSI will let the valve seat. If after dropping the pressure and it still does not seat, there may be an obstruction in the valve or a binding in the action of the valve. Follow normal steam down procedure. Remove valve and send to a certified shop for repairs or replace the valve.

[dkp13]

S2.14.14 LEAKING PIPE PLUGS

Usually threads were not properly cleaned before installation or thread tape/sealant not properly applied. Under no circumstance should plugs be tightened with boiler under pressure. Usually the leak is very small and does not mean any immediate danger. Follow normal steam down procedure.

S2.14.15 MELTED GRATES

a) Closing damper with a hot coal fire. This restricts air flow to the grates, although rare for a grate to melt from this, it is possible to warp or ruin a good set of grates. Grates need air flow to keep them cool. Closing damper all the way with a hot coal fire should only be done in an emergency.
b) Carrying ashes too high in ash pan is usually the reason for melted grates. The hot coals in the ash pan touching the grates and the restricted air flow is going to damage the grates. In some cases a grate bar can entirely melt out leaving a huge hole in your fire bed and an intense fire burning in your ash pan. Follow normal steam down procedure.

S2.15 TABLES AND FIGURES

a) TABLE S2.8.1 Minimum Pounds of Steam per hour per Square Foot of Heating Surfaces[dkp14]
b) TABLE S2.10.2 Sizes for Rivets Based on Plate Thickness
c) TABLE S2.10.3.1 Maximum Allowable Working Pressure for Cylindrical Components – Single-Riveted Lap Joint
d) TABLE S2.10.3.2 Maximum Allowable Working Pressure for Cylindrical Components – Double-Riveted Lap Joint
191

e) All re-closing pressure relief valves shall be externally inspected for any corrosion or damage that might prevent the device from operating as designed;

1) All re-closing pressure relief valves on cargo tanks carrying lading corrosive to the pressure relief valve shall be removed from the cargo tank for inspection and testing;
2) Each re-closing pressure relief valve required to be removed and tested as specified in e) 1) above must open at the required test pressure and reseat to a leak-tight condition at 90% of the set-to discharge pressure or the pressure prescribed for the applicable cargo tank specifications.

[dkp15]

the test shall include all appurtenances, all baffles, bulkheads, and upper coupler (fifth wheel) that comprise the cargo tank and shall be pressure tested at pressures established in NBIC Part 2, Table S6.13.6. The pressure test procedure shall include the following:
a) The pressure test shall be performed in accordance with a test pressure that includes provision for the

inspector to perform an internal and external visual inspection of all surfaces of the cargo tank. For MC 338 cargo tanks, and cargo tanks not equipped with a manhole, an internal visual inspection is not required.
1) The visual external inspection shall be conducted while the cargo tank is under test pressure.
2) The visual internal inspection shall be conducted after the pressure test is completed.
b) When performing the pressure test all self-closing pressure relief valves, including emergency relief vents, and normal vents shall be removed for inspection and test, except for line safety devices that may be removed or left in place.
1) Each self-closing pressure relief valve that is an emergency relief vent shall be capable of opening at the required set pressure and seat to a leak-tight condition at 90% of the set-to-discharge pressure, or the pressure prescribed for the applicable cargo tank. It should be noted that self-closing pressure relief valves not tested or failing the pressure test must be repaired or replaced[dkp16];

S6.15.3.3 RUPTURE DISCS AND FUSIBLE PLUGS

All rupture discs required by NBIC Part 2, S6.15.1 l) 2) and fusible plugs required by NBIC Part 2, S6.15.1 m) shall be removed from the ton tank and inspected. The inspection shall include but not be limited to the following:
a) All rupture discs shall be inspected for corrosion, leakage, and manufacturer tolerances;
b) All fusible plugs shall be inspected for corrosion, loose, or deteriorated temperature sensitive materials;
c) Any indication specified in a) and b) above will require the rupture disc or fusible plug to be replaced with devices specified in NBIC Part 2, S6.15.1 l) 2) and S6.15.1) m).[dkp17]

S6.15.3.4 SUCCESSFUL COMPLETION OF THE PERIODIC RETESTING

If the results of the periodic retest are successful, the ton tank shall be plainly and permanently stamped on one head or chime of each ton tank. The stamping shall include:
a) The month and year of the test followed by a "V", and
b) Dates of previous tests and all prescribed markings shall not be removed. Previous dates and markings on the ton tank's head or chime shall be legible.

S6.15.3.5 EXEMPTIONS TO PERIODIC HYDROSTATIC RETESTING

Ton tanks that satisfy DOT 106A and DOT 110A and are used exclusively for transporting fluorinated hydrocarbons and mixtures thereof, and are free from corroding components related to the ton tank may be exempted from the periodic hydrostatic retest if:
a) The ton tank is given a complete internal and external visual inspection of all heads, shells, nozzles, couplings, pressure relief devices, i.e. pressure relief valves and rupture discs and fusible plugs for deterioration and leakage.
b) The visual internal and external inspection is performed by qualified personnel, i.e., registered inspector, employee of the owner-user, etc.

S6.16 PRESSURE RELIEF DEVICES

S6.16.1 SCOPE

This Section provides details for the application, continued service inspection, and repair of pressure relief devices specified for overpressure protection of transport tanks.
Pressure relief devices are provided for all transport tanks to prevent internal pressure from exceeding design values. They may also be provided to prevent excessive internal vacuum. Overpressure protection may be provided by reclosing pressure relief valves, non-reclosing devices such as rupture disks or breaking bar or breaking pin valves, or combinations of pressure relief valves and non-reclosing devices.

S6.16.2 SAFETY CONSIDERATIONS

When inspections of pressure relief devices are being performed, inspectors should be aware that tests of these devices involve the discharge of the test fluid, which can result in high velocity fluid flow, possible high or low temperature fluids, and high noise levels. If a test is being performed with the service fluid, it should be a fluid that is safe for discharge and not toxic or hazardous. Due to the nature of fluids being transported, most testing will involve removing the device from the transport tank and testing it on a test stand. (See NBIC Part 2, S6.12.1, Pre-Inspection Activities.)

S6.16.3 INSTALLATION PROVISIONS

Incorrect installation of a pressure relief device can have a detrimental effect on device performance. The following provisions shall be followed when installing pressure relief devices on transport tanks:
a) Inlet piping shall have an area at least equal to the pressure relief device inlet size with no restrictions

which can affect flow through the device;
b) Pressure relief devices shall be installed to be in communication with the vapor space of the tank in its normal transport orientation as near as practicable on the longitudinal center line, and in the center of the tank;
c) If discharge piping is provided, it shall have an area at least equal to the pressure relief device, be as short and straight as possible, and of a length that will not affect the pressure relief device flow performance. It will typically discharge upward, and should be directed away from personnel that may be around the tank at ground level;
d) Provisions for protection of the outlet of pressure relief devices from contamination from the effects of rain, weather, etc., shall be provided. Where rain caps are provided, the fit shall not be tight enough to affect the valve performance;
e) Pressure relief devices may be installed inside a protective housing consisting of mechanical elements designed to protect the valve during roll-over events. These elements shall not obstruct the outlet of the device;
f) If a rupture disk is used in combination with a pressure relief valve, it shall be located inboard of the pressure relief valve;
g) When a rupture disk is used in combination with a pressure relief valve, a device to detect leakage through the rupture disk, or actuation of the rupture disk, shall be provided. These devices detect leakage or actuation by observation of the accumulation of pressure between the disk and the pressure relief valve, and shall consist of a needle valve, try-cock, tell-tale indicator or pressure gage. Where a valve is provided, it shall be closed during normal operation. Leaking disks or disks, which have discharged, shall be replaced as soon as possible; and
h) Block valves shall not be used on either device inlets or outlets.

S6.16.4 PRESSURE RELIEF DEVICE INSPECTION

For pressure relief valves, inspection shall consist of an External and Internal Visual Inspection and a Pressure Test to determine valve function. For non-reclosing pressure relief devices, inspection shall consist of an External and Internal Visual Inspection as well.

S6.16.5 SCHEDULE OF INSPECTIONS

Pressure relief devices shall be inspected at the frequency as required by NBIC Part 2, Tables S6.13.4, S6.14, or S6.16.3. For both an External Visual Inspection and a Pressure Test, the frequency of inspection for pressure relief devices shall be the same as the frequency required for inspection of the transport tank itself.

S6.16.6 EXTERNAL VISUAL INSPECTION OF PRESSURE RELIEF DEVICES

The following items shall be inspected during the External Visual Inspection.
a) Pressure relief device nameplate data shall be reviewed, and the marked device set pressure compared to the transport tank data. The pressure relief device set pressure shall not exceed the tank maximum allowable working pressure (MAWP) except as permitted by the applicable transport tank specification Appendix.
b) Where seals are provided to seal external adjustments of pressure relief valves, the seal must be intact and bear the identification of the organization responsible for performing the adjustment. If the valve has been repaired or reset, it must bear a supplemental nameplate identifying the organization responsible for the repair or resetting.
c) Valves that have the set pressure adjustment permanently sealed by means such as a rivet or roll pin through the adjustment, shall be checked to ensure there has been no tampering with the set pressure adjustment.
d) Check for evidence of leakage through the valve. For a valve installed with a rupture disk at the inlet, the rupture disk leakage detection device shall be checked for signs of leakage through the disk. When possible, this inspection should be performed with normal transport tank operating pressure present.
e) All connecting bolting shall be present and tight.
f) Evidence of rust or corrosion of the pressure relief device shall be investigated.
g) Where drain holes are provided on the side of the valve, check that the drain holes are not plugged.
h) Check that a valve spindle restraint (test gag) has not been left in place after pressure testing of the transport tank.
i) Check for proper orientation of rupture disk devices. These devices will have a flow direction arrow or other designation such as inlet or vent side to designate the flow direction. Installation of rupture disk devices in the reverse direction can cause a disk to burst at a higher pressure than its marked burst pressure.

S6.16.7 PRESSURE TESTING OF PRESSURE RELIEF VALVES

A check of pressure relief valve operation shall be performed to ensure the valve is functioning properly. This testing shall be performed at the time of the transport tank pressure test when the tank pressure test will necessitate removal of the pressure relief valve. When the valve is removed for testing, the connection on the transport tank shall be inspected for corrosion or deposits which could block or reduce the connection area.

a) Prior to the test, the inlet and outlet passages of the valve shall be visually inspected for corrosion or deposits of material which could affect valve operation.

b) The test fluid shall be air or other suitable non-hazardous gas.

c) The valve shall be installed on a test stand and a calibrated test gage of suitable range shall be used.

d) Valves shall be tested for the following operational characteristics:

1) Seat Leakage: The test pressure shall be increased to seat leakage test pressure at which there should be no leakage as determined by a bubble test. This pressure will typically be 90% of the stamped set pressure or the pressure prescribed for the applicable transport tank specification. There shall be no audible or visible leakage at the specified seat leakage test pressure.

2) Set Pressure: The set pressure definition used by the valve manufacturer to originally set the valve shall be determined, and shall be used during evaluations of valve performance. For most transport tank valves this will usually be the "start" to "discharge" pressure which is the pressure at which the first audible discharge is detected. The test pressure shall be increased until the set pressure is determined. The valve shall open within the tolerance for set pressure as specified by the applicable transport tank specification.

3) Re-seal pressure: The test pressure shall then be decreased and the pressure at which the valve reseals shall be recorded. The valve shall reseal at or above the pressure specified by the applicable transport tank specification, or above the normal transport tank operating pressure.

4) It is recommended that the test sequence be repeated several times to ensure repeatable valve performance. Erratic performance may indicate damage to the valve, including damage or deposits on the seating surface.

e) The results of testing shall be documented and be made available to the Inspector.

f) Testing shall be performed by trained individuals from an organization acceptable to the Competent Authority.

S6.16.8 CORRECTION OF DEFECTS

Any failure of the valve to meet applicable test specifications shall be brought to the attention of the Inspector and owner, and steps shall be taken to correct the defect. If repairs are required they shall be performed by a qualified organization acceptable to the Competent Authority.

When a valve is to be repaired, it shall be completely disassembled, cleaned, all parts inspected, and repaired as necessary. It shall then be tested and all adjustments resealed with a seal identifying the repair organization. Parts replaced shall be from the valve manufacturer or meet the valve manufacturer's specifications. Where soft goods such as gaskets, o-rings, and other seals are replaced, new parts shall be used.

Repairs shall be identified with a repair nameplate which includes the organization responsible for the repair, date of the repair, and a unique identifier, identifying repair documentation. The goal of the repair is to bring the valve back to a "like new" condition.

A valve found to be defective may be replaced by a new valve or previously repaired valve. Care shall be taken to ensure that the replacement valve meets the same requirements as the valve being replaced.

S6.16.9 INSPECTION OF RUPTURE DISKS AND NON-RECLOSING DEVICES

Rupture disks and other non-reclosing devices cannot be tested. In lieu of the required pressure test for a pressure relief valve, the disk and disk holder must be removed from the transport tank and the disk inlet and outlet surfaces visually inspected. (This is considered the "Internal Inspection.") Signs of corrosion, damage, or deposits will require that the rupture disk be replaced.

A program to periodically replace rupture disks is recommended to prevent premature disk opening during normal operation. This can be caused by corrosion or deterioration of the disk or fatigue of the disk material due to cyclic operation of the transport tank and vibration during normal operation. The rupture disk manufacturer may have recommendations for the frequency of disk replacement. Replacement disks shall have the same specifications for burst pressure and coincident temperature as the disk being replaced, unless the service conditions for the transport vessel are being changed. It is recommended that replacement disks be specified by the complete disk description including model number, burst pressure, and coincident temperature, and the lot number from the disk being replaced. Disks and disk holders from different manufacturers shall not be interchanged.

Dave Parrish Comments

[dkp18]

NATIONAL BOARD INSPECTION CODE
SECTION 6 PART 2 — INSPECTION
2011

SEE PART 4 for Supplement 8 6

~~**SUPPLEMENT 8**~~
~~**PRESSURE DIFFERENTIAL BETWEEN SAFETY OR SAFETY RELIEF VALVE SETTING AND BOILER OR PRESSURE VESSEL OPERATING PRESSURE**~~
~~**S8.1 SCOPE**~~

~~If a safety valve or safety relief valve is subjected to pressure at or near its set pressure, it will tend to weep or simmer, and deposits may accumulate in the seat and disk area. Eventually, this can cause the valve to freeze closed and thereafter the valve could fail to open at the set pressure. Unless the source of pressure to the boiler or pressure vessel is interrupted, the pressure could exceed the rupture pressure of the vessel. It is important that the pressure differential between the valve set pressure and the boiler or pressure vessel operating pressure is sufficiently large to prevent the valve from weeping or simmering.~~

~~**S8.2 HOT-WATER HEATING BOILERS**~~

~~For hot-water heating boilers, the recommended pressure differential between the pressure relief valve set pressure and the boiler operating pressure should be at least 10 psi (70 kPa), or 25% of the boiler operating pressure, whichever is greater. Two examples follow:~~

~~a) If the safety relief valve of a hot-water heating boiler is set to open at 30 psi (200 kPa), the boiler operating pressure should not exceed 20 psi (140 kPa).~~

~~b) If the safety relief valve of a hot-water heating boiler is set to open at 100 psi (700kPa), the boiler operating pressure should not exceed 75 psi (520 kPa). Section IV of the ASME Code does not require that safety relief valves used on hot-water heating boilers have a specified blowdown. Therefore, to help ensure that the safety relief valve will close tightly after opening and when the boiler pressure is reduced to the normal operating pressure, the pressure at which the valve closes should be well above the operating pressure of the boiler.~~

~~**S8.3 STEAM HEATING BOILERS**~~

~~For steam heating boilers, the recommended pressure differential between the safety valve set pressure and boiler operating pressure should be at least 5 psi (35 kPa), i.e., the boiler operating pressure should not exceed 10 psi (70 kPa).~~

~~Since some absorption-type refrigeration systems use the steam heating boiler for their operation, the boiler operating pressure may exceed 10 psi (70 kPa). If the boiler operating pressure is greater than 10 psi (70 kPa), it should not exceed 15 psi (100 kPa), minus the blowdown pressure of the safety valve.~~

~~This recommendation can be verified by increasing the steam pressure in the boiler until the safety valve pops, then slowly reducing the pressure until it closes, to ensure that this closing pressure is above the operating pressure.~~

~~309~~
~~NATIONAL BOARD INSPECTION CODE~~
~~PART 2 — INSPECTION SECTION 6~~
~~2011~~

~~**S8.4 POWER BOILERS**~~

~~For power boilers (steam), the recommended pressure differentials between the safety valve set pressure and the boiler operating pressure are as follows:~~

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

~~DESIGN PRESSURE : over 15 psi to 300 psi~~
~~10% but not less than 7 psi~~
~~(100 KPa to 2.10 MPa)~~
~~(50 KPa)~~
~~over 300 psi to 1000 psi~~

7% but not less than 30 psi
(2.14 MPa to 6.89 MPa)
(200 KPa)
over 1000 psi to 2000 psi
5% but not less than 70 psi
(6.89 MPa to 13.8 MPa)
(480 KPa)
over 2000 psi
per designer's judgment
(13.8 MPa)
Notes:
1. Above 2000 psi (13.8 MPa) the pressure differential between operating pressure and the maximum allowable working pressure is a matter for the designer's judgement , taking into consideration such factors as satisfactory operating experience and the intended service conditions.
2. Safety relief valves in hot water service are more susceptible to damage and subsequent leakage, than safety valves relieving steam. It is recommended that the maximum allowable working pressure of the boiler and safety relief valve setting for high-temperature hot -water boilers be selected substantially higher than the desired operating pressure, so as to minimize the time the safety relief valve must lift.

S8.5 PRESSURE VESSELS

Due to the variety of service conditions and the various designs of pressure relief valves, only general guidelines can be given regarding differentials between the set pressure of the valve and the operating pressure of the vessel. Operating difficulty will be minimized by providing an adequate differential for the application. The following is general advisory information on the characteristics of the intended service and of the pressure relief valves that may bear on the proper pressure differential selection for a given application. These considerations should be reviewed early in the system design since they may dictate the maximum allowable working pressure of the system.
To minimize operational problems it is imperative that the user consider not only normal operating conditions of the fluids (liquids or gases), pressures, and temperatures, but also start-up and shutdown conditions, process upsets, anticipated ambient conditions, instrument response time,and pressure surges due to quickclosing valves, etc. When such conditions are not considered, the pressure relief devices may become, in effect, a pressure controller, a duty for which it was not designed. Additional consideration should be given to the hazard and pollution associated with the release of the fluid. Larger differentials may be appropriate for fluids which are toxic, corrosive, or exceptionally valuable.
310
NATIONAL BOARD INSPECTION CODE
SECTION 6 PART 2 — INSPECTION
2011

The blowdown characteristics and capabilities are the first consideration in selecting a compatible valve and operating margin. After a self-actuated release of pressure, the valve must be capable of reclosing above the normal operating pressure. For example: if the valve is set at 100 psi (700 kPa) with a 7% blowdown, it will close at 93 psi (640 kPa). The operating pressure must be maintained below 93 psi (640 kPa) in order to prevent leakage or flow from a partially open valve. Users should exercise caution regarding the blowdown adjustment of large, spring-loaded valves. Test facilities, whether owned by the manufacturer, repair house, or user, may not have sufficient capacity to accurately verify the blowdown setting. The setting cannot be considered accurate unless made in the field on an actual installation.
Pilot operated valves represent a special case from the standpoint of both blowdown and tightness. The pilot portion of some pilot operated valves can be set at blowdowns as short as 2%. This characteristic is not, however, reflected in the operation of the main valve in all cases. The main valve can vary considerably from the pilot depending on the location of the two components in the system. If the pilot is installed remotely from the main valve, significant time and pressure lags can occur, but reseating of the pilot ensures reseating of the main valve. The pressure drop in connecting piping between the pilot and the main valve must not be excessive, otherwise the operation of the main valve will be adversely affected.
Tightness capability is another factor affecting valve selection, whether spring-loaded or pilot operated. Tightness varies somewhat depending on whether metal or resilient seats are specified and also on such factors

~~as corrosion and temperature. The required tightness and test method should be specified to comply at a pressure not lower than the normal operating pressure of the process. It should be remembered that any degree of tightness obtained should not be considered permanent. Service operation of a valve almost invariably reduces the degree of tightness.~~

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

~~a) For set pressures up to 70 psi (480 kPa), the recommended pressure differential is 5 psi (35 kPa);~~

~~b) For set pressure between 70 and 1000 psi (480 kPa and 6.89 MPa), the recommended pressure differential is 10% of set pressure; and~~

~~c) For set pressures above 1000 psi (6.89MPa), the recommended pressure differential is 7% of set pressure.~~

Ballot Comments NB11-0401 R&A

Name	Document	Comment	Date Created	Is Active
William Vallance		I have no comments	05/23/2012	☑ True
Wayne Jones		No comment	05/23/2012	☑ True
Michael Webb		No adverse comments. My apologies for my delayed response.	05/22/2012	☑ True
Joseph Ball		Voting to access public comments - not a member.	05/01/2012	☐ False
Joseph Ball		5.13.6 and 5.13.6.1 are a combination of VR and NR requirements, although the forms come from the NR program only (there is no VR data report form). I think this was actually missed during the Part 4 draft, but it appears that they might be better staying in Part 3 to stay tied to the rest of the NR program. We are certainly open to suggestions over this question.	05/01/2012	☑ True
George Galanes, PE		I do have a comment. There are some items that were not extracted on this first draft; 5.13.6, 5.13.6.1	05/01/2012	☑ True
Jim Sekely		No Comment Joe No way to submit comments without choosing a voting option - please disregard	04/29/2012	☑ True