# Table of Contents

| NBIC Committee Attendance Sheet - 1/14/16 | | | | |
|---|---|---|---|---|
| **Name** | **Company** | **Phone Number** | **Email** | **Signature** |
| Donald Cook | State of California | (510) 622-3050 | dcook@dir.ca.gov | Don Cook |
| Robert Wielgoszinski | Hartford Steam Boiler | (860) 722-5064 | robert_wielgoszinski@hsbct.com | R Wielgoszinski |
| Brad Besserman | National Board | (614) 431-3236 | bbesserman@nationalboard.org | [illegible] |
| Joel Amato | State of Minnesota | (651) 284-5137 | joel.amato@state.mn.us | [illegible] |
| Benjamin Anthony | State of Rhode Island | (401) 462-8574 | ben.anthony@dlt.ri.gov | |
| Paul Bourgeois | Arise | (732) 943-6078 | paul.bourgeois@ariseinc.com | |
| Sid Cammeresi | Furmanite | (409) 392-0271 | scammeresi@furmanite.com | Sid Cammeresi |
| Domenic Canonico | Canonico & Assoc. | (423) 886-1008 | canonicod@ebpfl.com | |
| Paul Edwards | WECTEC/ ~~CBI~~ CB&I | (617) 589-~~5677~~ 5690 | EDWARDPD@ ~~paul.edwards@CBI.com~~ WESTINGHOUSE.COM | Paul D. Edwards |
| George Galanes | Diamond Technical Services | (815) 634-2727 | ggalanes@diamondtechnicalservices.com | [illegible] |
| Craig Hopkins | Seattle Boiler Works | (206) 762-0737 | chopkins@seattleboiler.com | [illegible] |
| Larry McManamon | Boilermakers National Apprenticeship Program | (708) 636-6656 | lmac@glabap.com | |
| Mark Mooney | Liberty Mutual | 781 697 ~~(781) 891-8900~~ 7218 | mark.mooney@libertymutual.com | [illegible] |
| Brian Morelock | Eastman Chemical Company | (423) 229-1205 | morelock@eastman.com | Brian Morelock |
| Venus Newton | Boiler & Property Consulting | (770) 614-3111 | venus.newton@boilerproperty.com | |
| James Pillow | Common Arc | (860) 688-2531 | jpillow@commonarc.com | J Pillow |
| Ron Pulliam | Babcock & Wilcox | (330) 860-2856 | rlpulliam@babcock.com | Ron Pulliam |
| Mike Richards | Southern Company | (205) 992-7111 | hmichaelrichards.pe@gmail.com | [illegible] |
| Jim Riley | Phillips 66 | (510) 245-5895 | jim.riley@p66.com | |
| Bryan Schulte | NRG Energy | (713) 795-1456 | bryan.schulte@nrgenergy.com | |
| James Sekely | Consultant | (412) 389-5567 | jsekely@comcast.net | Jim Sekely |

| Name | Company | Phone Number | Email | Signature |
|---|---|---|---|---|
| Kevin Simmons | Pentair | (281) 274-4526 | kevin.simmons@pentair.com | [signature] |
| Stanley Staniszewski | U.S. DOT | (202) 366-4545 | stanley.staniszewski@dot.gov | [signature] |
| Rob Troutt | State of Texas | (512) 638-2727 | rob.troutt@tdlr.texas.gov | [signature] |
| Michael Webb | Xcel Energy | (303) 885-9398 | mike.webb@xcelenergy.com | [signature] |
| ERNEST BRANTLEY | XL INSURANCE | 337 842-7044 | ERNEST.BRANTLEY @ BPCLLCGA.COM | [signature] |
| Stanley Konopacki | NRG Energy | 815 372-4740 | Stanley.Konopacki@ NRG.COM | [signature] |
| ADAM RENALDO | PRAXAIR | 716 8792928 | Adam_Renaldo@ Praxair.com | [signature] |
| Keith SANFORD | State of TEXAS | 832453 3017 | Keith.Sanford@ TDLR.TEXAS.GOV | [signature] |
| Rickey Bryan | State of Texas | 682-888 4806 | rickey.bryan@ tdlr.texas.gov | [signature] |
| Eric Cutlip | Babcock + Wilcox | 216 337 0037 | evcutlip@babcock.com | [signature] |
| Brian Boseo | Graycor Services | 630 684 7300 | brian_boseo@graycor.com | [signature] |
| RAY MILETTI | B&W | 330-860-2589 | RLMILETTI@BABCOCK.com | [signature] |
| JIM LARSON | OneCIS | 612 868-1192 | JMLOGHOME@EARTHLINK.NET | [signature] |
| RICK Valdez | ARB, INC | 661 331-6024 | rvaldez@arbinc.com | [signature] |
| DON PATTEN | BAY CITY BOILER | 510 786-3711 | dpatten@baycityboiler.com | [signature] |
| Frank Johnson | PBF Energy | 419 386-8450 | Frank.Johnson@PBF Energy.Com | [signature] |
| Paul Schuelke | Weil-McLain | 219 879-6561 | pschuelke@ weil-mclain.com | [signature] |
| EDDIE WIGGINS | LIBERTY MUTUAL | 256 497-7092 | EDWARD.WIGGINS@ LIBERTYMUTUAL.COM | [signature] |
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| JIM GETTER | WORTHINGTON INDUSTRIES | 614-840 3087 | Jim.GETTER@ WORTHINGTONINDUSTRIES.COM | [signature] |
| TIM BARKER | FM GLOBAL | 360 801 3790 | TIMOTHY.BARKER@ FM GLOBAL.COM | [signature] |
| Bill Valence | MB | 517 231 2700 | | [signature] |

| Name | Company | Phone Number | Email | Signature |
|---|---|---|---|---|
| GREG MCRAE | TRINITY INDUSTRIES | 214 454 9498 | GREG.MCRAE@TRIN.NET | |
| Angelo Bramucci | GE Renewable Energy | 860-285-9176 | Angelo.Bramucci@ge.com | |
| David Martinez | FM Global | 703-262-6311 | david.martinez@fmglobal.com | |
| Gary Scribner | NBBI | | GScribner@nationalboard | |
| KATHY MOORE | JOE MOORE & COMPANY | 919-600 7472 | kathymoore@joemoorecompany.com | |
| GEOFF HALLEY | ARMA | 636 394 3483 | ghalleysjr@aol.com | |
| Paul McHugh | Allied Valve | 312-520-0235 | mchughp@alliedvalve.com | |
| Thomas P. Beirne | NBBI | 614-431-3239 | tbeirne@nationalboard.org | |
| JOHN SIEFERT | EPRI | 704 595 2886 | jsiefert@epri.com | |
| DAVE BUECHEL | MUNICH RE HSB | 412-885 8120 | DAVID.D.BUECHEL@HSB.COM | |
| Nathan Carter | HSB Global Stds | 860-722-5750 | nathan_carter@hsbct.com | |
| Mike Schwartzwalder | Stress Engineering Services | 614-581-6456 | mschwartzwalder@stress.com | |
| DAWN HOLT | Babcock & Wilcox | (330) 860-1080 | drholt@babcock.com | |
| PAT BECKER | B&W | (330) 860-2807 | pabecker@babcock.com | |
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| Paul WELCH | ARISE | 678-446 5290 | paul.welch@ARISEINC.com | |
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| BOB UNDERWOOD | HSBGS | 618-593 6231 | robert_underwood@hsbct.com | |
| Joe Brockman | State of Missouri | 573-751 8708 | Joe.Brockman@dfs.dps.mo.gov | |
| BRYAN TOTH | WECTEC | 980.321. 8638 | TOTHBM@WESTINGHOUSE.COM | |
| DAN MAREK | MAINTHIA TECHNOLOGIES | 216 433 5494 | DANIEL.T.MAREK@NASA.GOV | |

| Name | Company | Phone Number | Email | Signature |
|---|---|---|---|---|
| John Burpee | STATE ME | | | John H Burpee |
| Bonnie Petersen | Marquip Ward United | 715-820 2668 | bonnie.petersen@ bwpapersystem.com | Bonnie Petersen |
| RANDY AUSTIN | STATE of ARIZONA | 602-542 1648 | RANDY.AUSTIN@ AZDOSH.GOV | RD Austin |
| Joe Frey | Stress Engr (B31) | 713 201 7861 | joe.frey@stress.com | Joe Frey |
| Charles Withers | NB | | | [illegible] |
| MARK CLEMENS | N.B. | 614-256 1109 | MCLEMENS@NATIONALBOARD.ORG | [illegible] |
| DARRELL GRAF | AIR PRODUCT & CHEMICALS | 6015690534 | GRAFDR@AIRPRODUCTS.COM | [illegible] |
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# Paul Welch
**2530 Trotters Lane**
**Social Circle, GA 30025**
**(678) 446-5290**

**Objective:**

To serve on the National Board Inspection Code (NBIC) Main Committee to represent the Authorized Inspection Agencies

**Education:**

Fall Mountain Regional High School, 1970 Diploma
Dekalb Technical College, 1994

**Experience:**

**Arise Boiler Inspection and Insurance Company**
Chief of Engineering Operations 3/2014 to Present
National Board Inspection Code (NBIC) Subgroup and Subcommittee for Installation (Part 2)
Territorial Supervisor (Jurisdictional) 7/2012 to 3/2014
Authorized Inspector Supervisor/Code Supervisor 7/2012 to 3/2014
Senior Technical Specialist 7/2012 to 3/2014
Authorized Inspector (AI)
Jurisdictional Inspector (JI)

**Georgia Department of Labor, Safety Engineering**
Director, 3/2010 to 6/2012
Acting Director, 9/2009 to 3/2010
National Board Member, 9/2009 to 6/2012
National Board Inspection Code (NBIC) Main Committee
National Board Inspection Code (NBIC) Subgroup and Subcommittee for Installation (Part 1)
ASME/NB Team Leader, 10/1999 to 6/2012
Safety Inspector Supervisor II, 2/2005 to 9/2009
Safety Inspector Supervisor I, 9/2001 to 2/2005
Boiler/Elevator/Amusement Ride Inspector, 3/1993 to 6/2012

**Norfolk Southern Railroad**
Electrician, 1/1991 to 2/1993

**United States Navy**
Electrician EMCM (SW), 7/6/1970 to 9/30/1990
Gas Turbine Engineering Officer of the Watch (EOOW)
1200 PSI Engineering Officer of the Watch (EOOW)
Senior Enlisted Steam Engineer School
400 PSI Engineering Officer of the Watch (EOOW)
Automated Propulsion Operator
Burner man

**References:**

**Available upon Request**

# Ernest Brantley
# Senior Field Consultant
# De Quincy LA

**EXPERIENCE IN ELECTRIC UTILITIES**

Currently making inspections at several power generation accounts and other high hazard locations

**GENERAL EXPERIENCE AND WORK HISTORY**

**B&PC/XL Insurance Company** **2010 to Date**
**Buford, GA.**

**Senior Boiler and Machinery Specialist**

Company resource for providing answers to jurisdictional questions and providing guidance on difficult issues. Well known throughout the industry and respected for depth of knowledge and knowledge of most Codes. Highly values resource for this organization. Recently obtained A endorsement.

**ACS Group/Seneca** **2002 to 2010**
**Orlando, Fl.**

**Senior Field Consultant**
Responsible for field risk assessment and jurisdictional activities for numerous clients throughout the Southern and Midwest portions of the United States. Audited loss prevention programs at utility, chemical, and pulp and paper locations that include inspections of boilers and pressure vessels. Work status dictates independent effort in scheduling inspections, determining compliance with Codes, providing property conservation training, making engineering judgments and managing workload. Established solid relationships with key insured personnel including management and engineering to effectively manage changes with no resulting recommendations.

**Qualifications**

Twenty years of inspection or supervisory experience in the NGL pipeline, Compressor Station, Refiner, Petro – chemical, Paper Mill industry.
All disciplines of inspection and/or coordination of shutdowns, new construction and on-stream inspections.
On site welder qualification to ASME and AWS code
SNT – TC -1Z level 11 PT, Level 11 MT, Level 11 UT (limited to thickness) RT (Film Interpretation)
National Board of Boiler and Pressure Vessel Inspectors
API – 510
AWS – CWI

**Boilermakers Union #79**
1974 – 1985
Worked as a welder on various construction/maintenance projects including boilers, power houses, refineries and paper mills.

**West – Cal Construction**
1985 – 1989

Project Superintendent over the construction/maintenance of NGL underground storage caverns, ship loading/off loading terminal, pipe lines & relation equipment. Also responsible for coordination of inspection of material and welding.

**Dynegy Corp.**
1989 – 1998

Inspector charged with inspection of approx. 1200 miles NGL pipelines, compressor/separation stations and offshore production platforms. Duties also included Catathodic Protection and testing of pressure safety valves and other production equipment also training employees and contractors in proper NDE procedures and x-ray film interruption, and vendor surveillance. Inspection of new construction of pipelines and pump stations.

**Turner Ind., BE&K, Cox Engineering**
1999 – 2000

Inspector on shut-downs in paper mills and refineries, chemical plants.

**Firestone Polymers/Petrocon Engineering**
2000 –

Chief Inspector for plant with the main duties to include mechanical integrity of pressure vessel and process equipment. Perform NDE as required for compliance of Code and plane specifications. Supervision and coordination of contract inspections. Assure compliance with ASME and APE codes. Vendor surveillance of all off-site work.

**PROFESSIONAL ASSOCIATIONS**

National Board of Boiler and Pressure Vessel Inspectors
American Petroleum Institute
American Welding Society
Past Chairman of Lake Charles LA Section 142 District 18

**EDUCATION**

De Quincy High School
McNeese State University – Welding Inspection Technology
Sowela Technical Institute – Computer Software
Louisiana State University – Industrial Fire Fighting

Benjamin Schaefer
American Electric Power
1 Riverside Plaza, 18th Floor
Columbus, Ohio 43211
Office: 614-716-1843; Cell: 614-949-3715
bschaefer@aep.com

AEP AMERICAN ELECTRIC POWER

## EDUCATION

THE OHIO STATE UNIVERSITY, Columbus, Ohio, *B. S. - Welding Engineering (2003)*

*American Electric Power (AEP) Internal* – Training and Certifications
NONDESTRUCTIVE EXAMINATION (NDE) CERTIFICATIONS – VISUAL (LII), PENETRANT TESTING (LII), (2008)
WELD CHECKER PLANNER (WCP) – DEVELOPMENT AND APPLICATION OF TRAVELERS, (2008)
WELDING INSPECTOR SPECIALIST (WIS) – AEP INTERNAL CERTIFICATION, (2014)

*American Society of Mechanical Engineers (ASME)*
ASME/API 579 FFS-1: RECOMMENDED PRACTICE FOR FITNESS-FOR-SERVICE AND CONTINUED OPERATION OF EQUIPMENT, (2009)
ASME SECTION I POWER BOILERS - TYPES, DESIGN, FABRICATION, INSPECTION AND REPAIR, (2010)

*National Board*
NBIC – NEW CONSTRUCTION COMMISSION & AUTHORIZED INSPECTOR COURSE, (2015)

## EXPERIENCE

2010 TO PRESENT - QUALITY CONTROL MANAGER, METALLURGY, WELDING & STANDARDS (MWS), AMERICAN ELECTRIC POWER (AEP), Columbus, Ohio

- **QUALITY CONTROL**
  - Provide leadership and technical guidance for ~50 indirect reports across the AEP fleet (nine states)
  - Responsible for the implementation, oversight, maintenance, issue resolution and renewal of the AEP's "R" Certification Mark, Quality System and Manual
  - Responsible for the implementation, oversight, maintenance, issue resolution and renewal of AEP's "S" Certification Mark, Quality System and Manual
  - Responsible for audits of applicable NBIC Certification Mark locations
  - Liaison between AEP Fleet and the nine operating jurisdictions
  - Liaison between AEP Fleet and the jurisdictional authorized inspection agency and repair program inspection agency
  - Assist in issues as needed pertaining to NDE and Welding Programs, failure analysis and materials issues
  - Manager the repair programs for AEP subsidiaries Buckeye Power Company, Indiana Kentucky Electric Company (IKEC) and Ohio Valley Electric Company (OVEC)

2008 TO 2010 - QUALITY CONTROL ENGINEER / WELDING ENGINEERING, AMERICAN ELECTRIC POWER (AEP), Columbus, Ohio

- **QUALITY CONTROL**
  - Responsible for audits of ASME and NBIC Stamp locations
  - Conducted ASME Contractor Shop Fabrication Evaluations for large O&M Boiler Projects
- **METALLURGY/WELDING/NONDESTRUCTIVE EVALUATION**
  - Developed AEP Creep Strength Enhanced Ferritic Fabrication Specification (P91, P92, T23, etc.)
  - Assist as needed in materials issues pertaining selection, failure analysis, optimization, etc.
  - Assist in maintenance of welding fleet personnel qualifications
  - Assist in approval of contractor NDE procedures and maintenance of contractor personnel qualifications

2007 TO 2008 - WELDING ENGINEER / BOILER INSPECTOR, DAYTON POWER & LIGHT (DPL), Aberdeen, Ohio

- **BOILER INSPECTION/QUALITY CONTROL/PROJECT MANAGEMENT**
  - Perform boiler, water (hydro) and air side, pressure tests for the purpose of detecting leak locations throughout the boiler as well as verification of successful welding repairs
  - Provide project oversight for contractors or plant maintenance on planned or forced outage repairs
  - Responsible for outage documentation, repair tracking, and final Routine Repair R-stamp documentation.

2003 TO 2007 - WELDING ENGINEER, CONSTELLATION ENERGY, Baltimore, Maryland

- **MANAGED THE FLEET WELDING PROGRAM**
  - Familiar working in nuclear and fossil generation environments, gas transmission and supply, and structural fabrication
- **QUALITY ASSURANCE/CONTROL (QA/QC)/CODES AND STANDARDS**

- Verified conformance by the local generating sites with state law, the NBIC - R, S, and U stamp requirements, the company Insurance Agency (AI), and the Corporate Welding and Nondestructive Evaluation (NDE) programs
- Provided contractor QC oversight of welding, repairs and documentation submittal
- Maintained and updated the ASME qualified fossil/nuclear/gas welding programs
  - Responsible for development, qualification, review, and issuance of welding procedures and welder qualifications

## MEMBERSHIP

MEMBER - AMERICAN WELDING SOCIETY (AWS)

MEMBER - AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

NATIONAL BOARD INSPECTION CODE COMMITTEE – SUBGROUP COMMITTEE MEMBER FOR PART 3 – REPAIRS AND ALTERATIONS, HEADQUARTERED IN COLUMBUS, OHIO (2011 TO PRESENT)

## AWARDS

ARMY – GOOD CONDUCT MEDAL, 1996
ARMY – NATIONAL DEFENSE MEDAL, 1996
ARMY – CERTIFICATE OF RECOGNITION, 1995
ARMY – ACHIEVEMENT METAL, 1993, 1996

## PUBLICATION

Schaefer, B., Bonnington, A. J. "Main Steam Bull Head Wye Weld Failure and Repair," presented at the EPRI International Conference for Welding and Repairs to Fossil Power Plants, June 2006, Sawgrass, FL.

**Resume of Experience for Linn W. Moedinger**

Started work for the Strasburg Rail Road in August of 1968 in grounds maintenance and as an enginehouse helper. Promoted to fireman sometime in the fall of 1968.Two and one half years in the Army from December 1969 until June 1972. Engine messenger on #89 from Bellows Falls Vt. to Strasburg via Wilkes Barre during Agnes in June/July of 1972. Promoted to engineer in 1973. Enginehouse foreman 1976 to 1988. Chief Mechanical Officer 1988 to 2000. President and Chief Mechanical Officer 2000 to present.

Member of Engineering Standards Committee for Steam Locomotives 1991 to present. Secretary of ESC and NBIC Sub Group for Steam Locomotives from approximately 1993 to the present (ESC), 2013 NBIC. Participated in writing the Federal Railroad Administration's new steam rule, 49 CFR, Part 230 and the NBIC repair rules for steam locomotive boilers. Chairman of ASME subgroup on locomotive boilers, chairman NBIC Subgroup Locomotives, member ASME BPV-I.

**Experience**

Locomotives – Steam – Boilermaking since 1972; Machinery work since 1972; design since 1976; inspection since 1976; operation since 1968;

Rolling Stock– Mechanical work since 1968; wood work since 1987; design since 1985; inspection since 1976; operation since 1968;

Roadway and Track – construction since 1968, design since 1987, inspection since 1976

General - Welding since 1972 – currently ASME certified; machinist since 1975; NDE – PT, MT, UT, VT since 1985; Operations, Rules and Testing since 1987;

**Agency and Organization Affiliations**

ASME – Strasburg Rail Road – "S" stamp holder since 1996; involvement since 1980;
Chairman – Sub Group Locomotives, Member BPV-I;
ASTM – voting member since 1991
Engineering Standards Committee for Steam Locomotives since 1991; secretary since 1993;
FRA – involvement since 1968
National Board - Rail Road – "R" stamp holder since 1996; involvement since 1991; secretary of NBIC Task Group (Sub-group) for Steam Locomotives, chairman since 2013;
NTSB – 1996 accident investigation of Gettysburg RR
TRAIN Inc. – director since 2002
ATRRM – vice president since merger of TRAIN and ARM in 2012
Colorado Railroad Museum Advisory Board – since 2008

# MARTY TOTH



2950 Foster Creighton Dr Nashville, TN 37204 615.504.9064 mtoth@boisco.com

## Summary

Innovative, multidisciplinary leader with demonstrated success in operations management. Exceptional ability to initiate, build, and manage new and changing organizations and profit generating programs. Consistent track record of meeting and exceeding established profit and operational objectives. Skilled in building strategic relationships and creating trust and confidence with both internal and external stakeholders.

## *Expertise:*

- Exceeds objectives by developing vision and strategic plans, with implementation of objective measurement tracking and employee recognition systems
- Builds strong teams through effective recruitment, inspiration, and development with a management style that encourages accountability, teamwork, and execution
- Thrives on meeting challenges including delivery of new, or turn-around, organization and relationship solutions

## Professional Experience

**Director of Marketing & Training;** Boiler Supply Co., Nashville, TN 2014-Present

Responsible for the development and implementation of the marketing and outside training department of the company while continuing to grow the aftermarket sales through closely working with the company's Parts department management and personnel.

- Marketing will be focused on the analytic, direct, email, and social marketing of the company to increase sales and customer growth.
- Boisco Training Group (BTG) will be focused on developing course curriculum geared toward customer needs and technician development that will be delivered the onsite, remote, and online mediums.
    - Lead instructor for the Basic Boiler Operator Training class throughout the southeast United States.
- Overseeing the continued growth of the Parts department within Boiler Supply Company by encouraging full team participation in establishing and implementing ideas of change

**Director of Service Operations;** Boiler Supply Co., Nashville, TN 2010-2014

Hired to support processes improvement changes throughout the company and promote change and growth operations within the company.

- Managing operations divisions within the company
    - Service Coordination
    - Service Billing
    - Process Development and Improvement
    - Code Support
- Instrumental in developing efficiency procedures that limited waste in all departments and resulting in thousands of dollars in profit savings for the company
- In charge of companywide safety management program development and implementation
- Overseeing Parts department operations and growth
- Directed the area of electric service ticket reporting and companywide scheduling

**Chief Boiler Inspector;** State of Tennessee, Nashville, TN 2001-2008

Responsible for all facets of The State of Tennessee's Inspection Program, including developing policies and procedures, recruit, hire, train and lead staff of 20 and represent the state as the youngest member of the National Board.

- Manager of the Boiler Inspection Section of the B & E Division
- Quality Control Review Team Leader
- Liaison for Legislative Actions & Public Presentations
- Serve as a Member of the National Board of Chief Boiler Inspectors
- Board of Trustees, National Board
- A.S.M.E. Conference Committee Member
- Lead the program in reducing the delinquent inspection from 33% to less than 2% in under three years
- Created the Annual Tennessee Boiler Inspectors Conference, which brought statewide awareness and training to the industry and industry inspectors

**Deputy Boiler Inspector;** State of Tennessee, Nashville, TN 1993-2001

Responsible for boiler and pressure vessel safety of thousands of vessels in hundreds of companies throughout Tennessee.

- As a key member of the State's inspection team, was responsible for bringing the program to the era of computer reporting and uniformed training
- Performed A.S.M.E. and National Board Code audits and company surveys
- Developed and presented key safety initiatives adopted as standards in the industry
- Instrumental in creating the industry's first fully integrated electronic inspection entry program

## Education

1996-2008 **National Board;** Columbus, OH
Authorized Inspector (A, B, & N endorsements) and Team Leader
- Management Related Subjects

1999-2001 **Volunteer State Community College;** Gallatin, TN
Associate of Science Studies

1986 **U.S. Navy;** Great Lakes, IL
Engineering Apprenticeship Program
- Boiler & Related Equipment Operations

## Awards

| | |
|---|---|
| 2009 | **Honorary Member – National Board of Boiler & Pressure Vessels Inspectors** |
| 1998 | **Tennessee Department of Labor Employee of the Year Nominee** |

## Community

| | |
|---|---|
| 2015 | **Nolensville Youth Association,** Board Director |
| 2011-Present | **Nolensville Baseball Board,** Director of League Development |
| 2011-Present | **Youth Athletics Coach,** Baseball – Football – Basketball |
| 2010-Present | **The Peoples' Church**, Bible Study/Small Group Leader: Franklin, TN |
| 2003-2008 | **Tennessee Government Institute,** Community Service Committee: Nashville, TN |
| 2003-2008 | **Habitat for Humanity**: Nashville, TN |
| 2001-2008 | **Nashville Union Mission**: Nashville, TN |
| 1994-1997 | **Junior Chamber of Commerce**, Director: Jackson, TN |

## Community

Married to Kristen Toth (10-1/2 Years), Daughter; Madaline Grace (9) and Son; Preston (7). In excellent health, I enjoy being with my family, coaching youth sports, playing sports and being a member for 12 years of The Peoples Church Franklin, TN.

# Daniel T. Marek

**21000 Brookpark Rd Cleveland, OH 44135 (216) 433–5494 daniel.t.marek@nasa.gov**

**Summary** An engineering professional with almost 20 years of code compliance, design, application and testing experience in areas ranging from pressure vessels/process piping, industrial components and mobile HVAC while insuring product/process quality, excellent customer service, and team work.

## Professional Experience

**MAINTHIA TECHNOLOGIES INCORPORATED –** Middleburg Hts, OH **04/2007 – Present**

Support Service Contractor to the NASA Glenn Research Center – Cleveland, OH

**Senior Pressure Systems Engineer -** (Pressure Systems Office)

- Responsible for conducting all phases of pressure vessel and pressure system (PV\S) certification in accordance with NASA NPD 8710.5, NASA STD 8719.17 and numerous national consensus codes including ASME B&PV Section VIII Div I & II, ASME B31.3, NBIC, EJMA, DOT and API
- Responsible for performing pressure vessel and pressure system certification utilizing the following skill sets:
  - Recommendation of non-destructive examinations
  - Field analysis of system/pressure vessel configuration to ensure code compliance
  - Performance of calculations in support of pressure vessel and pressure system certification
    - Determination of maximum allowable working pressure and mechanical integrity
    - Fracture mechanics flaw analysis
    - Relief device capacity sizing and vent system analysis
    - Piping flexibility analysis
  - Determination of inspection and recertification frequencies based upon mechanical integrity calculations and remaining life analysis
  - Working with pressure vessel/pressure system owners to ensure all issues found during certification are corrected and required documentation is archived
  - Preparation of risk assessment reports (RACs)
- Responsible for coordinating piping and pressure vessel repairs as required in support of certifying the NASA Glenn Research Center’s 40# Combustion Air System and the annual Central Process System header inspections. Responsibilities include the following:
  - Preparation of a scope of work for each repair
  - Sourcing and soliciting of competitive bids for presentation to NASA system owner
  - Coordination of environmental abatement as required
  - Coordination of required health and safety plan and hot work/excavation permits
  - Daily worksite inspections along with a final inspection to ensure contract requirements were met
- Have worked with the NASA Glenn Research Center’s Facilities Division since conception of the following new pressure systems to ensure code compliance is maintained during both design and fabrication:
  - Service air compressor SA-24
  - Combustion air dehydrator TD5

**NOSHOK, INCORPORATED –** Berea, OH **10/1999 – 03/2007**

**Design Engineer -** (Valve and Instrumentation Products)

- Developed and designed new products from conception to production utilizing the following skill sets:
  - Created 3D models using PTC Pro/Engineer Wildfire 2.0
  - Created detailed drawings for both individual components and final assemblies
  - Created various macros in Microsoft Excel for mechanical design calculations
  - Utilized Pro/Engineer Mechanica Structural Simulation Software for analysis of structural integrity
- Performed high pressure burst, life cycle, and control valve flow tests as part of product development
- Developed a receiving inspection program for incoming components

**EAGLE ENGINEERING & MANUFACTURING -** Cleveland, OH **03/1999 – 07/1999**

**Project Engineer – (**Aftermarket / OEM HVAC Systems)

- Responsible for final design and production release of an aftermarket medium duty rooftop mobile A/C system.

**PARKER HANNIFIN CORPORATION –** Mayfield Hts, OH **12/1995 – 03/1999**

**Application Engineer** – Heavy Truck / Off Road Business Unit (Batesville, MS) 9/98-3/99

- Responsible for application engineering and pricing of mobile A/C plumbing for Case IH (US Models) and John Deere programs from initial concept to production release

**Quality Engineer / Launch Coordinator** – Plant Quality Department (Batesville, MS) 3/98-9/98

- Responsible for managing program launches/pilot runs from the release of production prints.
- Supervised a staff of six in-process quality control inspectors over two production shifts

**Application Engineer** – Chrysler Business Unit (Troy, MI) 1/97-3/98

- Responsible for various engineering projects for mobile A/C plumbing, expansion valves, receiver driers, and electric vehicle-cooling modules in support of various Chrysler product lines.

**Project Engineer** – Dodge Truck Climate Control (Detroit, MI) 12/95-12/96

- Contracted thru Parker Hannifin to Chrysler Corporation – Jeep & Truck Division
- Responsible for multiple projects to analyze and improve the function and performance of the Dodge Ram Truck's HVAC System

## Education

**Bachelor of Mechanical Engineering Technology -** University of Toledo, Toledo, OH 1997

**Interpretation** IN15-0801

**Proposed Interpretation**

| | |
|---|---|
| **Inquiry:** | IN15-0801 |
| **Source:** | Sean Dust |
| **Subject:** | Part 1, 3.3.4 |
| **Edition:** | 2015 |
| **Question 1:** | **Question 1:** Can the proposed boilers be installed with 1 inch of side clearance between each boiler, per the manufacturers installation recommendations? |
| **Reply 1:** | Yes.  The proposed boilers can be installed with 1 inch of side clearance between each boiler, per the manufacturers installation recommendations. |
| **Committee's Question:** | **Question 1:** Is it permissible to install boilers less than the minimum 36" clearance if recommended by the manufacturer and approved by the Jurisdiction? |
| **Committee's Reply:** | **Proposed Reply 1:** Yes |
| **Rationale:** | In accordance with Part 1 Section 3.3.4 a) |
| **SC Vote** | unanimous |
| **NBIC Vote** | |

Requesting Code Interpretation.

Inquiry:
Can the proposed boilers be installed with 1 inch of side clearance between each boiler, per the manufacturers installation recommendations?

Reply:
Yes. The proposed boilers can be installed with 1 inch of side clearance between each boiler, per the manufacturers installation recommendations.

Background Information:
We need to install five natural gas fired hot water boilers, where each boiler is rated at 6,000,000 btu/hr. The manufacturer has recommended these boilers be installed as a modular system, with 1 inch of clearance between the sides of each boiler, that is fully assembled at the factory, on a skid, complete with header. The manufacturer has provided documentation (a UL listing certificate) which indicates the 1 inch of side clearance between the boilers is acceptable, safe, as all operation, maintenance and inspection is accessible from the front, top and back of the boilers. Initial review by boiler inspectors has provided mixed results. Several inspectors indicate that the installation is acceptable with the 1 inch of clearance between the sides of the boilers, because operation, maintenance and inspection is accessible from the front, top, and back of the boilers. However one of the inspectors indicates that regardless of the manufacturers recommendations, history of installations, and UL certificate, it is not acceptable, and 36 inches of clearance must be provided on all sides of the boilers. The clearances come from PART1 section 3.3.4 of the code. Section 3.3.4 a) says 36 inches between all sides. But it also states alternative clearances in accordance with the manufacturer's recommendations, subject to acceptance by jurisdiction of course. The manufacturer has provided all documentation which indicates it is acceptable along with a history of similar installations. However, as mentioned, some feel it is acceptable, and some do not. Requesting a final ruling from the committee to resolve dispute.

Sincerely,

Sean Dust
Mechanical Engineer
Engineering Plans and Services
Corpus Christi Army Depot
308 Crecy Street
Corpus Christi, TX 78419
Phone: (361) 961-7058
E-mail: sean.c.dust.civ@mail.mil

## NB10-1201

## 1.6 GENERAL REQUIREMENTS

The following are general requirements for the boilers, heaters and pressure vessels covered in NBIC Part1, Section 2, NBIC Part 1 Section 3, NBIC Part 1 Section 4, and NBIC Part 1 Supplement S5. Refer to each referenced section for additional requirements specific to the type of equipment covered by each section.

### 1.6.1 SUPPORTS, FOUNDATIONS, AND SETTINGS

Each boiler, heater, vessel and its associated piping must be safely supported. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal expansion and contraction), and loadings (including the weight of the fluid in the system during a pressure test) in accordance with jurisdictional requirement, manufactures recommendations, and/or other industry standards, as applicable.

### 1.6.2 STRUCTURAL STEEL

a) If the boiler, heater, vessel is supported by structural steel work, the steel supporting members shall be so located or insulated that the heat from the furnace will not affect their strength.

b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.

### 1.6.3 EXIT

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

### 1.6.4 LADDERS AND RUNWAYS

a) All walkways, runways, and platforms shall be:
   1) of metal construction or equivalent material;
   2) provided between or over the top of boilers, heaters, vessels that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;
   3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);
   4) of bolted, welded, or riveted construction; and
   5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe board.

b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.

c) Ladders that serve as a means of access to walkways, runways, or platforms shall:
   1) be of metal construction and not less than 18 in. (460 mm) wide;
   2) have rungs that extend through the side members and are permanently secured;
   3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;
   4) have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and
   5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.

d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.

## 1.6.5 FUEL

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

## 1.6.6 VENTILATION AND COMBUSTION AIR

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

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

c) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2000 Btu/hr (586 W) maximum fuel input of the combined burners located in the equipment room or as specified by the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room supply openings shall be kept clear at all times.

d) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1000 Btu/hr (293W) of maximum fuel input for the combined burners of all boilers and heaters located in the equipment room. Additional capacity may be required for other fuel burning equipment in the equipment room.

e) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that burners will not operate without an adequate number of ventilators/fans in operation.

f) The size of openings specified in c) above may be reduced when special engineered air supply systems approved by the Jurisdiction are used.

g) Care should be taken to ensure that steam, water and fluid lines are not routed across combustion air openings, where freezing may occur in cold climates.

## 1.6.7 LIGHTING

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

## 1.6.8 CHIMNEY OR STACK

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

## 1.6.9 FINAL ACCEPTANCE

Boilers, heaters, or pressure vessels may not be placed into service until its installation has been inspected and accepted by the appropriate jurisdictional authorities

# PART 1, SECTION 2
# POWER BOILERS

## 2.3.1 SUPPORTS, FOUNDATIONS, AND SETTINGS

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

See NBIC Part 1, Section 1.6.1, *Supports, Foundations and Settings*

## 2.3.2 STRUCTURAL STEEL

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

~~b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.~~

See NBIC Part 1, Section 1.6.2, *Structural Steel*

## 2.4.1 EXIT

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

See NBIC Part 1, Section 1.6.3, *Exit*

## 2.4.2 LADDERS AND RUNWAYS

~~a) All walkways, runways, and platforms shall be:~~

~~1) of metal construction;~~

~~2) provided between or over the top of boilers that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;~~

~~3) constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);~~

~~4) of bolted, welded, or riveted construction; and~~

~~5) equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe- board.~~

~~b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and shall be equipped with handrails 42 in. (1070 mm) high with an intermediate rail.~~

~~c) Ladders that serve as a means of access to walkways, runways, or platforms shall:~~

~~1) be of metal construction and not less than 18 in. (460 mm) wide;~~

~~2) have rungs that extend through the side members and are permanently secured;~~

~~3) have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;~~

~~4) have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and~~

~~5) have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.~~

~~d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.~~

See NBIC Part 1, Section 1.6.4, *Ladders and Runways*

## 2.5.2 FUEL

~~Fuel systems, whether firing coal, oil, gas, or other substance, shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.~~

See NBIC Part 1, Section 1.6.5, *Fuel*

## 2.5.4 VENTILATION AND COMBUSTION AIR

~~a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the boiler room. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans.~~[2]

~~b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2,000 Btu/ hr (586 W} maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room air supply openings shall be kept clear at all times.~~

~~c) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1,000 Btu/hr (293 W} of maximum fuel input for the combined burners of all boilers located in the equipment room. Additional capacity may be required for any other fuel burning equipment in the boiler room.~~

~~d) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.~~

~~e) The size of openings specified in NBIC Part 1, 2.5.4 b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.~~

~~f) Care should be taken to ensure that steam and water lines are not routed across combustion air openings, where freezing may occur in cold climates.~~

See NBIC Part 1, Section 1.6.6, *Ventilation and Combustion Air*

## 2.5.5 LIGHTING

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

See NBIC Part 1, Section 1.6.7, *Lighting*

## 2.6.1 CHIMNEY OR STACK

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

See NBIC Part 1, Section 1.6.8, *Chimney or Stack*

## 2.6.3.1 CONNECTION

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

## 2.10.5 FINAL ACCEPTANCE

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

See NBIC Part 1, Section 1.6.9, *Final Acceptance*

# PART 1, SECTION 3
# INSTALLATION — STEAM HEATING BOILERS, HOT-WATER HEATING BOILERS, HOT-WATER SUPPLY BOILERS, AND POTABLE WATER HEATERS

## 3.3.1 SUPPORTS

~~Each heating boiler shall be supported by masonry and/or structural supports of sufficient strength and rigidity to safely support the heating boiler and its contents without vibration in the heating boiler or its connecting piping and to allow for expansion and contraction.~~

See NBIC Part 1, Section 1.6.1, *Supports, Foundations and Settings*

## 3.3.2 SETTINGS

~~Steam heating, hot-water heating, and hot-water supply boilers of wrought materials of the wet-bottom type having an external width of over 36 in. (914 mm) shall be supported so as to have a minimum clearance of 12 in. (305 mm) between the bottom of the boiler and the floor to facilitate inspection. When the width is 36 in. (914 mm) or less, the clearance between the bottom of the boiler and the floor line shall be not less than 6 in. (150 mm), except when any part of the wet bottom is not farther from the outer edge than 12 in. (305 mm), this clearance shall be not less than 4 in. (100 mm). Boiler insulation, saddles, or other supports shall be arranged so that inspection openings are readily accessible.~~

See NBIC Part 1, Section 1.6.1, *Supports, Foundations and Settings*

## 3.3.3 STRUCTURAL STEEL

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

~~b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer's recommendations, and/or industry standards as appropriate.~~

See NBIC Part 1, Section 1.6.2, *Structural Steel*

## 3.4.1 EXIT

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

See NBIC Part 1, Section 1.6.3, *Exit*

## 3.4.2 LADDERS AND RUNWAYS

~~a) All walkways, runways, and platforms shall be:~~

~~1) of metal construction;~~

~~2) provided between or over the top of boilers that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;~~

3) ~~constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);~~

4) ~~of bolted, welded, or riveted construction; and~~

5) ~~equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe board.~~

b) ~~Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.~~

c) ~~Ladders that serve as a means of access to walkways, runways, or platforms shall:~~

1) ~~be of metal construction and not less than 18 in. (460 mm) wide;~~

2) ~~have rungs that extend through the side members and are permanently secured;~~

3) ~~have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;~~

4) ~~have a clearance of not less than 6-1/2 in. (165 mm) from the back of rungs to the nearest permanent object; and~~

5) ~~have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.~~

d) ~~There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8 m) in length.~~

See NBIC Part 1, Section 1.6.4, *Ladders and Runways*

## 3.5.2 FUEL

~~Fuel systems, whether firing coal, oil, gas, or other substance, shall be installed in accordance with jurisdictional and environmental requirements, manufacturer's recommendations, and/or industry standards, as applicable.~~

See NBIC Part 1, Section 1.6.5, *Fuel*

## 3.5.4 VENTILATION AND COMBUSTION AIR

a) ~~The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room. The combustion and ventilation air may be supplied by either an unobstructed air opening or by power ventilation or fans.~~[5]

b) ~~Unobstructed air openings shall be sized on the basis of 1 sq. in. (645 sq mm) free area per 2,000 Btu/ hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The equipment room air supply openings shall be kept clear at all times.~~

c) ~~Power ventilators or fans shall be sized on the basis of 0.2 ft³ (0.006 m³) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all boilers and/or water heaters located in the equipment room. Additional capacity may be required for any other fuel burning equipment in the equipment room.~~

~~d) When power ventilators or fans are used to supply combustion air, they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.~~

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

~~f) The size of openings specified in NBIC Part 1, 3.5.4 b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.~~

~~g) Care should be taken to ensure that steam and water lines are not routed across combustion air openings, where freezing may occur in cold climates.~~

See NBIC Part 1, Section 1.6.6, *Ventilation and Combustion Air*

## 3.5.5 LIGHTING

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

See NBIC Part 1, Section 1.6.7, *Lighting*

## 3.6.1 CHIMNEY OR STACK

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

See NBIC Part 1, Section 1.6.8, *Chimney or Stack*

## 3.10.2 FINAL ACCEPTANCE

~~a) In addition to determining that all equipment called for is furnished and installed in accordance with the plans and specifications, all controls shall be tested by a person familiar with the control system.~~

~~b) Before any new heating plant (or boiler) is accepted for operation, a final (or acceptance) inspection by a person familiar with the system shall be completed and all items of exception corrected.~~

See NBIC Part 1, Section 1.6.9, *Final Acceptance*

# PART 1, SECTION 4
# INSTALLATION — PRESSURE VESSELS

## 4.3.1 SUPPORTS

~~Each pressure vessel shall be safely supported. The potential for future hydrostatic pressure tests of the vessel after installation shall be considered when designing vessel supports. Design of supports, foundations, and settings shall consider vibration (including seismic and wind loads where necessary), movement (including thermal movement), and loadings (including the weight of water during a hydrostatic test) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.~~

See NBIC Part 1, Section 1.6.1, *Supports, Foundations and Settings*

## SUPPLEMENT 5
## INSTALLATION OF THERMAL FLUID HEATERS

### S5.3.1 SUPPORTS, FOUNDATIONS, AND SETTINGS

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

See NBIC Part 1, Section 1.6.1 *Supports, Foundations, and Settings*

### S5.3.2 STRUCTURAL STEEL

~~a) If the thermal fluid heater is supported by structural steel work, the steel supporting members shall be so located or insulated that the heat from the furnace will not affect its strength.~~

~~b) Structural steel shall be installed in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.~~

See NBIC Part 1, Section 1.6.2 *Structural Steel*

### S5.4.1 EXIT

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

See NBIC Part 1, Section 1.6.3 *Exit*

### S5.4.2 LADDERS AND RUNWAYS

~~a) All walkways, runways and platforms shall be:~~

~~1) Of metal construction;~~

~~2) Provided between or over the top of heaters that are more than 8 ft. (2.4 m) above the operating floor to afford accessibility for normal operation, maintenance, and inspection;~~

~~3) Constructed of safety treads, standard grating, or similar material and have a minimum width of 30 in. (760 mm);~~

~~4) Of bolted, welded, or riveted construction; and~~

~~5) Equipped with handrails 42 in. (1,070 mm) high with an intermediate rail and 4 in. (100 mm) toe-board.~~

~~b) Stairways that serve as a means of access to walkways, runways, or platforms shall not exceed an angle of 45 degrees from the horizontal and be equipped with handrails 42 in. (1,070 mm) high with an intermediate rail.~~

~~c) Ladders that serve as a means of access to walkways, runways, or platforms shall:~~

~~1) Be of metal construction and not less than 18 in. (460 mm) wide;~~

~~2) Have rungs that extend through the side members and are permanently secured;~~

~~3) Have a clearance of not less than 30 in. (760 mm) from the front of rungs to the nearest permanent object on the climbing side of the ladder;~~

~~4) Have a clearance of not less than 6½ in. (165 mm) from the back of rungs to the nearest permanent object; and~~

~~5) Have a clearance width of at least 15 in. (380 mm) from the center of the ladder on either side across the front of the ladder.~~

~~d) There shall be at least two permanently installed means of exit from walkways, runways, or platforms that exceed 6 ft. (1.8m) in length.~~

See NBIC Part 1, Section 1.6.4 *Ladders and Runways*

## S5.5.6 FUEL

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

See NBIC Part 1, Section 1.6.5 *Fuel*

## S5.5.8 VENTILATION AND COMBUSTION AIR

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

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

~~b) Unobstructed air openings shall be sized on the basis of 1 sq. in. (650 sq. mm) free area per 2,000 Btu/ hr (586 W) maximum fuel input of the combined burners located in the equipment room, or as specified in the National Fire Protection Association (NFPA) standards for oil and gas burning installations for the particular job conditions. The heater equipment room air supply openings shall be kept clear at all times.~~

~~c) Power ventilators or fans shall be sized on the basis of 0.2 cfm (0.0057 cu meters per minute) for each 1,000 Btu/hr (293 W) of maximum fuel input for the combined burners of all thermal fluid heaters located in the equipment room. Additional capacity may be required for any other fuel burning equipment in the equipment room. Pressure in the room should be consistently neutral.~~

~~d) When power ventilators or fans are used to supply combustion air they shall be installed with interlock devices so that the burners will not operate without an adequate number of ventilators/fans in operation.~~

~~e) The size of openings specified in b) may be reduced when special engineered air supply systems approved by the Jurisdiction are used.~~

~~f) Care should be taken to ensure that thermal fluid lines are not routed across combustion air openings, where freezing may occur in cold climates.~~

See NBIC Part 1, Section 1.6.6 *Ventilation and Combustion Air*

## S5.5.9 LIGHTING

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

See NBIC Part 1, Section 1.6.7 *Lighting*

## S5.6.1 CHIMNEY OR STACK

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

See NBIC Part 1, Section 1.6.8 *Chimney or Stack*

## S5.8.5 FINAL ACCEPTANCE

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

See NBIC Part 1, Section 1.6.9, *Final Acceptance*

| Archived Comments for Ballot: NB13-1101-MC | |
|---|---|
| **Simmons,Kevin** 10/16/2015 11:19:40 AM | Abstain pending response to questions raised by other committee members |
| **Webb,Michael** 10/16/2015 8:36:52 AM | I too would like to abstain until I see a response to the approve & disapprove comments posted. |
| **Edwards,Paul** 10/6/2015 12:31:00 PM | I will abstain pending resolution of the negatives and comments. |
| **Staniszewski,Stanley** 10/2/2015 6:40:15 AM | Agree with comments of Mr. Cook & Trout. Proposal should also consider using consistent terminology with Part 1. Is there a difference in Boiler manufacturer vs burner mfg as used in the proposal that warrants its use? |
| **Mooney,Mark** 10/1/2015 7:55:25 AM | I think Don Cook And Rob Troutt make valid comments. |
| **,** 9/29/2015 10:55:29 AM | I don't think we should carve out that the supplement only applies to Owner/User/Installer and that this should be struck from the proposal. The supplement applies to all users of the Code and this type of exception is not appropriate. |
| **Amato,Joel** 9/21/2015 11:34:37 AM | I believe the venting of flue gases should also include requirements for the location of the termination, this would include distances from doors and windows. |
| **Troutt,Robby** 9/21/2015 11:30:30 AM | I have several concerns with the proposed. -The Scope talks about CO detector/alarm, however the body has no requirements listed for these components. If we are going to address detector/alarm in the Scope, then there should be verbiage in the body for the requirement. -Because this is addressing Condensing Boilers (which gets Combustion Air from outside) and we do not address "Ventilation", I fear the requirements of Part 1, Paragraph 3.5.4 (Ventilation and Combustion Air) will not be adhered to. For this reason, I feel we should reinforce requirements of 3.5.4 for "Ventilation" purposes. Reasoning: Here in Texas we had the same ventilation requirements as NBIC up to June 15th of this year. When we saw Condensing Boilers being installed, we found the installers felt they did not need ventilation as the boiler pulls air for combustion from the outside. They stated, because the mechanical room was an interior room, Fire Codes required up to a 2 hour "Fire Wall" (depending on the building use, size of mech. room, etc.), they could not provide ventilation. They further stated, since the air for combustion was pulled from outside the building, it was not required. We made a revision to Texas Boiler Rules to require CO Detectors if ventilation was not installed and Condensing Boilers were installed. I am not stating we should make this the same as Texas did, instead I am concerned other Jurisdictions will see the same occurrences as we did. I just feel it should be addressed. |

R. Troutt – comment was addressed in adding S6.4 e)
J. Amato – comment was addressed in S6.4 d) by adding National Fuel Gas Code (ANSI Z223.1)
D. Cook – comment was addressed in S6.1 b)

**SUPPLEMENT 6**
**(Rev. July 14, 2015)**

## PART 1, SECTION 6

## SPECIAL REQUIREMENTS FOR THE INSTALLATION OF CONDENSING BOILERS

### S6.1 SCOPE

a) NBIC Part 1 Section 6 Supplement 6 provides requirements for various aspects of the installation of Condensing Boilers which are unique from other products covered by this section.

b) This supplement ~~is intended for the Owner/User/Installer only, and~~ is based on Local, State or National Building Codes requiring the installation of a Carbon Monoxide (CO) detector/alarm in the boiler room.

### S6.2 DETERMINATION OF ALLOWABLE OPERATING PARAMETERS

The allowable operating parameters of the combustion air intake and the exhaust gas venting shall be in accordance with jurisdictional, environmental and manufacturers recommendations, as applicable.

### S6.3 GENERAL REQUIREMENTS

Condensing boilers shall meet all the requirements of NBIC Part 1, Section 3 and this Supplement.

### S6.4 FLUE GAS VENTING SYSTEM PIPING REQUIREMENTS

a) The vent piping shall be corrosion resistant and fabricated from either stainless alloy or plastic material as defined by the boiler manufacturer and certified for the application.

b) The diameter of the vent piping shall be as defined by the boiler manufacturer and shall not be reduced, except as allowed by the boiler manufacturer.

c) The "Total Equivalent Length" of the vent piping, and the pressure drop through the vent piping, shall not exceed that stated in the Boiler Manufacturer's Installation Manual. (Note Equivalent Length includes the pressure loss effect of various pipe fittings, such as elbows, etc.) Horizontal pipe runs shall slope toward the boiler and the condensate collection point.

d) The termination point of the vent piping shall be positioned such that there is no possibility of vented flue gas being entrained in the combustion air intake, as defined by the manufacturer and National Fuel Gas Code (ANSI Z223.1). Additionally the vent termination shall be located above the highest known snowline for the location involved, and be designed in such a manner, so as to prevent freezing.

e) This supplement requires the owner/user/installer contact the authority having Jurisdiction regarding the installation of carbon monoxide (CO) detector/alarm in boiler rooms in which condensing boilers are to be installed.



## S6.5 SEALED COMBUSTION SYSTEM REQUIREMENTS

a) The location of the outside air intake, relative to the flue gas vent, shall be such that there shall be no cross contamination with products of combustion or other airborne corrosive or hazardous contaminants, as defined by the manufacturer. Additionally the location of the combustion air intake shall be above the highest known snowline for the location involved.

b) The diameter, length and routing of the combustion air intake piping shall be such that the pressure drop though the system, including any filters, shall not exceed the maximum pressure drop stated by the boiler/burner manufacturer.

## S6.6 CONDENSATE DRAIN SYSTEM REQUIREMENTS

The flue gas condensate from an individual boiler shall be collected at a single point, and the routing of the drain piping shall include the following features:

1) A water trap, the height of which cannot be varied by field manipulation, and is in accordance with boiler manufacturers requirements.

2) A visible means of ensuring that the condensate water trap contains the correct water level.

3) A discharge point away from occupied areas.

4) A method of controlling the pH of the condensate prior to its discharge into a sewer system, if required by local building Codes.

**NB15-0107**

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Proposed item for NBIC

**ITEM NB15-0107**

**3.8.2.3 TEMPERATURE CONTROL**
Each automatically fired hot-water heating or hot-water supply boiler shall be protected from over-temperature by two temperature-operated controls.

a) Each individual hot-water heating or hot-water supply boiler or each system of commonly connected boilers shall have a control that will cut off the fuel supply when the water temperature reaches an operating limit, which shall be less than the maximum allowable temperature.

b) In addition to a) above, each individual automatically fired hot-water heating or hot-water supply boiler shall have a safety limit control with manual reset that will cut off the fuel supply ~~to prevent the water temperature from exceeding the~~ at or below maximum allowable temperature at the boiler outlet.

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**For information only:**

Rational: BPV IV, CSD-1 and NBIC have similar language but not the same. This item has been opened to make the language between the 3 Codes consistent. The ASME BPV IV item is shown below and has been board approved. There is an open item in CSD-1 15-2057 that will go to ballot . A mark-up of the intended changes based on the 2012 Edition is shown for information only.

**Item 11-223 board approved by ASME**
**HG-613 TEMPERATURE CONTROL**
Each automatically fired hot water heating or hot water supply boiler shall be protected from over-temperature by two temperature-operated controls. These temperature control devices shall conform to UL 353, Standard for Limit Controls, and shall be accepted by a nationally recognized testing agency.

*(a)* Each individual automatically fired hot water heating or hot water supply boiler shall have a high temperature limit control that will cut off the fuel supply ~~to prevent water temperature~~

~~from exceeding its~~ at or below the marked maximum water temperature at the boiler outlet. This control shall be constructed to prevent a temperature setting above the maximum.

*(b)* Each individual hot water heating or hot water supply boiler shall have a control that will cut off the fuel supply when the system water temperature reaches a preset operating temperature, which shall be less than the maximum water temperature.

Proposed item for CSD-1

**(12) CW-410 Requirements for Temperature Controls for Hot-Water Heating and Supply Boilers**

*(a)* Each temperature control device shall conform to UL 353, Standard for Limit Controls, and shall be accepted by a nationally recognized testing agency.

*(b)* Each automatically fired hot-water boiler or each system of commonly connected hot-water boilers shall have at least one temperature-actuated control to shut off the fuel supply when the system water reaches a preset operating temperature. This requirement does not preclude the use of additional operating control devices where required.

*(c)* In addition to the temperature control required in CW-410(b), each individual automatically fired hot-water boiler unit shall have a high temperature limit control that will ~~prevent the water temperature from exceeding~~ cut off the fuel supply at or below the maximum allowable temperature. The upper set point limit or the maximum fixed stop limit of the selected control shall not exceed the maximum allowable temperature. Functioning of this control shall cause safety shutdown and lockout. The manual reset may be incorporated in the temperature limit control. Where a reset device is separate from the temperature limit control, a means shall be provided to indicate actuation of the temperature limit control. EXCEPTION: Lockout is not required for boiler units installed in residences, as defined by the authority having jurisdiction.

*(d)* Each limit and operating control shall have its own sensing element and operating switch, unless the boiler temperature and limit control functions are performed by a primary safety control system meeting all the requirements of CW-210(a).

*(e)* A temperature limit control of the automatic or manual reset type shall be

**2.8.5 AUTOMATIC LOW-WATER FUEL CUTOFF AND/OR WATER FEEDING DEVICE FOR STEAM OR VAPOR SYSTEM BOILERS**

a) Each automatically fired steam-or vapor-system boiler shall have an automatic low-water fuel cutoff so located as to automatically cut off the fuel supply when the surface of the water falls to the lowest visible part of the water-gage glass. If a water feeding device is installed, it shall be so constructed that the water inlet valve cannot feed water into the boiler through the float chamber and so located as to supply requisite feedwater.

b) Such a fuel cutoff or water feeding device may be attached directly to a boiler. A fuel cutoff or water feeding device may also be installed in the tapped openings available for attaching a water glass directly to a boiler, provided the connections are made to the boiler with nonferrous tees or Y's not less than NPS 1/2 (DN 15) between the boiler and water glass so that the water glass is attached directly and as close as possible to the boiler; the run of the tee or Y shall take the water glass fittings, and the side outlet or branch of the tee or Y shall take the fuel cutoff or water feeding device. The ends of all nipples shall be reamed to full-size diameter.

c) In addition to the requirements in a) and b) above, a secondary low-water fuel cutoff with manual reset shall be provided on each automatically fired steam or vapor system boiler.

d) Fuel cutoffs and water feeding devices embodying a separate chamber shall have a vertical drain pipe, extended to a safe point of discharge, and a blowoff valve not less than NPS 3/4 (DN 20), located at the lowest point in the water equalizing pipe connections so that the chamber and the equalizing pipe can be flushed and the device tested.

**Action Item Request Form**

**8.3 CODE REVISIONS OR ADDITIONS**

Request for Code revisions or additions shall provide the following:

a) Proposed Revisions or Additions

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

Existing Text:

There are 7 footnotes which occur throughout Part 1.

1 Caution, some Jurisdictions may independently administer a program of authorization for organizations to perform repairs and alterations within that Jurisdiction.
2 Fans – When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.
3 (NB-27) can be found on the National Board web-site, www.nationalboard.org,.
4 Maintenance – This includes the removal of tubes.
5 Fans – When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.
6 Side — The top side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the safety valves be located below the normal operating level and in no case shall the safety relief valve be located below the lowest permissible water level.
7 Pressure roll load, line load, and nip load are terms that are used interchangeably to refer to the interaction between the pressure roll(s) and the Yankee dryer. It is called "nip" load because the pressure roll is rubber-covered and is pressed up against the Yankee with enough force to create a nip (or pinch) that forces the paper into line contact between the rolls and provides some mechanical dewatering. The paper then sticks onto the Yankee surface and follows the Yankee dryer for thermal dewatering by the steam-heated Yankee surface. This "nip load" is called a "line load" because the units are load (force) per length of line contact. The units are pounds per linear inch (PLI) and kilonewtons per meter (kN/m).

b) Statement of Need

Provide a brief explanation of the need for the revision or addition.

The desire is to avoid footnotes where possible in order to better manage changes and revisions within the context of the Part. It was determined that some footnotes could be easily placed within the paragraph and incorporated as part of the section. Where the footnotes can be blended back into the text, maintenance of the Part can be achieved in a more efficient manner. All but one of the footnotes were able to be merged into the paragraph. The one remaining footnote was better applied as a definition, therefore moved to this section.

c) Background Information

Provide background information to support the revision or addition, including any data or changes in technology that form the basis for the request that will allow the Committee to adequately evaluate the proposed revision or addition. Sketches, tables, figures, and graphs should be submitted as appropriate.

When applicable, identify any pertinent paragraph in the Code that would be affected by the revision or addition and identify paragraphs in the Code that reference the paragraphs that are to be revised or added.

| |
|---|
| See the attached document. |

d) TG Assigned – SG Installation

| |
|---|
| Project Manager: Milton Washington<br><br>Members: Brian Moore, Paul Bourgeois, Ken Watson and Todd Creacy |

**Recommended Revisions for NB15-2303**

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## Page 12 – Section 2

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

### 2.5.4 VENTILATION AND COMBUSTION AIR

a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the boiler room. The combustion and ventilation air should be supplied by either an unobstructed air opening or by power ventilation or fans.[2] ~~Fan –~~When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.

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## Page 15 – Section 2

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

### 2.7.5 BLOWOFF

p) Boiler blowoff systems shall be constructed in accordance with the *Guide for Blowoff Vessels* (NB-27) [3] ~~*The Guide for Blowoff Vessels* (NB-27)~~ which, can be found on the National Board web-site, www.nationalboard.org.

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## Page 27 – Section 3

Original Text, Footnote 4. Maintenance – This includes the removal of tubes.

### 3.3.4 CLEARANCES

c) Heating boilers shall be located so that adequate space is provided for proper operation, maintenance[4] ~~Maintenance – This~~ and inspection of equipment and appurtenances which shall include the removal of tubes if applicable.

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**Page 30 – Section 3**

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

**3.5.4 VENTILATION AND COMBUSTION AIR**

a) The equipment room shall have an adequate air supply to permit clean, safe combustion, minimize soot formation, and maintain a minimum of 19.5% oxygen in the air of the equipment room. The combustion and ventilation air may be supplied by either an unobstructed air opening or by power ventilation or fans.~~5~~ ~~Fans –~~ When combustion air is supplied to the boiler by an independent duct, with or without the employment of power ventilators or fans, the duct shall be sized and installed in accordance with the manufacturer's recommendations. However, ventilation for the equipment room must still be considered.

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**Page 47 – Section 3**

Original Text, Footnote 6. Side — The top side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the safety valves be located below the normal operating level and in no case shall the safety relief valve be located below the lowest permissible water level.

**3.9.1.1.1 PERMISSIBLE MOUNTING**

Safety valves and safety relief valves shall be located at the top side~~6~~ of the boiler. ~~Side -~~ The top side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the safety valves be located below the normal operating level and in no case shall the safety relief valve be located below the lowest permissible water level. They shall be connected directly to a tapped or flanged opening in the boiler, to a fitting connected to the boiler by a short nipple, to a Y-base, or to a valveless header connecting steam or water outlets on the same boiler. Coil or header type boilers shall have the safety valve or safety relief valve located on the steam or hot-water outlet end. Safety valves and safety relief valves shall be installed with their spindles vertical. The opening or connection between the boiler and any safety valve or safety relief valve shall have at least the area of the valve inlet.

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**Page 66 – Supplement 1**

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

## S1.2 ASSESSMENT OF INSTALLATION

4) Pressure roll load (line or nip load)~~7~~ due to pressing the wet web onto the dryer. Overload protection is usually provided by a control valve that limits the pneumatic or hydraulic forces on the roll loading arms such that the resultant nip load does not exceed the allowable operating nip load.

**Amend this footnote to Part 1, Section 9, Installation – Glossary of Terms**

## 9.1 DEFINITIONS

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

**NB15-3001**

These two paragraphs have redundant requirements.

**2.5.3.2 REMOTE EMERGENCY SHUTDOWN SWITCHES**

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

d) Consideration should be given to the type and location of the remote emergency shutdown switch(es) in order to safeguard against tampering. Where approved by the Jurisdiction, alternate locations of remote emergency switch(es) may be provided.

**Proposed changes:**

**2.5.3.2 REMOTE EMERGENCY SHUTDOWN SWITCHES**

a) A manually operated remote shutdown ~~switch~~ switch(es) or circuit breaker shall be located just outside the equipment room door and marked for easy identification. Consideration should also be given to the type and location of the ~~switch~~ switch(es) in order to safeguard against tampering. Where approved by the Jurisdiction, alternate locations of remote emergency switch(es) may be provided.

~~d) Consideration should be given to the type and location of the remote emergency shutdown switch(es) in order to safeguard against tampering. Where approved by the Jurisdiction, alternate locations of remote emergency switch(es) may be provided.~~

Note: This will require renumbering 2.5.3.2 e) to 2.5.3.2 d) and 2.5.3.2 f) to 2.5.3.2 e).

## Proposal:

## NB15-0401 approved July 2015

### 2.5.1.3 PUMPS

a) Boiler feedwater pumps shall have discharge pressure in excess of the ~~maximum allowable working pressure (MAWP)~~ highest set pressure relief valve in order to compensate for frictional losses, entrance losses, regulating valve losses, and normal static head, etc. Each source ~~of feedwater~~ shall be capable of supplying feedwater to the boiler at a minimum pressure of 3% higher than the highest setting of any ~~safety~~ pressure relief valve on the boiler proper ~~plus the expected pressure drop across the boiler~~. Detailed engineering evaluation of the pump selection shall be performed. The following table is a guideline for estimating feedwater pump differential:

### NB15-3101 proposed January 2016

### 2.5.1.3 PUMPS

a) Boiler feedwater pumps shall have discharge pressure in excess of the highest set pressure relief valve in order to compensate for frictional losses, entrance losses, regulating valve losses, and normal static head, etc. Each source shall be capable of supplying feedwater to the boiler at a minimum pressure of 3% higher than the highest setting of any pressure relief valve on the boiler proper. Detailed engineering evaluation of the pump selection shall be performed and available. The following table is a guideline for estimating feedwater pump differential:

**NB07-0910**

## SUPPLEMENT 6
## CONTINUED SERVICE AND INSPECTION OF DOT TRANSPORT TANKS

### S6.1 SCOPE

This supplement provides rules for continued service inspections of transport tanks, i.e., cargo tanks, rail tanks, portable tanks, and ton tanks that transport dangerous goods as required in the Code of Federal Regulations, Title 49, Parts 100 through 185, and the United Nations Recommendations for Transport of Dangerous Goods-Model Regulations. This supplement, where applicable, shall be used in conjunction with other applicable Parts of the *National Board Inspection Code* (NBIC) and ASME Section XII, Rules for Construction and Continued Service of Transport Tanks.~~*Transport Tanks*, of the *ASME Boiler and Pressure Vessel Code*.~~

### S6.2 TERMINOLOGY

a) The terminology used in this supplement in some cases may be in conflict with terms and definitions normally used ~~in~~ for inspection,~~the~~ repair, and alteration of pressure-retaining items. Considering these differences, this supplement ~~in the Definition section~~includes a definition section, ~~has incorporated~~ listing definitions and terms specified in CFR 49, Parts 100 through 185.

b) When conflicts are identified between this part and the regulations of the ~~competent~~ Competent ~~authority~~ Authority regarding the examination, inspection, testing, repair, and maintenance for the continued qualification of transport tanks, the regulations of the Competent Authority take precedence.

c) Rules for repairs, alterations, and modifications of transport tanks are provided in NBIC Part 3, *Repairs and Alterations*, Supplement 6.

### S6.3 ADMINISTRATION

a) The Competent Authority's requirements describe the frequency, scope, type of inspection (internal, external, or both), type of examination (nondestructive, spark test, etc.), and the documentation requirements for the inspection.

b) For transport tanks under the Jurisdiction of the Department of Transportation, the Registered Inspector shall have a thorough knowledge of the Code of Federal Regulations, Title 49, Parts 100 through 185.

### S6.4 INSPECTION

This section ~~will~~ establishes the appropriate methods to be used for continued service inspections. ~~Inspections for repairs and modifications of~~Specific requirements for inspections of repairs, alterations, and modifications to transport tanks ~~is~~ are located in NBIC Part 3, *Repairs and Alterations*, Supplement 6.

### S6.4.1 SCOPE

This section describes the duties, qualifications, and responsibilities of the Registered Inspector, and the scope of inspection activities permitted.

### S6.4.2 GENERAL REQUIREMENTS FOR INSPECTORS

a) The Inspector shall be a Registered Inspector and qualified as a National Board ~~recognized~~ Commissioned Inspector~~, i.e.~~, Authorized Inspector (AI), Qualified Inspector (QI), or a Certified

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Individual (CI), as applicable, to perform continued service inspections~~or a Registered Inspector (RI)~~. The Registered Inspector is a position established by CFR 49 Parts 100 through 185 for Continued Service Inspections. This ~~individual's~~ Inspector's duties and responsibilities are ~~subject to DOT and not ASME QAI-1.~~ identified in this supplement and subject to DOT regulations, not ASME QAI-1.

b) For continued service inspections, the owner or user's designated and qualified Registered Inspector can be used to perform inspections and testing in accordance with the Code of Federal Regulations, Title 49, Parts 100 through 185, Transportation, as stated below.

c) Inspections for continued service of transport tanks shall be performed by the type of inspector identified below for the specific class of vessel as defined in the applicable Modal Appendices of ASME Section XII and as required by the Competent Authority. Inspectors shall be a Registered Inspector and meet the following additional requirements:

1) For Class 1 vessels, Inspectors shall be designated as an Authorized Inspector regularly employed by an ASME accredited Authorized Inspection Agency (AIA). The AIA, supervisors, and inspectors shall meet the qualifications and duties as required in the latest edition of ASME QAI-1 Qualification~~s~~ for Authorized Inspection.

2) For Class 2 vessels, Inspectors shall be designated as Qualified Inspectors regularly employed by an ASME accredited Qualified Inspection Organization (QIO). The QIO, supervisors, and inspectors shall meet the qualifications and duties as required in the latest edition of ASME QAI-1, Qualifications for Authorized Inspection.

3) For Class 3 vessels, Inspectors shall be designated a Certified Individual (CI) employed full or part time by an ASME Section VIII or Section XII Certificate Holder or contractor to the Certificate Holder manufacturing DOT Transport Tanks. The CI shall meet the qualifications and duties as required in the latest edition of ASME QAI-1, Qualification for Authorized Inspection.

4) Authorized Inspection Agencies may provide inspection services for Class 2 and Class 3 vessels. Qualified Inspection Organizations may provide inspection services for Class 3 vessels.

~~b)~~5) Users may perform continued service inspections including repairs and alterations if the user possesses a valid Owner-User Inspection Organization (OUIO) Certificate of Authorization (NB-371) issued by the National Board of Boiler and Pressure Vessel Inspectors, inspectors have a current and valid NB Commission, and are employed by the OUIO.

### S6.4.3 REGISTRATION OF INSPECTORS

Each ~~Registered~~ Inspector performing duties and responsibilities for continued service inspections or ~~inspections for repairs and modifications~~ as specified in this section and 49 CFR Part 180 is required to meet the qualification requirements of NBIC Part 2, S6.4.4~~, S6.4.6 and~~ through S6.4.7~~, as applicable to be registered with DOT.~~.

### S6.4.4 QUALIFICATIONS OF INSPECTORS

Registered Inspector (RI) means a person registered with the US Department of Transportation (DOT) in accordance with Subpart F of Part 107 of 49 CFR who has the knowledge and ability to determine whether a ~~cargo~~ Transport tank conforms to the applicable DOT specification. A Registered Inspector may or may not be an employee of the approved facility. In addition, Registered Inspector means a person who meets, at a minimum, any one of the following:

a) Has an engineering degree and one year of work experience;

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**NB07-0910**

b) Has an associate degree in engineering and two years of work experience;

c) Has a high school diploma or GED and three years of work experience; and

d) Has at least three years of experience in performing the duties of a Registered Inspector by September 1, 1991, and was registered with the DOT by December 31, 1995.

### S6.4.5 CODES OF CONSTRUCTION

a) The Registered Inspector is responsible to ensure that all repairs, alterations or modifications (including re-rating) are performed in accordance with the original code of construction of the transport tank.

b) For repairs, alterations, or modifications, the original code of construction for DOT vessels shall be either ASME Section VIII Division I or Section XII.

### S6.4.6 INSPECTOR DUTIES FOR CONTINUED SERVICE INSPECTIONS

a) Inspectors performing Continued Service Inspections required by the Code of Federal Regulations (CFR), Title 49, Part 180 shall be a Registered Inspector. The Inspector shall satisfy the following requirements:

   1) Has satisfied DOT requirements as a Registered Inspector;

   2) Has successfully completed the National Board's web-based training program for Registered Inspectors and been issued a National Board certificate of completion;

   3) Has received authorization from DOT as a Registered Inspector; and

   4) Has been registered by DOT for the classification(s) of Transport Tanks to be inspected.

b) Inspectors performing Continued Service Inspections meeting the requirements of NBIC Part 2, S6.13 (Cargo Tanks), S6.14 (Portable Tanks), or S6.15 (Ton Tanks), and 49 CFR, Part 180 shall perform all inspections and tests required by this Section and any additional requirements, as applicable in 49CFR Part 180. The Inspections and tests shall be documented as follows:

   1) All inspections and tests shall be conducted, as applicable, in accordance with NBIC Part 2, S6.13, S6.14, and S6.15;

   2) All inspections and tests shall be documented in an Inspection Report as required by NBIC Part 2, S6.5;

   3) All inspection and test reports shall be maintained by the owner, user, or shipper of the transport tank in accordance with NBIC Part 2, S6.5;

   4) All inspection and test reports shall be available for review by an authorized representative of the Department of Transportation; and

c) The requirements for inspections are provided for each classification of transport tanks as specified in NBIC Part 2, S6.4.6.1, Cargo Tanks, S6.4.6.2, Portable Tanks and S6.4.6.3, Ton Tanks.

### S6.4.6.1 INSPECTOR DUTIES FOR CONTINUED SERVICE INSPECTION OF CARGO TANKS

a) Cargo tanks constructed in accordance with a DOT Specification that are required to be tested or inspected can not be used for transportation until the required test or inspection has been successfully completed.

**NB07-0910**

1) The Registered Inspector shall inspect cargo tanks in accordance with S6.13, and in conjunction with the requirements of 49 CFR Parts 180.401 through 180.417.
2) The Registered Inspector in the performance of their duties shall ensure that the following requirements for Periodic Inspection and test frequencies in S6.13 are properly satisfied as specified by:
   a. Periodic Inspection and Test frequencies: NBIC Part 2, Table S6.13;
   b. Pressure Test Requirements for Cargo Tank by specification: NBIC Part 2, Table S6.13.6.

b) Additional criteria for material thickness requirements for a cargo tank specification are listed, as applicable for material type (ferrous and non ferrous) in various tables in NBIC Part 2, S6.13.

### S6.4.6.2 INSPECTOR DUTIES FOR CONTINUED SERVICE INSPECTION OF PORTABLE TANKS

a) Portable tanks constructed in accordance with DOT, United Nations (UN), or Inter Modal (IM) specifications that are required to be tested or inspected cannot be used for transportation until the required test or inspections have been successfully completed.
b) The Registered Inspector shall inspect portable tanks in accordance with NBIC Part 2, S6.14, in conjunction with the requirements of 49CFR, Parts 180.601 to 180.605.
c) The Registered Inspector in the performance of their duties shall ensure that the following requirements for Inspection Intervals and Pressure Test Requirements in NBIC Part 2, S6.14, are properly satisfied as specified by:
   1) Inspection Intervals: NBIC Part 2, Table S6.14;
   2) Pressure Testing Requirements: NBIC Part 2, Table S6.14.6.

### S6.4.6.3 INSPECTOR DUTIES FOR CONTINUED SERVICE INSPECTIONS OF TON TANKS

a) Ton Tanks constructed in accordance with DOT 106A or DOT 110A requirements that are required to be tested and inspected cannot be used for transportation until the required test and inspection has been made.
b) The Registered Inspector, shall inspect ton tanks in accordance with NBIC Part 2, S6.15, in conjunction with the requirements of 49CFR, Part 180.519.
c) The Registered Inspector, in the performance of his or her duties, shall ensure that the requirements for Ton Tank Periodic Inspection and Test Frequencies in NBIC Part 2, Table S6.15.3 are properly satisfied.
d) Additional criteria for material thickness, safety valve, and acceptable material with acceptable tensile strength and elongation requirements for ton tanks, are listed in the following tables of NBIC Part 2, S6.15:
   1) Thickness of Plate and Safety Valve Requirements: NBIC Part 2, Table S6.15.1-a;
   2) Acceptable materials with acceptable tensile strength and elongation requirements: NBIC Part 2, Table S6.15.1-b.

### S6.4.7 CONTINUED SERVICE, INSPECTION FOR DOT TRANSPORT TANKS SCOPE

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This supplement details frequencies of testing requirements, type of tests required, acceptance criteria, and inspection reports of transport tanks.

### S6.4.7.1 ADMINISTRATION

The Competent Authority's requirements describe the frequency, scope, type of inspection, and documentation requirements for the inspection and are noted in the US Code of Federal Regulations, Title 49 CFR, Parts 100 through 185.

### S6.4.7.2 INSPECTION AND TEST REQUIRED FREQUENCIES

Inspection and frequencies for periodic testing of cargo tanks are found in NBIC Part 2, S6.13; portable tanks S6.14; and ton tanks S6.15.

### S6.4.7.3 EXTERNAL VISUAL AND PRESSURE TESTS

External visual inspection tests shall be performed in accordance with NBIC Part 2, S6.13.1, for cargo tanks; S6.14.5 for portable tanks; and NBIC Part 2, S6.15.2, for ton tanks. The pressure tests for cargo tanks shall be as specified in S6.13.6; S6.14.6, for portable tanks; and NBIC Part 2, S6.15.3, for ton tanks.

### S6.4.7.4 LEAK TIGHTNESS TESTING OF TRANSPORT TANKS

#### S6.4.7.4.1 CARGO TANKS

a) Each cargo tank must be tested for leaks in accordance with NBIC Part 2, Table S6.13, *Periodic Inspections and Tests,* and per the requirements in NBIC Part 2, S6.13.9. The minimum leakage test pressure of 80% of MAWP may be accepted by provisions of the Competent Authority (see 49 CFR 180.407[h]).

b) All external and accessible portions of piping up to the first closure when offered for transportation shall be tested for leak tightness.

   1) All closure fittings must be in place during the leak tightness test.

   2) The leak tightness test pressure must be maintained for at least 5 minutes.

   3) All sources of leakage must be properly repaired.

   4) A cargo tank that fails to retain leakage test pressure may not be returned to service as a specification cargo tank.

#### S6.4.7.4.2 PORTABLE TANKS

Each portable tank's piping must be tested for leaks in accordance with the inspection intervals in NBIC Part 2, Table S6.14, and per the procedures in NBIC Part 2, S6.14.6.

a) The minimum leakage test pressure is as specified in NBIC Part 2, Table S6.14.6.

b) All closure fittings must be in place during the leak tightness test.

c) The test pressure must be maintained for at least 5 minutes.

d) All sources of leakage must be properly repaired.

e) A portable tank that fails to retain leakage test pressure may not be returned to service as a specification portable tank.

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### S6.4.7.4.3 TON TANKS

Each ton tank shall be tested at intervals specified in NBIC Part 2, Table S6.15.3, by procedure at pressures specified for the classification of the tank.

### S6.4.7.4.4 LEAK TIGHTNESS TESTING OF VALVES

#### S6.4.7.4.4.1 CARGO TANKS

Cargo tank valves shall be periodically visually inspected in accordance with the applicable provisions in NBIC Part 2, S6.13 and leak tested at time intervals specified in Table S6.13. This test should coincide with the leak test for piping as specified in NBIC Part 2, S6.4.7.4.1, and shall include:

a) All valves under pressure shall be leak tested at the pressure specified, for leakage through the valve, and externally (e.g., valve bonnet).

b) During the inspection a suitable method must be used for detecting the existence of leaks. This method must consist either of coating the entire surface of all joints under pressure with a solution of soap and water, or using other equally sensitive methods.

c) All emergency devices and valves including self-closing stop valves, excess flow valves and remote closure devices must be free from corrosion, distortion, erosion, and external damage that will prevent safe operation. Remote closure devices and self-closing stop valves must be functioned to demonstrate proper operation.

#### S6.4.7.4.4.2 PORTABLE TANKS

Portable tank valves shall be periodically visually inspected in accordance with the applicable provisions of NBIC Part 2, S6.14.3, and leak tested at time intervals specified in NBIC Part 2, S6.14. Leak tightness testing requirements are as specified in NBIC Part 2, Table S6.14.6, and shall include:

a) Piping, valves, and gaskets must be free from corroded areas, defects, and other conditions, including leakage, that might render the portable tank unsafe for filling, discharge, or transportation;

b) All emergency valves shall be free from corrosion, distortion, and any damage or defect that could prevent their normal operation;

c) Remote closure devices and self-closing stop valves must be operated to demonstrate proper function;

d) For testing of internal self-closing stop valves see Appendix A and B of 49CFR180; and

e) The intermediate periodic inspection and test shall include an internal and external inspection, unless exempted, and an external inspection of the portable tank and fittings, leakage test, and test for satisfactory operation of all service equipment.

#### S6.4.7.4.4.3 TON TANKS

Ton tank valves shall be periodically visually inspected in accordance with the applicable provisions of NBIC Part 2, S6.15.2 and leak tested in accordance with the provisions of NBIC Part 2, S6.15.3 and S6.15.3.1. This test should coincide with the tank retest intervals as stipulated in NBIC Part 2, Table S6.15.3.

### S6.4.7.5 LEAK TIGHTNESS TESTING OF SAFETY RELIEF DEVICES

### S6.4.7.5.1 CARGO TANKS

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a) All reclosing pressure relief devices for cargo tanks shall be visually inspected per NBIC Part 2, S6.13.2 e) and pressure tested for leak tightness as stipulated in NBIC Part 2, S6.13.6 b) at frequencies specified in NBIC Part 2, Table S6.13.

**Note**: When performing this test, all reclosing pressure relief valves, including emergency relief vents, and normal vents shall be removed for inspection and tested as follows:

b) Leakage test for any venting device required for the interval specified in NBIC Part 2, Table S6.13, must include testing the device in place, except that any venting device set to discharge at less than the leakage pressure must be removed or rendered inoperative during the test.

c) Non-reclosing relief device discs should be evaluated for replacement at the time of the pressure test intervals.

### S6.4.7.5.2 PORTABLE TANKS

Portable tanks subject to a five-year periodic inspection and leak tightness test, except for DOT Specification 56 and 57 Portable Tanks, shall include:

a) All re-closing pressure relief devices must be removed from the tank and tested separately unless they can be tested while installed on the portable tank.

b) If a leakage test is specified being less than the MAWP, the re-closing pressure relief valves can be tested in place.

c) Visual inspection shall include all emergency devices to ensure that they are free from corrosion, distortion, and any damage or defects that could prevent the devices from operating as designed.

d) For Specification 57 Portable Tanks, during the air test, the pressure relief device may be removed or left in place. If the relief device is left in place during the test, the device's discharge opening shall be plugged. (See Special Requirements for testing of pressure relief devices for Specifications 51 and 56 Portable Tanks in NBIC Part 2, S6.14.6.2.)

e) For Specification 60 Portable Tanks, re-closing pressure relief devices may be removed from the tank and tested separately unless they can be tested while installed in the portable tank.

f) If portable tanks are fitted with non-reclosing relieving devices, consideration for replacing the discs for these devices should be evaluated at the time of the leak tightness test interval.

### S6.4.7.5.3 TON TANKS

Each ton tank designed to be removed from tank cars for filling and emptying shall have their safety relief devices, if fitted, tested and subjected to a periodic inspection and test at frequencies established in NBIC Part 2, Table S6.15.3.

1) All pressure relief devices shall be retested by air or gas for the start-to-discharge and vapor tightness requirements.

2) For ton tanks fitted with rupture discs and fusible plugs, the inspection of these devices and disposition must be as described in NBIC Part 2, S6.15.3.3.

### S6.4.7.6 TESTING OF MISCELLANEOUS PRESSURE PARTS

### S6.4.7.6.1 CARGO TANKS

Cargo tanks provided with manholes (or handholes) shall be inspected in accordance with NBIC Part 2, S6.13.2 and all major structural attachments as defined in CFR180.407(d)(2)(viii), including the upper

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coupler (fifth wheel) assembly and ring stiffeners shall be inspected in accordance with NBIC Part 2, S6.13.3. Other miscellaneous items shall comply with the following:

a) Cargo tanks equipped with linings that protect the cargo tank from the commodity being transported shall be inspected, unless exempted, in accordance with the provisions of NBIC Part 2, S6.13.5.
b) For cargo tanks equipped with a heating system, the heating system shall be pressure tested as required by NBIC Part 2, S6.13.6.4.
c) Delivery hoses for MC330 and MC331 cargo tanks shall be leak tightness tested. Any conditions as noted in NBIC Part 2, S6.13.9, which exist for the delivery hose, shall be unacceptable and prevent its continued use.
d) New or replaced delivery hose assemblies shall meet all of the requirements of NBIC Part 2, S6.13.10. In addition to this requirement, for commodities transported in MC330 and MC331, the delivery hose assemblies may be installed or carried on the cargo tank. The operator is required to perform inspections as required in 49CFR180.416.

#### S6.4.7.6.2 PORTABLE TANKS

For portable tanks, the periodic visual inspection shall include:

a) The operation of tightening devices for manhole and handhole covers, or the gaskets are operative and there is no leakage at the manhole or handhole cover or gasket at leakage pressure.
b) The framework structural supports and the lifting device located on the portable tank shall be in satisfactory condition.

#### S6.4.7.6.3 TON TANKS

Visual inspection of ton tanks shall include damaged chimes or protective rings, if so fitted.

### S6.4.7.7 ACCEPTANCE CRITERIA

All defects or deficiencies discovered during the inspection process of a transport tank shall be documented in the Inspection Report and discussed with the owner or user of the transport tank at the time of the inspection. Defects or deficiencies shall be corrected using appropriate methods, and tested prior to returning the transport tank to service. (See NBIC Part 2, S6.10)

### S6.4.7.8 INSPECTION REPORT

#### S6.4.7.8.1 CARGO TANKS

Cargo tank Inspection Reports, as a minimum, shall include the information specified in NBIC Part 2, S6.13.6.7 and S6.13.8 (as applicable) and 49 CFR 180.417.

#### S6.4.7.8.2 PORTABLE TANKS

Portable tank Inspection Reports shall satisfy the requirements of NBIC Part 2, S6.14.9, in addition to those of 49 CFR Part 180.605.

#### S6.4.7.8.3 TON TANKS

Ton tank Inspection Reports shall satisfy the requirements of NBIC Part 2, S6.15.3.6 in addition to those of 49 CFR Part 180.519.

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## S6.5 STAMPING AND RECORD REQUIREMENTS FOR DOT TRANSPORT TANKS IN CONTINUED SERVICE

This section provides for preparation, distribution and maintenance of inspection records and stamping requirements for Continued Service Inspections of Transport Tanks, i.e., cargo tanks, portable tanks, and ton tanks.

### S6.5.1 GENERAL

To ensure that transport tanks can maintain their authorization to transport hazardous materials by the mode of transport permitted by the competent authority (DOT), the specification transport tank's owner or user shall satisfy, as applicable, that the records and stamping requirements of this supplement and Code of Federal Regulations, Title 49, Part 180 (49 CFR 180) have been satisfied.

### S6.5.2 STAMPING

a) Transport tanks represented as manufactured to a DOT specification or a United Nations (UN) standard shall be marked on a non-removable component of the transport tank with specification markings conforming to the applicable specification. The specification marking is required to be located in an unobstructed area with letters and numerals identifying the standard or specification. Unless otherwise specified by Part 178.3 of the Code of Federal Regulations, the markings must identify the name and address or symbol of the transport tank manufacturer or, where specifically authorized, the symbol of the approval agency certifying compliance with a UN standard.

b) Symbols required by the Department of Transportation (DOT) must be with the approval of the DOT Associate Administrator. Duplicative symbols are not authorized. Stamping and symbol requirements for transport tanks that are under different rules than CFR 49, Parts 100 through 185, shall comply with the applicable competent authority's rules and regulations.

c) The detailed markings, i.e., stamped, embossed, burned, printed, etc., size of the markings, capacities, etc., are specified in Part 178.3 of the Code of Federal Regulations, Title 49, as follows:

   1) ASME-Stamped Transport Tanks

      a. Transport tanks stamped with the ASME Section XII Code Symbol shall satisfy the applicable requirements of that code. Transport tanks manufactured prior to the adoption of ASME Section XII by the Competent Authority were manufactured in accordance with ASME Section VIII, Div. 1. Stamping with the ASME Section VIII, Div. 1 "U" Code Symbol Stamp is dependent on pressure and/or media limitations.

      b. When the stamping on a transport tank becomes indistinct or the nameplate is lost or illegible, but traceability to the original transport tank is still possible. To satisfy this requirement, as a minimum, original source data from the manufacturer of the vessel or records in possession of the tank Owner should be used to establish traceablity to the stamping with the concurrence of the Inspector, and approval of the Competent Authority, and if required the Jurisdiction. The Inspector shall instruct the Owner or user to have the stamped data replaced. All restamping shall be done in accordance with the original code of construction (ASME Section XII, or ASME Section VIII, Div. 1, as applicable). Request for permission to restamp or replace the nameplate shall be made to the Competent Authority and, if required, the Jurisdiction. Application must be made on the *Replacement of Stamped Data Form*, NB-136 (See NBIC Part 2, 5.5.2). Proof of the stamping and other such data, as

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is available, shall be furnished with the request. When traceability cannot be established, the Competent Authority shall be contacted.

2) Restamping or replacement of nameplates

Restamping or replacement of the nameplate as authorized by the Competent Authority shall only be done in the presence of the Inspector, i.e., AI, QI, CI, or National Board Commissioned Inspector, as required by ASME Section XII and the applicable Modal Appendix, or as required by the Competent Authority. For transport tanks manufactured to ASME Section VIII, Division 1, restamping or replacement shall only by done in the presence of an Authorized Inspector or a National Board Commissioned Inspector.

### S6.5.3 OWNER OR USER REQUIRED RECORDS FOR CARGO TANKS

a) Each owner or user of a DOT Specification cargo tank shall retain the appropriate ASME Manufacturer's Data Report, Form T-1, for Section XII Transport Tanks, or Form U-1A for Section VIII, Division 1 Pressure Vessels, and related papers certifying that the DOT Specification cargo tank identified in the documents was manufactured and tested in accordance with the applicable tank specification.

1) In addition to the appropriate ASME Manufacturer's Data Report, the required documents shall include any certification of emergency discharge control systems required by 49 CFR 173.315(n) or 49 CFR 180.405(m).

a. The Certificate of Compliance issued by the cargo tank motor vehicle manufacturer (CTMVM) and all preceding certificates issued by preceding manufacturers signed and dated by a Registered Inspector or Company Official or Design Certifying Engineer as required by 49 CFR 178.337-18(a)(1) or (a)(2) as appropriate. The certificate must contain a statement indicating whether or not the cargo tank was postweld heat treated for anhydrous ammonia service as specified in 49 CFR 178.337-1(f);

b. Cargo tank fabrication drawings;

c. Piping drawing that identifies the location, make, model, and size of each valve and the arrangement of all piping associated with the cargo tank motor vehicle;

d. Assembly drawing;

e. Pressure test report for the piping, valves and fittings;

f. Hose certification; and

g. Certification of emergency discharge control systems.

2) The documents required by 49 CFR shall be retained throughout ownership of the cargo tank and for one year after relinquishing ownership.

3) In the event of a change in ownership, the prior owner shall retain non-fading photocopies of these documents for one year.

4) Users of a cargo tank that are not the owner shall retain a copy of the vehicle certification report as long as the cargo tank motor vehicle is used by the user and for one year thereafter.

5) The required documents specified in this Section shall be maintained at the owner's or users' principal place of business, or at a location where the cargo tank is housed or maintained.

6) Items 4) and 5) do not apply if the user leases the cargo tank for less than 30 days.

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b) For DOT Specification cargo tanks that were manufactured prior to September 1, 1995, that were not constructed to ASME Section VIII, Division 1 (Non Code Pressure Vessels), but wishes to certify the cargo tank to a DOT Specification Cargo Tank, the following shall be complied with:

1) The owner shall perform the appropriate tests and inspections as required by 49 CFR Part 178 under the direct supervision of a Registered Inspector to determine if the cargo tank conforms to the applicable specification.

2) Both the owner and the Registered Inspector shall certify that the cargo tank fully conforms to the applicable specification.

3) The owner shall maintain the certification as specified in this section.

c) For ASME stamped cargo tanks, the owner must have the manufacturer's certification and the appropriate ASME Manufacturer's Data Report on file.

1) If the owner does not have the manufacturer's certification and the appropriate ASME Manufacturer's Data Report, the following shall be satisfied:

a. If the pressure vessel of the cargo tank is registered with the National Board of Boiler and Pressure Vessel Inspectors (National Board), they shall obtain a copy of the Manufacturer's Data Report from the National Board.

b. If the pressure vessel of the cargo tank is not registered with the National Board, shall copy the cargo tank's identification and ASME Code nameplate information and retain this information in their files.

2) If the nameplate information is copied as identified in c) 1) b., the owner and the Registered Inspector shall certify that the pressure vessel of the cargo tank fully conforms to the DOT specification.

3) The owner shall retain all certification documents in accordance with retention periods specified in this supplement.

### S6.5.3.1 REPORTING REQUIREMENTS BY THE OWNER OR USER OF TESTS AND INSPECTIONS OF DOT SPECIFICATION CARGO TANKS

The owner or user that performs the required test and the Registered Inspector that performs the inspection as specified at frequencies established in NBIC Part 2, Table S6.13, shall prepare a written report in English that satisfies the requirements of NBIC Part 2, S6.13. Each test and inspection facility that fails a cargo tank based on a test or inspection report shall notify the Owner, register the report with the National Board, and provide a copy of the test report indicating the failure to the competent authority.

### S6.5.3.2 DOT MARKING REQUIREMENTS FOR TESTS AND INSPECTIONS OF DOT SPECIFICATION CARGO TANKS

Each cargo tank that has successfully completed the test and inspection contained in NBIC Part 2, S6.13, shall be durably and legibly marked, in English. The markings shall comply with the following:

a) Date (month and year) of the type of test or inspection performed, subject to the following:

1) Date shall be readily identifiable with the applicable test or inspection;

2) Markings shall be 32 mm (1.25 in.) high, near the specification plate or anywhere on the front head of the cargo tank.

b) The type of test or inspection may be abbreviated as follows:

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1) "V" for external visual inspection;
2) "I" for internal visual inspection;
3) "P" for pressure test;
4) "L" for lining inspection;
5) "T" for thickness inspection;
6) "K" for leakage test for a cargo tank tested to the requirements of NBIC Part 2, S6.13.9, except for cargo tanks subject to the requirements of NBIC Part 2, S6.13.9 d) 10); or
7) "K-EPA27" for a cargo tank tested to the requirements of NBIC Part 2, S6.13.9 d) 10), that was manufactured after October 1, 2004.

c) For a cargo tank motor vehicle composed of multiple cargo tanks constructed to the same specification, which are tested and inspected at the same time, one set of test and inspection markings may be used to satisfy the requirements of NBIC Part 2, S6.5.3.2.

d) For a cargo tank motor vehicle composed of multiple cargo tanks constructed to different specifications, which are tested and inspected at different intervals, the test and inspection markings shall appear in the order of the cargo tank's corresponding location, from front to rear.

### S6.5.4 OWNER OR USER REQUIRED RECORDS FOR PORTABLE TANKS

a) The owner of each portable tank or their authorized agent shall retain a written record of the date and results of all required inspections and tests, including the ASME Manufacturer's Data Report.

b) The written record, if applicable, shall indicate the name and address of the person that performed the inspection or test. The inspection and test shall comply with the requirements of the portable tank's specification, as provided in 49 CFR, Part 178.

c) The owner shall maintain a copy of the ASME Manufacturer's Data Report. He shall also maintain a certificate(s) that is signed by the manufacturer of the portable tank, and by the authorized design approval agency, as applicable indicating compliance with the applicable portable tank specification.

d) The signed certificate, including the ASME Manufacturer's Data Report, shall be maintained by the owner or their authorized agent during the time that the portable tank is used for service. DOT Specifications 56 and 57 portable tanks are exempt from this requirement.

### S6.5.4.1 REPORTING OF PERIODIC AND INTERMEDIATE PERIODIC INSPECTION AND TESTS OF DOT SPECIFICATION PORTABLE TANKS

a) The user of portable tanks shall satisfy the requirements for Periodic and Intermediate Periodic Inspection and Tests of portable tanks as specified in Table S6.14 of this supplement and shall maintain the results of these tests as required in NBIC Part 2, S6.5.4.

b) The methods and procedures to be used in the performance of the required Intermediate Periodic and Inspections and Tests are specified in NBIC Part 2, S6.14.

### S6.5.4.2 MARKING REQUIREMENTS FOR PERIODIC AND INTERMEDIATE INSPECTION AND TESTS FOR IM OR UN PORTABLE TANKS

Each IM or UN portable tank that has successfully completed the required Periodic or Intermediate Inspection and Test shall be durably and legibly marked, in English. The markings shall comply with the following:

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a) Date (month and year) of the last pressure test;

b) Identification markings of the approval agency witnessing the test;

c) When required, the date (month and year) of the last visual inspection;

d) Markings shall be placed on or near the metal identification plate; and

e) Markings shall be 3 mm (0.118 in.) high when on the metal identification plate and 12 mm (0.47 in.) high when on the portable tank.

### S6.5.4.3 DOT MARKING REQUIREMENTS FOR PERIODIC AND INTERMEDIATE INSPECTION AND TESTS OF DOT SPECIFICATION 51, 56, 57, OR 60 PORTABLE TANKS

Each DOT Specification 51, 56, 57, or 60 portable tank that has successfully completed the required Periodic or Intermediate Inspection and Test shall be durably and legibly marked, in English. The markings shall comply with the following:

a) Date (month and year) of the most recent test;

b) Markings shall be placed on or near the metal certification plate;

c) Markings shall be accordance with 49 CFR, Part 178.3; and

d) Letters and numerals shall not be less than 3 mm (0.118 in.) high, when on a metal certification plate and 12 mm (0.47 in.) on the portable tank, except that a portable tank manufactured under a previously authorized specification may continue to be marked with smaller markings if originally authorized under that specification (for example, DOT specification 57 portable tanks).

### S6.5.5 OWNER OR USER REQUIRED REPORTS FOR DOT SPECIFICATION 106A AND DOT 110A TON TANKS

a) The owner or user of a DOT Specification ton tank shall retain the certificate of construction (AAR-Form 4-2) and related papers certifying that the manufacturer of the specification tank identified in the documents is in accordance with the applicable specification.

b) The owner or user shall retain the documents throughout the period of ownership of the specification ton tank and for one year thereafter.

c) Upon a change in ownership of the specification ton tank, the owner shall satisfy the requirements of Section 1.3.15 of the ARR Specification.

### S6.5.5.1 REPORTING OF INSPECTION AND TESTS FOR DOT SPECIFICATION 106A AND DOT 110A TON TANKS

a) The owner or user shall inspect and test ton tanks at frequencies specified in NBIC Part 2, Table S6.15.3 and shall perform the inspections and tests in accordance with NBIC Part 2, S6.15.3.

b) The owner or user is required to develop a written record of the results of the pressure test and visual inspection and shall record the information on a suitable data sheet. Completed copies of these reports shall be retained by the owner and by the person performing the pressure test and visual inspection, as long as the ton tank is in service.

c) The required information to be recorded and checked on these data sheets is:

   1) Date of test and inspection;

   2) DOT Specification Number;

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3) Ton tank identification (registered symbol and serial number);
4) Date of manufacturer and ownership symbol;
5) Type of protective coating (painted, etc.), and statement as to need for refinishing or recoating;
6) Conditions checked, i.e., leakage, corrosion, gouges, dents or digs, broken or damaged chime or protective ring, fire, fire damage, internal condition;
7) Test pressure;
8) Results of tests;
9) Disposition of ton tank (returned to service, returned to manufacturer for repair, or scraped); and
10) Identification of person conducting the retest or inspection.

d) If a Retest Inspection is required, the owner or user shall prepare a written report in accordance with NBIC Part 2, S6.15.3.6, of this supplement.

### S6.5.5.2 DOT MARKING REQUIREMENTS FOR TESTS AND INSPECTION OF DOT SPECIFICATION 106A AND 110A TON TANKS

a) When a ton tank passes the required inspection and test with acceptable results, the tank car facility shall mark the following information on the ton tank:
   1) Date of the inspection and test;
   2) Due date of the next inspection and test;
   3) The markings on the ton tank shall be in accordance with Appendix C of the ARR Specifications for Tank Cars.

b) When a tank car facility performs multiple inspections and tests at the same time, one date may be used to satisfy the requirements of NBIC Part 2, S6.5.5.2. Additionally, one date may be shown when multiple inspections and tests have the same due date.

## S6.6 CORROSION AND FAILURE MECHANISMS IN TRANSPORT TANKS

An effective inspection and test program requires an understanding of the applicable potential failure mechanisms and the applicable inspection and test methods to ensure the continued structural integrity of a transport tank.

### S6.6.1 SCOPE

This section provides an overview of the causes of deterioration and failure mechanisms in transport tanks. As provided in this overview, some forms of deterioration and failure mechanisms may include stress corrosion cracking, fatigue, and temperature gradients (brittle fracture behavior) applicable to transport tanks during their normal operation.

### S6.6.2 GENERAL

a) This supplement includes a general discussion of mechanisms and effective inspection and test methods. Additionally, some specific guidance is given on how to evaluate the transport tanks for repairs, modifications, and continued service requirements.

b) There are a variety of inservice conditions that may cause deterioration of the materials used in the construction of transport tanks. These inservice conditions should be taken into consideration during

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any repair activity. Prior to any repair activity, it is important to identify the cause of the deterioration, and to prevent its recurrence.

### S6.6.3 INTERNAL AND/OR EXTERNAL CORROSION

Internal and/or external wastage from corrosion is probably one of the most common causes of deterioration in transport tanks while in operation. All metals and alloys are susceptible to corrosion. Corrosion is deterioration that occurs when a metal reacts with its environment. Corrosion can be classified based on three factors. These factors are:

Nature

Wet — liquid or moisture present in the transport tank;

Dry — high temperatures that may be present in the transport tank;

Mechanism — electrochemical or direct chemical reactions; and

Appearance — either uniform or localized.

### S6.6.3.1 TYPES OF CORROSION

To implement the proper corrective actions will depend on which factors caused the problems, making it important to diagnose the reason for failure. Early detection of corrosion problems are important to prevent failures and can be achieved by performing regular inspections and encouraging employees to be observant and communicate their observations. The following types of corrosion mechanisms are commonly found in transport tanks:

a) Pitting Corrosion

1) Pitting corrosion is the formation of holes in an otherwise relatively un-attacked surface. Some of the characteristics of pitting corrosion are:

2) Usually a slow process causing isolated, scattered pitting over a small area that does not substantially weaken the transport tank. It could, however, eventually cause leakage;

3) In some cases, local corrosion pits can be caused by microbiological activity, commonly known as MIC (microbiologically influenced corrosion) attack; or

4) Generally, the area of the steel surrounding a corrosion pit from MIC will exhibit discoloration or a ring as evidence of a thriving bacteria colony.

b) Line Corrosion

1) This is a condition where pits are connected; or nearly connected to each other in a narrow band or line. Line corrosion frequently occurs in the interior surfaces of a transport tank at the following locations:

2) The liquid-vapor interface in the transport tank, or

3) The bottom of the transport tank.

c) General Corrosion

1) This is corrosion that covers a considerable area of the vessel surface of the transport tank. When this condition occurs, the owner or user of the transport tanks has to consider if this condition has compromised the continued safe operation of the transport tank. The following should be used in making this determination:

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2) Inspect the affected area or areas to ensure that the required minimum thickness of the vessel is within acceptable limits; and

3) If the affected area's or areas' minimum thickness is below tolerance, depending on the degree of deterioration, restore the area or areas to the required thickness by using the weld buildup method or a flush patch.

d) Grooving Corrosion

1) This type of corrosion is a form of metal deterioration caused by localized corrosion, and may be accelerated by stress concentration. Grooving is generally noticed:

2) Adjacent to welded surfaces, and

3) On flange-mating surfaces.

e) Exfoliation and Selective Leaching

1) Exfoliation is a subsurface corrosion that begins on a clean surface, but spreads below the surface of the metal. This type of corrosion differs from pitting in that the damage to the metal exhibits a laminated appearance, recognized by a flaky and sometimes blistered surface.

2) Selective leaching results in the removal of one of the elements in an alloy material. This corrosion mechanism is detrimental because it yields a porous metal with poor mechanical properties.

f) Galvanic Corrosion

1) Occurs when two dissimilar metals come in contact with each other in the presence of an electrolyte (e.g., film of water containing dissolved oxygen, nitrogen, and carbon dioxide) constituting an electrolytic cell. The difference in galvanic potential between the two dissimilar materials creates a local electrical cell that may cause rapid corrosion of the less- noble metal. This corrosion mechanism becomes more active when there are large differences between the electrode potentials of the two metals.

2) Galvanic corrosion may also exist with relatively minor changes of alloy composition (e.g., between a weld metal and the base metal). Natural (e.g., an oxide coating on aluminum) or a protective coating may inhibit galvanic corrosion, but in most instances the metals or alloys must be selected on the basis of intrinsic resistance to corrosion.

3) In transport tanks, the effects of galvanic corrosion are most noticeable at welds or at flanged and bolted connections that have been exposed to contact with a fluid that is conductive.

g) Erosion/Corrosion

1) This type of damage mechanism is generally attributed to the movement of a corrodent over a metal surface that increases the rate of attack due to mechanical wear and corrosion. This type of damage mechanism is generally characterized as having an appearance of smooth bottomed shallow pit, and may also exhibit a directional pattern or surface texture related to the path taken by the corrodent. This deterioration would normally occur at locations where the transport tank is filled or emptied.

h) Crevice Corrosion

1) Environmental conditions in a crevice can, with time, become different from those on a nearby clean surface. A more aggressive environment may develop within the crevice and cause local corrosion. Crevice corrosion commonly can be found in:

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   a. Gasket surfaces;
   b. Lap joints; and
   c. Bolts and flanges.

2) Crevice corrosion can also be caused by dirt deposits, corrosion products, scratches in paint, etc.

3) To avoid or greatly reduce corrosion, the owner or user of transport tanks, when having a transport tank manufactured, can specify materials and protection methods (such as coating). By implementing proper selection of materials and protection methods, corrosive attack in transport tanks can be predicted and controlled. However, there may be unexpected failures as a result of one or more of the following:
   a. Poor choice of materials used in transport tank repairs or new construction;
   b. Operating conditions different from those anticipated in service;
   c. Defective fabrication;
   d. Improper design;
   e. Inadequate maintenance; and
   f. Defective material.

### S6.6.4 FAILURE MECHANISMS

There are various failure mechanisms that can result in cracks or loss of structural integrity to transport tanks. The more common failure mechanisms described below are fatigue, mechanical, thermal, and corrosion induced brittle fracture and hydrogen embrittlement, as a result of poor handling practices during welded repairs.

a) Fatigue — Stress reversals (such as cyclic loading) in parts of transport tank equipment are common, particularly at points of high secondary stress. These stresses can originate adjacent to locations of weld repairs and from over-the-road vibratory stresses. If stresses are high and reversals frequent, failure of parts may occur because of mechanical fatigue crack propagation. Fatigue failures in transport tanks may also result from exposure to cyclic temperature and pressure changes. Locations where metals having different thermal coefficients of expansion that are joined by welding may be susceptible to thermal fatigue upon exposure to service temperature variations.

   1) In specific cases where the combined effects of exposure to a corrosive environment and cyclic loading occur together in a transport tank, the damage mechanism that can occur is corrosion assisted fatigue or simply corrosion fatigue.

   2) Corrosion fatigue crack propagation typically occurs along a straight direction, with minimal branching. Some sources of fatigue crack initiation are:
      a. At sharp corners;
      b. At openings in the transport tank; and
      c. At structural attachments.

b) Temperature — At subfreezing temperatures, water and some chemicals handled in transport tanks may freeze and cause failure. Carbon and low-alloy steels may be susceptible to brittle fracture, even at ambient temperatures. A number of failures have been attributed to brittle fracture of steels that

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were exposed to temperatures below their ductile-to-brittle transition temperature (DBTT) during a pressure test or hydrostatic test. However, most brittle fractures have occurred on the first application of a particular stress level (that is, the first hydrostatic test or overload).

Special attention should be given to low-alloy steels because they are prone to temper embrittlement, which can result in a loss of toughness.

Temper embrittlement is defined as a loss of ductility and notch toughness due to postweld heat treatment or high temperature service, above 370°C (700°F).

c) Hydrogen Embrittlement — A loss of strength and/or ductility in steels caused by atomic hydrogen dissolved in the steel. It is a low-temperature phenomenon, seldom encountered above 95°C (200°F), and most often occurs as a result of hydrogen evolved from aqueous corrosion reactions or hydrogen generated during welding. Weld underbead cracking (also know as delayed cracking and cold cracking) is also a form of hydrogen embrittlement; however, in this case, the hydrogen comes from the welding operation rather than from a corrosion reaction.

   1) Weld underbead cracking is caused by hydrogen dissolved in a hard, high-strength weld heat-affected zone. Use of low-hydrogen welding practices to minimize dissolved hydrogen, and/or use of high-preheat, and/or postweld heat treatment to reduce heat-affected zone hardness, will reduce the likelihood of weld underbead cracking in susceptible steel.

   2) Hydrogen embrittlement is reversible as long as no physical damage, e.g., cracking, has occurred in the steel. If the atomic hydrogen is removed from the steel before any damage occurs, for example by heating for a short time in the absence of hydrogen between 150°C (300°F) and 205°C (400°F), normal mechanical properties will be restored.

   3) Welding procedures, repair methods, and inspection procedures must include careful consideration of potential failure in corrosive environments, including the various forms of hydrogen embrittlement.

d) Stress Corrosion Cracking (SCC) — Cracking of a metal caused by the combined action of stress and a corrosive environment. SCC only occurs with specific combinations of metal and environment. The stress required may be either applied or residual. Examples of stress corrosion cracking include chloride stress corrosion cracking of stainless steels in hot, aqueous chloride solutions; caustic cracking of carbon steel in hot sodium hydroxide solutions, and ammonia stress corrosion cracking of brass in ammonia solutions (season cracking).

   1) Corrosivity alone is not a good indicator of the likelihood of a particular environment to cause SCC in a particular metal. Solutions that are highly corrosive to a material almost never promote SCC.

   2) The principal variables affecting SCC are tensile stress, service temperature, solution chemistry, duration of exposure, and metal properties. Removing any one of these parameters sufficiently can reduce or eliminate the possibility of SCC occurring in service.

### S6.7 CLASSIFICATION BOUNDARIES

Transport tanks are classified as Class 1, Class 2, and Class 3. The classification is established by the applicable Modal Appendix of ASME Section XII. Also contained in the Modal Appendix is the type of Inspector, i.e., Authorized Inspector, Qualified Inspector, and Certified Individual, that is permitted to perform the applicable fabrication inspection of the transport tank, i.e., cargo tank, tank car, portable tank,

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and ton tank. The classification of the transport tank, except for continued service inspections, determines the code of construction requirements for repairs or modifications.

### S6.8 PRESSURE, TEMPERATURE, AND CAPACITY REQUIREMENTS FOR TRANSPORT TANKS

a) ASME Section XII has established pressure, temperature, and maximum thickness requirements for transport tanks as follows:

   1) Pressure: full vacuum to 208 bar (full vacuum to 3,000 psia);

   2) Temperature: -269°C to 343°C (-452°F to 650°F); and

   3) Maximum material thickness: 38 mm (1-1/2 in.).

b) Transport tanks manufactured prior to the adoption of ASME Section XII by the Competent Authority were manufactured in accordance with ASME Section VIII, Div. 1. Transport tanks manufactured to this Code were required to be stamped with the “U” Code Symbol Stamp in accordance with Section VIII, Div. 1, if the design pressure of the transport tank was 241 kPa (35 psi) (depending on material being transported) and greater. If the design pressure was less than 241 kPa (35 psi) (depending on the media being transported), the transport tank was constructed in accordance with Section VIII, Div. 1, but not stamped with the “U” Code Symbol Stamp.

c) For these transport tanks, the requirements established in NBIC Part 2, for continued service inspection, repairs, or modifications shall apply, unless specifically exempted by the DOT.

### S6.9 REFERENCES TO OTHER CODES AND STANDARDS

Other existing inspection codes, standards, and practices pertaining to the continued service inspection, i.e., CFR 49, Parts 100 through 185, ASME Section XII, etc., of transport tanks can provide useful information and references relative to the inspection techniques listed in this Appendix. Additionally, supplementary guidelines for assisting in the evaluation of inspection results and findings are also available. Some acceptable requirements and guidelines are as follows:

a) American Society of Mechanical Engineers — *ASME Boiler and Pressure Vessel Code*, Section VIII, Div. 1 (*Rules for Construction of Pressure Vessels*).

b) American Society of Mechanical Engineers:

   1) ASME Section V (*Nondestructive Examination*)

   2) ASME Section IX (*Welding and Brazing Qualifications*).

c) Code of Federal Regulations, Title 49, Parts 100 through 185, *Transportation*.

d) American Petroleum Institute — API 579, *Fitness for Service*.

e) ADR 2003, *European Agreement Concerning the International Carriage of Dangerous Goods by Road*. (Published by the UN Economic Commission for Europe, Information Service, Palais des Nations, C7-1211 Geneve, Suisse.)

f) CGA 6-4.1, *Cleaning Equipment for Oxygen Service*.

g) CGA S-1.2, *Pressure Relief Device Standard*, Part 2: *Cargo and Portable Tanks for Compressed Gases*. (Published by the Compressed Gas Association, Inc. [CGA], 4221 Walney Road, Chantilly, VA 20151.)

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h) IMDG Code 2002, *International Maritime Dangerous Goods Code* (including Amendment 31-02. (Published by the International Maritime Organization [IMO], 4 Albert Embankment, London, SE1 7SR England.)

i) RID 2003, *Carriage of Dangerous Goods*. (Published by the Intergovernmental Organization for International Carriage by Rail [OTIF], Gyphenhubeliweg 30, C7-3006 Bern, Switzerland.)

j) *United Nations Recommendations on the Transport of Dangerous Goods – Modal Regulations.* (Published by the United Nations Publications, 2 UN Plaza, New York, New York 10017.)

k) SSPC Publication #91-12, *Coating and Lining Inspection Manual*. (Published by Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, PA 15212-2683.)

### S6.10 CONCLUSION

a) During any continued service inspections or tests of transport tanks, performed by the Registered Inspector, the actual operating and maintenance requirements as specified in this Supplement shall be satisfied. The Registered Inspector shall determine, based on the applicable requirements of the *Code of Federal Regulations*, Title 49, Parts 100 through 185, and NBIC Part 2, Supplement 6, whether the transport tank can continue to be safely operated.

b) Defects or deficiencies in the condition, operation, and maintenance requirements of the transport tank, including piping, valves, fittings, etc., shall be discussed with the owner or user of the transport tank at the time of inspection. Defects or deficiencies shall be corrected using the appropriate methods prior to returning the transport tank to service.

### S6.11 PERSONNEL SAFETY AND INSPECTION ACTIVITIES

a) Proper inspection of transport tanks may require pre-inspection planning. This planning should include development of an inspection plan that will satisfy the applicable technical requirements of this Part, the *Code of Federal Regulations*, Title 49, Parts 100 through 185, Transportation, and appropriate safety considerations. The inspection plan should also include the applicable failure and deterioration mechanisms, and inspection methods and the requirements of the applicable Competent Authority.

b) This supplement describes pre-inspection and post-inspection activities applicable to all transport tanks. Specific inspection requirements for transport tanks are identified in NBIC Part 2, S6.13 for Cargo Tanks, S6.14 for Portable Tanks, NBIC Part 2, S6.15 for Ton Tanks.

c) Personnel safety is the joint responsibility of the owner or user and the Registered Inspector. All applicable safety regulations shall be followed. This includes, if applicable, all governmental rules and regulations. owner's or user's personnel safety programs and/or safety programs by the Inspector's employer or similar regulations such as confined space requirements also apply.

### A) S6.12 TRANSPORT TANK ENTRY REQUIREMENTS

b) No transport tank shall be entered until it has been properly prepared for inspection. The owner or user and the Inspector shall determine that the transport tank may be entered safely. This shall include:

1) Potential hazards associated with the entry into the transport tank have been identified by the owner or user and are brought to the attention of the Inspector, along with acceptable means or methods for mitigating each of these hazards;

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2) Coordination of entry into the transport tank by the Inspector and the owner or user representative(s) working in or near the transport tanks;

3) If personal protective equipment is required to enter the transport tank, the necessary equipment is available, and the Inspector is properly trained in its use; and

4) An effective energy isolation program is in place and in effect that will prevent the unexpected release of energy or media to enter the transport tanks.

c) The Inspector shall be satisfied that a safe atmosphere exists before entering the transport tank. The oxygen content of breathable atmosphere shall be between 19.5% and 23.5%.

d) The Inspector shall not be permitted to enter an area if toxic, flammable, or inert gases or vapors are present and above acceptable limits without proper personal protective equipment. Protective equipment may include, among other items, protective outer clothing, gloves, eye protection, foot protection, and/or respirators.

e) The Inspector shall have proper training governing the selection and use of any personal protective clothing and equipment necessary, particularly related to respiratory protection if the testing of the atmosphere of the transport tank reveals any hazards. This requirement is to ensure that the inspection may be performed safely.

### S6.12.1 PRE-INSPECTION ACTIVITIES

a) Prior to conducting the inspection, a review of the history of the transport tank and a general assessment of current conditions shall be performed. This shall include a review of information, such as:

1) Date of the last inspection;

2) Current Inspection Certificate;

3) ASME Code Name Plate and/or Specification;

4) If applicable, National Board registration number;

5) Serial number of identification marking of the transport tank;

6) Operating conditions and normal contents of the transport tank;

7) Previous inspection report or inspection certificates;

8) Records of wall thickness checks, especially where corrosion is a consideration; and

9) Observations of the condition of the complete transport tank, including, piping, fitting, valves, etc.

b) The following activities should be performed as required to support the inspection:

1) Verify the pressure gages, thermometers, and indicating devices are in proper calibration;

2) Ensure that all overpressure protection devices are in proper operation, and that they are operating as designed; and

3) Ensure that all structural attachments are free of defects and are operating as designed.

### S6.12.2 PREPARATION FOR INTERNAL INSPECTION

The owner or user has the responsibility to prepare a transport tank for internal inspection. Requirements for safety including occupational safety and health regulations (federal, state, local, or other), the owner’s or user’s own safety program, and the safety programs of the Inspector’s employer are applicable for

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inspections. The transport tank shall be prepared in the following manner or as deemed necessary by the Inspector.

a) When a transport tank is connected to a common header with other transport tanks or in a system where liquids or gases are present, the transport tank shall be isolated by closing, locking, and/or tagging stop valves in accordance with the owner's or user's procedures.

b) When toxic or flammable materials are involved, additional safety precautions should require removing pipe sections or blanking pipelines before entering the transport tank. The means of isolating the transport tank shall be acceptable to the Inspector and in compliance with applicable occupational safety and health regulations.

c) The transport tank shall be allowed to cool or warm to ambient temperature at a rate to avoid damage to the transport tank.

d) The transport tank shall be drained of all liquid and shall be purged of any toxic or flammable gases or other contaminants that were contained in the transport tank. Mechanical ventilation using a fresh air blower or fan shall be started after the purging operation and maintained until all pockets of "dead air" that may contain toxic or flammable or inert gases are reduced to acceptable limits. During the air purging and ventilation of the transport tank involved with flammable gases, the concentration of the vapor in air should pass through the flammable range before a safe atmosphere is obtained. All necessary precautions shall be taken to eliminate the possibility of explosion or fire.

e) Manhole, if applicable, and handhole plates, washout plugs, inspection plugs, and any other item requested by the Inspector shall be removed.

f) The Inspector shall not enter a transport tank until all safety precautions have been taken. The temperature of the transport tank shall be such that the inspection personnel will not be exposed to excessive heat or cold. The transport tank should be cleaned as necessary.

g) A qualified person (attendant) shall remain outside the transport tank at the point of entry while the Inspector is inside and shall monitor activities inside and outside and communicate with the Inspector as necessary. The attendant shall have means of summoning rescue assistance, if needed, and to facilitate rescue procedures for those inside the transport tank without personally entering the transport tank.

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

### S6.12.3 POST-INSPECTION ACTIVITIES

a) Any defects or deficiencies in the condition, operation, and maintenance practices of the transport tank and auxiliary equipment shall be reported to the owner or user, including recommendations for correction.

b) Documentation of inspections shall contain pertinent data such as a description of the transport tank, classification (Class 1, 2, or 3), the transport tank identification number, inspection intervals, date of inspection, type of inspection, or type of test performed, and any other information required by the Competent Authority. 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.

## S6.13 INSPECTION AND TESTS OF CARGO TANKS

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All cargo tanks shall be examined and tested at frequencies specified in NBIC Part 2, Table S6.13. The examination and tests shall provide for a visual external, visual internal, leakage test, pressure test, thickness test, and lining test. It should be noted that the information in NBIC Part 2, Table S6.13 is a summary of United States Code of Federal Regulations, Title 49, Part 180. The user shall compare the requirements provided with Part 180 to ensure full compliance.

**TABLE S6.13**

PERIODIC INSPECTIONS AND TESTS

(OMITTED)

**Note 1:**

If a cargo tank is subject to an applicable inspection or test requirement under the regulations in effect on December 30, 1990, and the due date (as specified by a requirement in effect on December 30, 1990) for completing the required test occurs before the compliance date listed in the Table, the earlier date applies.

**Note 2:**

Pressure testing is not required for MC 300 and MC 331 cargo tanks in dedicated sodium metal service.

**Note 3:**

Pressure testing is not required for uninsulated lined cargo tanks with a design pressure of MAWP 103 kPa (15 psi) or less, which receive an external visual inspection and lining inspection at least once each year.

**Note 4:**

Insulated cargo tanks equipped with manholes or inspection openings may receive either an internal visual inspection in conjunction with the external visual inspection or a hydrostatic or pneumatic test of the cargo tank.

### S6.13.1 VISUAL EXTERNAL INSPECTION

a) Visual inspections are required of the complete cargo tank as required in NBIC Part 2, Table S6.13. The visual inspection shall include the heads, shell, nozzle connections, support attachments, all welded seams (longitudinal and circumferential), nozzle attachment welds, support, piping, appurtenances, structural attachments, and any attachment welds for possible defects. The visual inspection shall include a thorough examination for scratches that affect the pressure-retaining capabilities of the cargo tank, dents, leaks, distortions, corroded or abraded areas, and any other condition that would affect the safe operation of the cargo tank. If the cargo tank is able to be externally inspected, this must be noted in the inspection report of the cargo tank.

b) If the cargo tank is insulated and equipped with an internal lining, the following inspections shall be performed:

   1) Insulated cargo tanks — If the insulation on the cargo tank precludes a complete and thorough external visual inspection, the cargo tank shall be subjected to an internal visual inspection, if equipped with a manhole or inspection openings. This inspection shall include all internal

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surfaces, including welds, nozzle attachments, and, if equipped, baffles, internal stiffeners, surge protection devices for defects, corrosion, and missing or loose attachment;

2) Lined or coated, or those designed to preclude an internal visual inspection — If the cargo tank is externally lined, coated, or of a design that would prevent a complete and thorough external visual examination, the internal areas of the cargo tank that are not obstructed by the lining or coating shall be internally inspected;

3) Lined or coated, or those so designed to preclude access to the internal surfaces — The cargo tank shall be subjected to a hydrostatic or pneumatic test in accordance with NBIC Part 2, S6.13.6;

4) All corroded or abraded areas of a cargo tank wall must be thickness tested in accordance with the following procedures:

   a. Measurements must be made using a device capable of accurately measuring thickness within ± 0.051 mm (± 0.002 of an inch);

   b. Any individual performing thickness testing must be trained in the proper use of the thickness testing device in accordance with the testing device manufacturer's instructions;

   c. The minimum thickness requirements for the heads, shell baffle, and bulkhead, when used as tank reinforcement, shall meet the minimum thickness requirements for inservice requirements for cargo tank specifications MC 300, MC 303, MC 304, MC 306, MC 307, MC 310, MC 311 transport tanks, and MC 312 cargo tanks constructed of steel, steel alloys, aluminum, and aluminum alloys are based on 90% of the minimum manufactured thickness. Table S6.13.1-a, provides minimum inservice minimum thicknesses for steel and steel alloys. Table S6.13.1-b provides minimum thicknesses for aluminum and aluminum alloys.

**TABLE S6.13.1-a**

INSERVICE MINIMUM THICKNESSES FOR STEEL AND STEEL ALLOYS

(OMITTED)

**TABLE S6.13.1-b**

INSERVICE MINIMUM THICKNESSES FOR ALUMINUM AND ALUMINUM ALLOYS

(OMITTED)

### S6.13.2 INSPECTION OF PIPING, VALVES, AND MANHOLES

a) The cargo tank piping, valves, and gaskets must be carefully inspected for corroded areas and the piping system and valve attachment welds or threads must be inspected for corrosion, leakage, or any other defects that might render the cargo tank unsafe for transportation service. This examination shall include:

b) All devices for securing manhole covers must be in satisfactory working condition, and the area must not show any evidence of leakage at either the manhole cover or the manhole gasket;

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1) When inspecting gaskets on any full opening of the cargo tank, the inspector should visually examine the gasket for defects to include cracks and/or splits that may prevent the gasket material from sealing properly;

2) If the gasket shows any evidence of cuts or cracks that are likely to cause failure, the gasket shall be replaced;

c) All emergency devices and valves including self-closing stop valves, excess flow valves, and remote closure devices must be free of corrosion, distortion, erosion, and any external damage that will prevent safe operation of the cargo tank. Remote closure devices and self-closing stop valves must be operated during inspection to demonstrate that the devices are operating as designed;

d) Any missing bolts, nuts, and fusible links or elements shall be replaced. Loose bolts and nuts must be tightened;

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 d) 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.

### S6.13.3 INSPECTION OF APPURTENANCES AND STRUCTURAL ATTACHMENTS

a) Major appurtenances, as defined in CFR 49, 180.407 (d)(2)(viii), include but are not limited to suspension system attachments, connecting structures, and those elements of the upper coupler (kingpin) assembly that can be inspected without dismantling the upper coupler (kingpin) assembly. Major appurtenances shall be inspected for any corrosion or damage that might prevent safe operations.

b) If the cargo tank transports lading that is corrosive to the cargo tank, the upper coupler (kingpin) assembly must be inspected at least once in a two-year period. The upper coupler (kingpin) shall be removed for inspection of the following:

1) Corroded and abraded areas;

2) Dents;

3) Distortions;

4) Weld failures; and

5) Any other condition that might render the cargo tank unsafe for transportation service.

c) If the cargo tank is constructed of mild-or high-strength low-alloy steel and employs ring stiffeners or other appurtenances that create air cavities adjacent to the ring stiffeners or other appurtenances to the cargo tank's shell and these areas cannot be visually externally inspected, then the following shall be performed:

1) A thickness test on the stiffener rings shall be performed at least once every two years of at least four symmetrically distributed readings to establish an average thickness for the ring stiffener or appurtenance. The thickness requirements are specified in NBIC Part 2, Tables S6.13.1-a or S6.13.1-b, as applicable;

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2) If any of the thickness testing readings for the ring stiffeners are less than the average thickness by more than 10%, thickness testing must be performed from inside the transport tank on the area of the tank wall covered by the appurtenance or ring stiffener. If the results of the thickness test of the transport tank fail to conform to the minimum thickness requirements prescribed for the design as manufactured, the tank must be repaired or removed from hazardous material service. The owner of the transport tank can de-rate the tank to transport authorized material and reduced maximum weight of lading, reduce pressure, or a combination thereof under the following conditions:

   a. The reduced loadings, based on the cargo tank's design conditions and material thicknesses, are appropriate for the reduced loading conditions. This reduced loading shall be certified by a Design Certifying Engineer, and a revised manufacturer's certificate shall be issued reflecting these reduced loading conditions;

   b. The cargo tank motor vehicle's manufacturer's nameplate shall be revised to reflect the reduced limits;

   c. If a. and b. above cannot be satisfied, the owner of the cargo tank should not return the cargo tank to hazardous material service. The owner shall remove, or obliterate, or in a secure manner cover the tank's specification plate; and

   d. The Inspector shall record the results of the thickness test on the cargo tank's inspection report.

### S6.13.4 VISUAL INTERNAL INSPECTION

When performing an internal visual inspection of a cargo tank and the cargo tank is equipped with a manhole or an inspection opening, the Inspector shall examine the internal surfaces for corroded and abraded areas, dents, distortions, defects in welds, and any other conditions that might render the cargo tank unsafe for transportation service. As a minimum the inspection shall include:

a) The internal surfaces of the cargo tank shell and heads, and appurtenances such as baffles, clips, pads, piping or other internals;

b) Linings or coatings installed to prevent corrosion to the cargo tank wall shall be inspected in accordance with NBIC Part 2, S6.13.5 and Table S6.13.4;

c) When baffle assemblies prevent access required to perform the inspection of the interior surfaces of the cargo tanks or other interior appurtenances, either the entire baffle assembly or part thereof shall be detached to allow access or, other alternative means of inspection such as the use of boroscopes or cameras must be utilized;

d) For cargo tanks equipped with baffle assemblies, the baffle panels and the means of their attachment to the cargo tank wall shall be inspected for: weld defects, cracks, corrosion, deterioration at point of attachment, loose bolting, distortion or any other condition that might affect the structural integrity of the baffle assembly:

   1) Baffle panels that cannot be inspected, as installed, shall be detached or removed for inspection;

   2) Cracked or corroded baffle clips shall be replaced with material whose properties are equivalent to the material used for the cargo tank wall or material approved by a Design Certifying Engineer;

   3) For baffle clips welded directly to the cargo tank wall on tanks constructed of quenched and tempered steel, the clip shall be examined for cracks using surface Non Destructive Examination (NDE) methods such as PT and MT. The attachment weld to the cargo tank wall shall be

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examined for cracks using the Wet Fluorescent Magnetic Particle method. NDE must be in accordance with Section V of the ASME Code;

4) Damaged or worn baffle panels shall be repaired or replaced. Particular attention must be given to bolt holes that are enlarged from original shape or size. Bolting that is worn shall be replaced;

e) If the cargo tank is not equipped with a manhole or inspection opening, or is welded closed and the cargo tank has not transported a lading that is corrosive to the cargo tank wall, it shall be subjected to a pressure test as provided in NBIC Part 2, Tables S6.13.4 and S6.13.6.

**TABLE S6.13.4**

PERIODIC INSPECTIONS AND TESTS

(OMITTED)

**Note 1:**

Pressure testing is not required for MC 300 and MC 331 cargo tanks in dedicated sodium metal service.

**Note 2:**

Pressure testing is not required for uninsulated lined cargo tanks with a design pressure of MAWP 103 kPa (15 psi) or less, which receive an external visual inspection and lining inspection at least once each year.

### S6.13.5 LINING INSPECTIONS

Cargo tank linings include rubber linings and linings other than rubber (elastomeric materials) that are used to protect the tank from corrosion or other harmful effects of the lading material being transported. The inspection requirements are:

a) Rubber linings must be inspected for holes by using a high-frequency spark tester, as described in this section. If holes are found, they must be repaired using equipment and procedures prescribed by the lining manufacturer or lining installer;

b) Linings other than rubber (elastomeric materials) must be inspected and tested in accordance with procedures using equipment and procedures prescribed by the lining manufacturer or lining installers; and

c) If degraded or defective areas of the cargo tank lining are discovered, the lining in these areas shall be removed and the thickness of the cargo tank wall area under the lining defect shall be tested in accordance with the following:

1) Measurements shall be made using a device capable of accurately measuring thickness to within ± 0.051 mm (± 0.002 of an inch);

2) The individuals performing the thickness test must be trained in the proper use of the thickness testing device in accordance with the manufacturer's instructions; and

3) The minimum inservice thickness requirements for series MC 300 cargo tanks for steel and steel alloy and aluminum and aluminum alloy material is specified in NBIC Part 2, Tables S6.13.1-a and S6.13.1-b.

### S6.13.6 PRESSURE TESTS

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Cargo tanks may be tested by either the hydrostatic or pneumatic test method. When performing a pressure test, the test procedure shall include the test method (hydrostatic or pneumatic) used for the cargo tank, and 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;

    2) Normal vents 6.895 kPa (1 psig) shall be tested according to the testing criteria established by the valve manufacturer.

c) If the cargo tank is not carrying a corrosive lading, all areas that are covered by the upper coupler (fifth wheel) assembly must be inspected for corroded, abraded areas, dents, distortions, defects in welds, and any other condition that might render the tank unsafe for transport service. The upper coupler (fifth wheel) assembly must be removed from the cargo tank for this inspection.

d) If the cargo tank motor vehicle has multiple cargo tanks, each cargo tank shall be tested separately. The adjacent cargo tanks shall be empty and at atmospheric pressure.

e) When performing the hydrostatic or pneumatic test, the following requirements shall be specified in the test procedure:

    1) All closures, except the pressure relief device, shall be in place during the test;

    2) All required loading and unloading venting devices that are rated less than the test pressure may be removed during the test, or:

        a. If the venting devices are not removed, the device shall be rendered inoperative by clamps, plugs, or other equally effective restraining devices;

        b. The restraining devices shall not prevent detection of leaks or damage of the venting device and shall be removed immediately after the test.

**TABLE S6.13.6**

PRESSURE TEST REQUIREMENTS

(OMITTED)

### S6.13.6.1 HYDROSTATIC OR PNEUMATIC TEST METHOD

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a) The owner or user of the cargo tank may apply either the hydrostatic or pneumatic test method to satisfy the requirements of the pressure test specified in NBIC Part 2, Table S6.13.4.

b) If the hydrostatic test method is used, the cargo tank shall be completely filled including, if equipped, its dome with water or other liquids having similar viscosity. During the hydrostatic test, the Inspector shall:

   1) Ensure that the cargo tank is completely filled and free of any air pockets. During this operation, the liquid should flow freely out of the cargo tank's test vent;

   2) Ensure that the temperature of the test media does not exceed 38°C (100°F);

   3) Ensure that the test pressure cannot exceed the test pressures specified in NBIC Part 2, Table S6.13.6;

   4) Ascertain that the test pressure shall be maintained for a minimum of 10 minutes; and

   5) Visually examine the cargo tank for leakage, bulging or other defects. If any of the preceding occurs, terminate the test, drain the cargo tank, and evaluate the cargo tank's capabilities for repair or replacement of the affected areas.

c) If the owner and/or user elect to use the pneumatic test method, precaution should be employed due to the possibility of failure of the cargo tank under pneumatic test pressure conditions. The test area should be limited to the authorized personnel only and the test personnel shall be experienced in the pneumatic testing method. The pneumatic test pressure for the cargo tank shall be:

   1) Gradually increased to one-half the test pressure;

   2) After reaching one-half the test pressure, the test pressure shall be increased at a rate of approximately one-tenth of the test pressure until the test pressure is reached. The test pressure shall not exceed the test pressures specified in NBIC Part 2, Table S6.13.6;

   3) When the test pressure is reached, the test pressure shall be held for a least 5 minutes, then reduced to the MAWP of the cargo tank;

   4) At MAWP the inspector shall examine the cargo tank for any leakage, bulging, or any other defects; and

   5) Visually examine the cargo tank for leakage, bulging, or other defects. If any of the preceeding occurs, terminate the test, drain the cargo tank of all air or inert gas, and evaluate the cargo tank's suitability for repairs or replacement of the affected areas.

### S6.13.6.2 PRESSURE TESTING INSULATED CARGO TANKS

a) When pressure testing an insulated cargo tank, the insulations and jacketing are not required to be removed, unless it is not possible to reach the test pressure and maintain a condition of pressure equilibrium after the test pressure is reached, or the vacuum integrity cannot be maintained in the insulation space.

b) For MC 338 cargo tanks that transport refrigerated liquid, flammable gas, or oxygen, if the cargo tank is opened for any reason, the cleanliness of the cargo tank shall be verified prior to closure as required by CFR Title 49, Part 178.338-15.

### S6.13.6.3 PRESSURE TESTING CARGO TANKS CONSTRUCTED OF QUENCHED AND TEMPERED STEELS

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When testing MC 330 and MC 331 cargo tanks constructed of quenched and tempered steels, in accordance with ASME Section XII, Modal Appendix 1, and for cargo tanks constructed prior to the adoption of ASME Section XII, Part UHT of ASME Section VIII, Div. 1, or constructed of other quenched and tempered steel, without postweld heat treatment, used for the transportation of anhydrous ammonia or any other hazardous material that are subject to stress corrosion cracking, and the transportation of liquefied petroleum gas, the following is required:

a) The cargo tanks must be subjected to an internal visual inspection of all internal surfaces of the cargo tank using the wet fluorescent magnetic particle examination method immediately prior to performing the required pressure test;

b) The fluorescent magnetic particle examination has to be performed in accordance with ASME Section V.

c) The required pressure test as specified in NBIC Part 2, Table S6.13.4 shall be required.

### S6.13.6.4 PRESSURE TESTING CARGO TANKS EQUIPPED WITH A HEATING SYSTEM

If the cargo tank is equipped with a heating system, employing a medium such as, but not limited to, steam or hot water hydrostatically, pressure is as follows:

a) The cargo tank must be tested at least once every 5 years;

b) The test pressure for the heating system shall be at least to the maximum system design operating pressure;

c) The test pressure shall be maintained for a least 5 minutes; and

d) If the heating system employs flues for heating the lading, the flues must be tested to ensure that the lading cannot leak into the flues or into the atmosphere.

### S6.13.6.5 EXCEPTIONS TO PRESSURE TESTING

a) MC 330 and MC 331 cargo tanks that are in dedicated sodium metal service are not required to be pressure tested.

b) Un-insulated cargo tanks, with a design pressure or MAWP of 103 kPa (15 psig) or less, which can be externally visually inspected and a lining inspection at least once every 5 years, are not required to be pressure tested.

### S6.13.6.6 ACCEPTANCE CRITERIA

a) The acceptance criteria for the hydrostatic or pneumatic pressure test of the heating system is based on the cargo tank's capabilities to successfully pass the pressure test, without showing evidence of permanent distortion or other evidence of weakness that might render the cargo tank unsafe for transportation service.

b) If the cargo tank does not satisfy the requirements for the pressure test of the heating system identified in a) above, the cargo tank cannot be returned to transportation service, unless:

    1) Cargo tanks with a heating system, which does not hold pressure, should remain inservice as an unheated cargo tank, if the heating system remains in place and is structurally sound and no lading may leak into the heating system; and

    2) The specification information for the heating system on the nameplate is changed to indicate that the cargo tank has no working heating system.

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### S6.13.6.7 INSPECTION REPORT

a) The Inspector shall prepare a written inspection report that identifies the results of the pressure test and specifies the following:

   1) Manufacturer's serial number of the cargo tank;

   2) Name of the cargo tank manufacturer;

   3) DOT or MC specification number;

   4) MAWP of the cargo tank;

   5) Minimum thickness of the head and shell of the cargo tank;

   6) Identify whether the cargo tank is lined, insulated, or both; and

   7) Identify if the cargo tank is for special service, i.e., transport material corrosive to the cargo tank, dedicated service, etc.

b) The written inspection report shall provide for the following additional information:

   1) The type of test or inspection performed;

   2) Date of the test or inspection (month and year).

c) Listing of all items tested or inspected, including information about pressure relief valve:

   1) If the relief valve is removed, inspected and tested, or replaced;

   2) If applicable, the type of device;

   3) Set to discharge pressure at which the device will reseat; or

   4) If the device was reinstalled, repaired, or replaced.

d) Information regarding the inspection of the upper coupler (fifth wheel) assembly, and when applicable:

   1) If the coupler assembly (fifth wheel) was visually inspected in place; or

   2) If the coupler assembly (fifth wheel) was removed for examination.

e) Information regarding leakage, and type of pressure test (hydrostatic or pneumatic);

f) The test pressure and holding time during the test;

g) Location of defects found and the method of repair;

h) Minimum thickness of the cargo tank's heads and shells, as specified in NBIC Part 2, Table S6.13.1-a or Table S6.13.1-b, as applicable;

   1) Name and address of the person performing the test;

   2) Registration number of the facility or person performing the test;

   3) Continued qualification statement, such as:

      a. "Cargo tank meets the requirements of DOT specification identified in this report."

      b. "Cargo tank fails to meet the requirements of the DOT specification identified in this report.

i) DOT registration number of the Registered Inspector, and dated signature of the Registered Inspector and the cargo tank owner.

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j) The owner and the motor carrier shall retain a copy of the test and inspection reports until the next test or inspection of the same type is successfully completed. This requirement does not apply to a motor carrier leasing a cargo tank for fewer than 30 days.

### S6.13.7 ADDITIONAL REQUIREMENTS FOR MC 330 AND MC 331 CARGO TANKS

After completion of the pressure test, each motor carrier operating a Specification MC 330 and MC 331 cargo tank in anhydrous ammonia, liquefied petroleum gas, or any other service that is prone to stress corrosion cracking, shall make a written report containing the following information:

a) Carrier's name, address of principal place of business, and telephone number;

b) Complete identification plate data required by Specification MC 330 and MC 331 cargo tanks, including data required by the *ASME Boiler and Pressure Vessel Code*;

c) Carrier's equipment number;

d) Statement indicating whether or not the cargo tank was stress relieved after fabrication;

e) Name and address of the person performing the test and date of the test;

f) Statement of the nature and severity of any defects found. As a minimum, the information shall include:

   1) Identification of the location of the defects detected, such as in weld, heat-affected zone, the liquid phase, the vapor phase, or the head to shell seam; or

   2) If no defects or damage were discovered, this also shall be reported.

g) Statement indicating the methods employed to make repairs; that made the repairs; and the date the repairs were completed. If the cargo tank was stress relieved after the repairs were completed, whether full or local stress relieving was performed;

h) Statement of the disposition of the cargo tank, such as:

   1) "cargo tank scrapped"; or

      a. "cargo tank returned to service."

i) Statement as to whether or not the cargo tank is used in anhydrous ammonia service that is subject to stress corrosion cracking. If the cargo tank had been used in anhydrous ammonia service since the last report, the owner has to provide a statement in the report indicating whether each shipment of ammonia was certified by its shipper as containing at least 0.2% water by weight.

j) A copy of the written inspection report must be retained by the carrier at its principal place of business during the period the cargo tank is in the carrier's service and for one year thereafter.

k) Upon written request to, and with the approval of the Field Administrator, Regional Service Center, and Federal Motor Carrier Safety Administration for the region in which a motor carrier has its principal place of business, the carrier may maintain the reports at a regional or terminal office.

### S6.13.8 CERTIFICATES AND REPORTS

a) Each person offering a DOT specification cargo tank for sale or lease must provide the purchaser or lessee with the following:

   1) A copy of the cargo tank certificate of compliance;

   2) If applicable, a copy of the record of repair, modification, stretching, or rebarrelling; and

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3) The most recent inspection and test reports.

b) Copies of the documents and reports identified in a) above must be provided to the lessee if the cargo tank is leased for more than 30 days.

### S6.13.9 LEAKAGE TEST

When leakage testing is required by NBIC Part 2, Table S6.13.4, the test shall include testing the product piping with all valves and accessories in place and operative, except that any venting devices set to discharge at less than the leakage test pressure must be removed or rendered inoperative during the test. The leakage test shall include:

a) All internal or external self-closing stop valves must be tested for leakage;

b) Each cargo tank of a multi-cargo tank motor vehicle must be tested with the adjacent cargo tanks empty and at atmospheric pressure;

c) The leakage test shall be maintained for a minimum of 5 minutes;

d) Cargo tanks in liquefied compressed gas service shall be:

1) Inspected externally for leaks during the leakage test;

2) Suitable safeguards must be provided to protect personnel should a failure occur, as follows:

a. Cargo tanks may be leakage tested with the hazardous material in the cargo tank during the test;

b. The leakage test pressure shall not be less than 80% of the MAWP marked on the specification plate, unless the cargo tank has a MAWP of 690 kPa (60 psig) or more, in which case it should be leakage tested at its maximum normal operating pressure provided it is in dedicated service or services;

c. MC 330 or MC 331 cargo tanks in dedicated liquefied petroleum gas service may be leakage tested at not less than 414 kPa (60 psig);

d. An operator of a MC 330 or MC 331 cargo tank and a non-specification cargo tank equipped with a meter should check leak tightness of the internal self-closing stop valve by conducting a meter creep test; and

e. A non-specification cargo tank is a cargo tank that conforms and is marked in conformance with the edition of the ASME Code in effect when the cargo tank was fabricated and should be used for the transportation of liquefied petroleum gas, provided the cargo tank satisfies the following:

1. The cargo tank has a minimum design pressure no lower than 172 kPa (250 psig);

2. The cargo tank has a water capacity of 13,250 l (3,500 gallons) or less.

3) The cargo tank has been manufactured in accordance with the ASME Code prior to January 1, 1981. This requirement requires the cargo tank to be stamped with the ASME Code Symbol Stamp and documented on an ASME Manufacturer's Data Report;

4) The cargo tank shall conform to the applicable provisions of NFPA 58, except if NFPA is inconsistent with the requirements of Parts 178 and 180 of Title 49;

5) The cargo tank shall be leakage tested in accordance with NBIC Part 2, Table S6.13.4;

6) MC 330 and MC 331 cargo tanks in dedicated service for anhydrous ammonia may be leakage tested at not less than 414 kPa (60 psig);

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7) Non-specification cargo tanks must be leakage tested at pressure of not less than 16.6 kPa (2.4 psig), if the cargo tanks comply with one of the following:
   a. For the transport of petroleum products that have a liquid capacity of 13,250 l (3,500 gal); and
   b. Permanently secured non-bulk tanks to a motor vehicle and protected against leakage or damage in the event of turnover, having a liquid capacity of less than 450 l (119 gal), used for transportation of a flammable liquid petroleum product.
8) The cargo tank is used to transport petroleum distillate fuels that are equipped with vapor collection equipment and should be leakage tested in accordance with the Environmental Protection Agency's "Model 27-Determination of Vapor Tightness of Gasoline Delivery Tank Using Pressure-Vacuum Test," as follows:
   a. The test method and procedures and maximum allowable pressure and vacuum changes are in 40 CFR 63.425(e)(1);
   b. The hydrostatic test alternative, using liquid in Environmental Protection Agency's "Method 27-Determination of Vapor Tightness of Gasoline Delivery Tank Using Pressure-Vacuum Test" should not be used to satisfy the leak testing requirements of this Section. The test shall be conducted using air; and
   c. Cargo tanks equipped with vapor collection equipment should be leakage tested in accordance with 8) b. above.
9) Cargo tanks that fail to retain leakage test pressure shall not be returned to service as a specification cargo tank, unless all sources of leakage are properly repaired prior to returning the cargo tank to hazardous material service.
10) It is required that after July 1, 2000, that the Registered Inspector who performs inspections on MC 330 and MC 331 cargo tanks inspect the delivery hose assembly and the piping system of the cargo tank under leakage test pressure utilizing the rejection criteria for cargo tanks unloading liquefied compressed gas. It should be noted that an operator should remove and replace damaged sections or correct defects discovered as provided in NBIC Part 2, S6.13.10. If any of the following is discovered, it is cause for rejection:
    a. No operator shall use a delivery hose assembly for liquefied compressed gas if it is determined that any of the following conditions exist:
       1. Damage to the hose cover that exposes the reinforcement;
       2. If the wire braid reinforcement is kinked or flattened so as to permanently deform the wire braid;
       3. Soft spots when the hose is not under pressure, or any loose outer covering on the hose;
       4. Damaged, slipping, or excessively worn hose couplings; and
       5. Loose or missing bolts or fastenings on the bolted hose coupling assembly.
    b. No operator can use a cargo tank with a piping system for unloading liquefied compressed gases if any of the following conditions exist:
       1. Any external leaks identifiable without the use of instruments;
       2. Bolting that is loose, missing, or severely corroded;
       3. Manual stop valves that will not actuate; and

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4. Rubber hose flexible connectors with any of the following conditions:
   aa. Damage to the hose cover that exposes the reinforcement;
   bb. If the wire braid reinforcement is kinked or flattened so as to permanently deform the wire braid;
   cc. Soft spots when the hose is under pressure, or any loose outer covering on the hose;
   dd. Damaged, slipping, or excessively worn hose couplings;
   ee. Loose or missing bolts or fastenings on the bolted hose coupling assembly;
   ff. Stainless steel flexible connectors with damaged reinforcement braid;
   gg. Internal self-closing stop valves that fail to close or that permit leakage through the valve detectable without the use of instruments; or
   hh. Pipes or joints that are severely corroded.

### S6.13.10 NEW OR REPLACED DELIVERY HOSE ASSEMBLIES

The operator shall repair hose assemblies and place the cargo tank back in service if retested successfully in accordance with the following:

a) The new and/or replaced hose assembly is tested at a minimum of 120% of the hose's MAWP;
b) The operator shall visually examine the delivery hose assembly while it's under pressure;
c) If the test is successful, the operator shall ensure that the delivery hose assembly is permanently marked with the month and year of the test; and
d) It should be noted that after July 1, 2000, the operator shall complete a record documenting the test and inspection, which shall include the following:
   1) The date and signature of the Inspector that performed the inspection;
   2) The owner of the hose assembly;
   3) The hose identification number;
   4) The date of the original delivery of the hose assembly and tests;
   5) Notes of any defects observed;
   6) Any repairs that may have been made; and
   7) Identification in the written report that the delivery hose assembly passed or failed the tests and inspections.

### S6.13.10.1 THICKNESS TESTING

a) Thickness testing of the head and shell of unlined cargo tanks used for the transportation of materials corrosive to the cargo tank shall be measured at least once every two years.
b) Cargo tanks measuring less than the sum of the minimum prescribed thickness in NBIC Part 2, Tables S6.13.1-a or S6.13.1-b, as applicable, plus one-fifth of the original corrosion allowance, shall be tested annually.

### S6.13.10.2 TESTING CRITERIA

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The testing criteria that shall be used for these requirements are as follows:

a) The measuring device shall be capable of accurately measuring thickness to within ± .50mm (.002 inch);

b) The individuals performing thickness testing shall be trained in the proper use of the thickness testing device used in accordance with the testing device manufacturer's instructions;

c) Thickness testing shall be performed in the following areas, as a minimum:

   1) Areas of the tank shell and heads, including around any piping that retains lading;

   2) Areas of high shell stress, such as the bottom center of the cargo tank;

   3) Areas near openings;

   4) Areas around weld joints;

   5) Areas around shell reinforcements;

   6) Areas around appurtenance attachments;

   7) Areas near the upper coupler (fifth wheel) assembly attachments;

   8) Areas near suspension system attachments and connecting structures;

   9) Known thin areas in the tank shell and nominal liquid level lines; and

   10) Connecting structures joining multiple cargo tanks of carbon steel in a self-supporting cargo tank motor vehicle.

### S6.13.10.3 THICKNESS REQUIREMENTS

a) The minimum thickness for MC 300, MC 301, MC 302, MC 303, MC 304, MC 305, MC 306, MC 307, MC 310, and MC 312 cargo tanks are determined based on the definition of minimum thickness defined in CFR, Title 49, Part 178.320(a).

b) NBIC Part 2, Tables S6.13.1-a and S6.13.1-b, identify the "Inservice Minimum Thickness" values to determine the minimum thickness for the referenced cargo tank.

c) The tables are divided into three columns. The column headed "Minimum Manufactured Thickness" indicates the minimum values required for new construction of DOT 400 series cargo tanks.

d) The "Inservice Minimum Thicknesses" for cargo tanks specified in (a) above are based on 90% of the manufactured thickness specified in the DOT Specification, rounded off to three places.

### S6.13.11 CARGO TANKS THAT NO LONGER CONFORM TO THE MINIMUM THICKNESS REQUIREMENTS IN NBIC PART 2, TABLES S6.13.1-a AND S6.13.1-b

If a cargo tank does not conform to the minimum thickness requirements in NBIC Part 2, Tables S6.13.1-a and S6.13.1-b, for the design as manufactured, the cargo tank should be used at a reduced maximum weight of lading or reduced MAWP, or combinations thereof, provided the following are met:

a) The cargo tank's design and thickness are appropriate for the reduced loadings conditions as follows:

   1) The cargo tank's design and thickness for the appropriate reduced loading shall be certified by a Design Certifying Engineer;

   2) A revised manufacturer's certificate shall be issued; and

   3) The cargo tank's motor vehicle's nameplate shall reflect the revised service limits.

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b) It is required if a cargo tank no longer conforms with the minimum thickness requirements prescribed in the specification, that the cargo tank cannot be returned to hazardous material service. The cargo tank's specification plate shall be removed, obliterated, or covered in a secure manner. The inspector shall require that the cargo tank is calculated to identify the thickness of the material as required in NBIC Part 2, S6.13.10.1 and S6.13.10.2, of this Section.

c) MC cargo tanks constructed prior to October 1, 2003, require the minimum thickness, minus the corrosion allowance as provided on the Manufacturer's Data Report; and

d) MC cargo tanks constructed after October 1, 2003, require the minimum thickness will be the value indicated on the specification plate of the cargo tank. If no corrosion allowance is indicated on the Manufacturer's Data Report, then the thickness of the cargo tank shall be the thickness of the material of construction indicated on the Manufacturer's Data Report, with no corrosion allowance.

### S6.13.11.1 MINIMUM THICKNESS FOR 400-SERIES CARGO TANKS

400 series cargo tanks are required to satisfy the minimum thickness requirements as established in Part 178.320(a) of Title 49 for DOT 406 cargo tanks, Part 178.347.2 of Title 49 for DOT 407 cargo tanks and Part 178.348.2 of Title 49 for DOT 412 cargo tanks.

### S6.13.11.2 DOT 406 CARGO TANKS

a) It is required that all head, shell, bulkhead, and baffle materials used in the construction of DOT 406 cargo tanks satisfy Parts A and B of Section II of the *ASME Boiler and Pressure Vessel Code*,except that the following materials are authorized for cargo tanks constructed in accordance with *ASME Boiler and Pressure Vessel Code* that are not stamped with the "U" Code Symbol Stamp must be constructed out of ASTM materials permitted in Part 178.345-2 of Title 49. These materials are as follows:

   1) ASTM A 569,
   2) ASTM A 570,
   3) ASTM A 572,
   4) ASTM A 607,
   5) ASTM A 622,
   6) ASTM A 656, and
   7) ASTM A 715.

b) Aluminum alloys suitable for fusion welding and conforming with the O, H 32, or H 34 temper of one of the following ASTM Specifications may be used for cargo tanks constructed in accordance with the *ASME Boiler and Pressure Vessel Code*:

   1) ASTM B 209, Alloy 5052,
   2) ASTM B 209, Alloy 5086,
   3) ASTM B 209, Alloy 5154,
   4) ASTM B 209, Alloy 5254,
   5) ASTM B 209, Alloy 5454, and
   6) ASTM B 209, Alloy 5652.

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c) All heads, bulkheads, and baffles must be of O temper (annealed) or stronger temper. All shell material shall be of H 32, or H 34 temper, except that the lower ultimate strength temper should be used if the minimum shell thicknesses in the tables are increased in proportion to the lesser ultimate strength.

d) NBIC Part 2, Table S6.13.11.2-a, specifies the minimum thickness requirements for heads or bulkheads and baffles when used as tank reinforcement that is based on the volume capacity in liters per mm (gallons per inch) of length for MC 406 cargo tanks constructed out of Mild Steel (MS), High-Strength Low -Alloy Steel (HSLA), Austenitic Stainless Steel (SS), or Aluminum (AL).

e) NBIC Part 2, Table S6.13.11.2-b specifies the minimum thickness requirements for shell based on the cargo tank motor vehicle rated capacity in gallons when the cargo tank is constructed out of Mild Steel (MS), High-Strength Low-Alloy Steel (HSLA), Austenitic Stainless Steel (SS), or Aluminum (AL). The thickness requirements in these tables are specified in decimal of a mm (inch) after forming.

**TABLE S6.13.11.2 -a**

MINIMUM THICKNESS FOR HEADS

(OMITTED)

**TABLE S6.13.11.2-b**

MINIMUM THICKNESS FOR SHELLS, IN. (MM)

(OMITTED)

### S6.13.11.3 DOT 407 CARGO TANKS

a) It is required that the type of materials used for DOT 407 cargo tanks, depending on the type of media being transferred be either Mild Steel (MS), High-Strength Low-Alloy Steel (HSLA), Austenitic Stainless Steel (SS), or Aluminum.

b) The minimum required thicknesses of materials specified in NBIC Part 2, Table S6.13.11.3-a, for DOT 407 cargo tanks, when the minimum thickness requirements are based on the volume capacity in liters per sq mm (gallons per square inch) for the cargo tank's heads, or bulkheads and baffles, when these items are used for reinforcement purposes. All thicknesses are expressed in decimals of a mm (inch) after forming.

c) The minimum required thicknesses of materials are specified in NBIC Part 2, Table S6.13.11.3-b, for DOT 407 cargo tanks, when the minimum thickness requirements are based on the volume capacity in liters per sq. mm (gallons per square inch) for the cargo tank shell. All thicknesses are expressed in decimals of a mm (inch) after forming.

**TABLE S6.13.11.3-a**

MINIMUM THICKNESS FOR HEADS (DOT 407), MM (IN.)

(OMITTED)

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**TABLE S6.13.11.3-b**

MINIMUM THICKNESS FOR SHELLS (DOT 407), MM (IN.)

(OMITTED)

### S6.13.11.4 DOT 412 CARGO TANKS

a) It is required that the type of materials used for DOT cargo tanks, depending on the type of media being transferred be either Mild Steel (MS), High-Strength Low-Alloy Steel (HSLA), Austenitic Stainless Steel (SS), or Aluminum.

b) The minimum required thickness of materials are specified in NBIC Part 2, Table S6.13.11.4-a, for DOT 412 cargo tanks, when the minimum thicknesses requirements are based on the volume capacity in liters per sq mm (gallons per square inch) for cargo tank heads, or bulkheads and baffles, when these items are used for reinforcement purposes. All thicknesses are expressed in decimals of mm (inch) after forming.

c) The minimum required thicknesses of materials are specified in NBIC Part 2, Table S6.13.11.4-b, for DOT 412 cargo tanks, when the minimum thickness requirements are based on the volume capacity in liters per sq mm (gallons per square inch) for the cargo tank's shell. All thicknesses are expressed in decimals of mm (inch) after forming.

### S6.14 INSPECTION AND TESTS OF PORTABLE TANKS

a) For hazardous material ladings, all portable tanks shall be inspected and tested at frequencies specified in NBIC Part 2, Table S6.14. The inspection and tests shall include visual inspection of external and internal surfaces, leak test, pressure test, thickness measurements, and lining test. It should be noted that the information in NBIC Part 2, S6.14, is a summary of CFR Title 49, Part 180.601 through Part 180.605. The user is responsible for full compliance with the requirements in CFR Title 49, Part 180.601 through Part 180.605.

b) All portable tanks shall be visually inspected (internally, unless otherwise noted, and externally) for any condition that might render the portable tank unsafe for transportation service. The inspection shall include:

   1) Inspection of the shell for pitting, corrosion or abrasions, dents, distortions or abrasions, defects in welds, or any other conditions, including leakage; and

   2) Inspection of the piping, valves, and gaskets for corroded areas, defects, and other conditions, including leakage that may be unsafe during filling and discharge or transportation.

c) In addition to the required frequencies established in NBIC Part 2, Table S6.14, it is required that portable tanks be inspected and tested when any of the following occurs:

   1) The portable tank has been in an accident and has been damaged to an extent that may adversely affect the portable tank's ability to retain hazardous materials;

   2) The portable tank has been out of hazardous material transportation service for a period of one year or more;

   3) The portable tank has been modified from its original design specification; and

   4) The portable tank is in an unsafe operating condition based on the existence of observed damage, leaks, or missing safety devices, etc.

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**TABLE S6.14**

INSPECTION INTERVALS

(OMITTED)

### S6.14.1 PERIODIC INSPECTION AND TEST

Portable tanks shall be tested and inspected in accordance with the frequency set forth in NBIC Part 2, Table S6.14 and the procedures set forth in NBIC Part 2, S6.14.3 through S6.14.6.4.

### S6.14.2 INTERMEDIATE PERIODIC INSPECTION AND TEST

a) Intermediate periodic inspections and testing shall be performed in accordance with NBIC Part 2, Table S6.14. The intermediate periodic inspection and testing shall include:

   1) An external and an internal inspection of the portable tank and its fittings taking into account the hazardous materials being transported;

   2) A leakage test of the transport tank; and

   3) A test for satisfactory operation of all service equipment;

b) When inspecting portable tanks equipped with sheathing and thermal insulation, etc., the insulation need only be removed to the extent required for a reliable appraisal of the condition of the portable tank;

c) For portable tanks intended for the transportation of a single hazardous material, the internal inspection may be waived if the portable tank is subjected to a leakage test that is performed in accordance with NBIC Part 2, S6.14.3 of this section prior to each filling;

d) Portable tanks used for dedicated transportation of refrigerated liquefied gases that are not fitted with inspection openings are exempt from the internal inspection requirements, but shall be externally inspected.

### S6.14.3 INTERNAL AND EXTERNAL INSPECTIONS

All portable tanks that are subject to five-year periodic inspection and testing (pressure test) are required to be inspected, both internally, unless exempt, and externally. The internal and external inspection shall include:

a) Sheathing, thermal insulation, etc. The sheathing and thermal insulation need only be removed to the extent required for reliable appraisal of the condition of the portable tank;

b) Except for DOT Specification 56 and 57 portable tanks, all re-closing pressure relief devices must be removed from the tank and tested separately unless they can be tested while installed on the portable tank;

c) For portable tanks where the shell and equipment have been pressure tested separately after assembly, the portable tank shall be subjected to a leakage test and effectively tested and inspected for corrosion;

d) Portable tanks used for the transportation of refrigerated, liquefied gases are exempt from the internal inspection and the hydrostatic test or other pressure test during the five-year periodic inspection if the

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portable tank was originally tested to a minimum test pressure of 1.3 times the design pressure using inert gas and provided that;

1) The portable tank and its appurtenances were constructed to ASME Section XII, or ASME Section VIII, Division 1; the portable tank shall be inspected in accordance with the applicable requirements of this Code;
2) Portable tanks shall be either hydrostatically or pneumatically tested with the formula 1.5 x design pressure + static head + 101 kPa (14.7 psi), if the tank is designed for external pressure;
3) The portable tank shall be subjected to either a hydrostatic or pneumatic test at a test pressure of 1.5 x the sum of the design pressure + the static head of lading + 101 kPa (14.7 psi), if subjected to external vacuum. If the portable tank is constructed in accordance with ASME Section XII or Part UHT of ASME Section VIII, Div. 1, the test pressure shall be twice the design pressure; and
4) A pneumatic test may be used in lieu of a hydrostatic test if the following conditions are met:
   a. The owner or user has taken necessary precautions to ensure the safety of the inspection and test personnel;
   b. The pneumatic test pressure shall be reached gradually by increasing the test pressure to one-half of the test pressure. Once this pressure is reached, the test pressure will be increased in increments of approximately one-tenth of the test pressure until the required test pressure is reached; and
   c. When the test pressure is reached, the test pressure shall be reduced to at least four-fifths of the test pressure and held for a sufficient time to permit inspection of the portable tank.

### S6.14.4 EXCEPTIONAL INSPECTION AND TEST

a) Exceptional inspection and test is necessary when a portable tank shows evidence of damage, corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the portable tank.
b) The extent of the exceptional inspection and test shall depend on the amount of deterioration of the portable tank. The exceptional inspection and test shall include the requirements of NBIC Part 2, S6.14.3 of this section.
c) Pressure relief devices do not need to be included in this test unless there is reason to believe the relief device has been affected by damage or deterioration.

### S6.14.5 INTERNAL AND EXTERNAL INSPECTION PROCEDURE

An internal and external inspection, when required, shall be performed by the owner or user. The inspection shall be conducted by the Inspector. This individual shall ensure that the portable tank is safe for continued transportation service. The Inspector shall evaluate the results of the inspection and report the applicable findings. The inspection shall include:

a) Inspection of the shell for pitting, corrosion or abrasions, dents, distortions, defects in welds, or any other conditions, including leakage;
b) Inspection of the piping, valves, and gaskets for corroded areas, defects, and other conditions, including leakage that might make the portable tank unsafe for filling, discharge, or transportation;
c) Ensuring that the tightening devices for manhole covers are operative, and there is no leakage at the manhole cover or gasket;

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d) Checking for any missing or loose bolts or nuts on any flanged connections including piping flanges, pressure relief device connections, or blank flanges. If any bolts are loose or missing, these shall be tightened or replaced;

e) Checking all emergency devices and valves to ensure that they are free from corrosion, distortion, and any damage or defects that could prevent the devices from operating as designed;

f) Ensuring all remote closures and self-closing stop valves are operated to demonstrate their proper operation;

g) Ensuring the required markings on the portable tanks are legible and in accordance with the applicable requirements of CFR Title 49, Part 178.3, and Part 180.605; and

h) Ensuring the framework, supports, and the arrangements for lifting the portable tank are in a satisfactory condition.

### S6.14.6 PRESSURE TEST PROCEDURES FOR SPECIFICATION 51, 57, 60, IM OR UN PORTABLE TANKS

This Section provides the requirements for pressure test procedures for Specification 51, 57, 60, IM or UN Portable Tanks as provided in CFR Title 49, Part 180.605(h). Pressure test requirements for Specification 51, 57, 60, IM and UN Portable Tanks are identified in NBIC Part 2, Table S6.14.6 of this Subsection.

**TABLE S6.14.6**

PRESSURE TESTING REQUIREMENTS

(OMITTED)

#### S6.14.6.1 SPECIFICATION 57 PORTABLE TANKS

a) Specification 57 portable tanks shall be leak tested by a minimum sustained air pressure of at least 21 kPa (3 psig) applied to the entire tank.

b) During each air pressure test, the entire surface of all joints, whether welded or threaded, shall be coated with or immersed in a solution of soap and water, heavy oil, or other material suitable for the purpose of detecting leaks.

c) The test pressure shall be held for a minimum of 5 minutes plus any additional time required to examine all portions of the portable tank.

d) During the air test, the pressure relief device may be removed or left in place. If the relief device is left in place during the test, the device's discharge opening shall be plugged.

e) All closure fittings must be in place during the pressure test.

f) If the portable tank is lagged or insulated, the lagging or insulation does not have to be removed if it is possible to maintain the required test pressure at a constant temperature with the portable tank disconnected from the source of pressure.

#### S6.14.6.2 SPECIFICATION 51 OR 56 PORTABLE TANKS

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a) Specification 51 or 56 portable tanks shall be tested using either air or liquid. The minimum test pressure shall be at least 14 kPa (2 psig) or at least one and one-half times the maximum allowable working pressure (or re-rated pressure) of the portable tank. The greater test pressure shall be used.

b) The leak testing of all refrigerated liquefied gas tanks shall be performed at 90% of the maximum allowable working pressure of the portable tank.

c) Leak testing for all other portable tanks shall be at a test pressure of at least 25% of the maximum allowable working pressure of the portable tank.

d) If the portable tank is hydrostatically tested, the entire surface of the portable tank shall be inspected for leaks. This includes all welded joints and threaded connections. The requirements below shall be followed for hydrostatic testing:

   1) The hydrostatic test pressure shall be held for a minimum of 5 minutes plus any additional time required to complete the inspection;

   2) The pressure relief device should be removed or left in place during the hydrostatic test. If the relief device is left in place during the test, the device shall be isolated to prevent the relief device from discharging in accordance with the device manufacturer's recommendations;

   3) It is required for DOT 51 specification tanks that the relief valve be removed during the pressure test; and

   4) All closure fittings shall remain in place during the hydrostatic test.

e) If the portable tank is pressure tested by air, during the test all surfaces of welded joints and thread connections of the portable tank shall be inspected for leaks and the following procedure shall be followed:

   1) All welded joints and threaded connections shall be coated with or immersed in a solution of soap and water, or heavy oil or other material suitable for the purpose of detecting leaks;

   2) The air test pressure shall be held for a minimum of 5 minutes. This time period should be increased if so required by the Inspector;

   3) The pressure relief device should be removed or left in place during the air test. If the relief device is left in place during the test, the device shall be isolated to prevent the pressure relief device from discharging in accordance with the device manufacturer's recommendations;

   4) For Specification 51 portable tanks, the relief device shall be removed during the pressure test; and

   5) All closure fittings shall remain in place during the air test.

f) If the portable tank is lagged or insulated and the pressure test performed is either hydrostatic or pneumatic, it is not necessary to remove the lagging or insulation for pressure testing provided the decay in test pressure can be measured at a constant temperature while the portable tank is disconnected from the source of pressure.

### S6.14.6.3 SPECIFICATION 60 PORTABLE TANKS

Specification 60 portable tanks shall be tested by completely filling the portable tank with water or other liquid having a similar viscosity. The test procedure shall include:

a) The temperature of the liquid shall not exceed 37.7°C (100°F) during the test;

b) The test pressure applied shall be at least 413 kPa (60 psig);

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c) The test pressure shall be maintained for a minimum of 10 minutes. This time period may be increased if required by the Inspector;

d) During the 10-minute time period, the portable tank shall be capable of maintaining the test pressure with no evidence of leakage;

e) All closures shall be left in place while the pressure test is being performed;

f) The pressure gage shall be located at the tip of the vessel during the test; and

g) Re-closing pressure relief devices must be removed from the tank and tested separately unless they can be tested while installed on the portable tank.

### S6.14.6.4 SPECIFICATION IM OR UN PORTABLE TANKS

All Specification IM or UN portable tanks, except for UN portable tanks used for non-refrigerated and refrigerated liquefied gases, and all piping, valves, and accessories, except pressure relief devices, shall be hydrostatically tested with water, or other liquid similar in density and viscosity as follows:

a) All IM portable tanks used for non-refrigerated and refrigerated liquid gases shall be hydrostatically tested with water to a pressure of not less than 150% of the portable tanks maximum allowable working pressure;

b) All UN portable tanks used for the transportation of non-refrigerated liquefied gases shall be hydrostatically tested, with water to a pressure not less than 130% of the portable tanks maximum allowable working pressure.

    1) UN portable tanks used for the transportation of refrigerated gases should be tested either hydrostatically or pneumatically using an inert gas to a pressure of not less than 1.3 times the design pressure of the portable tank.

    2) If the portable tank is subjected to the pneumatic test method, the owner or user shall take necessary precautions for the safety of the inspection and test personnel.

    3) The pneumatic test pressure shall be reached gradually by increasing the test pressure to one-half of the test pressure. Once this pressure is reached, the test pressure will be increased in increments of approximately one-tenth of the test pressure until the required test pressure is reached.

    4) When the test pressure is reached, the pressure shall be reduced to a value equal to four-fifths of the test pressure and held for a sufficient time to permit the inspection for leaks.

c) The minimum test pressure of IM and UN portable tanks is determined on the basis of the hazardous materials that are intended to be transported in the portable tank as required by CFR Title 49, Part 172.101.

d) For liquid, solid, and non-refrigerated gases, the minimum test pressure for a specific hazardous material is provided in the applicable “T” Codes assigned for a particular hazardous material, as specified in CFR Title 49, Part 172.102 Tables. See NBIC Part 2, Table S6.14.6.4.

e) While the portable tank is under test pressure, it shall be inspected for leakage, distortion, or any other condition that might render the portable tank unsafe for service.

f) If a portable tank fails to meet the requirements of the pressure test or if during the pressure test there are any of the following conditions, the portable tank shall be removed from transportation service, unless the portable tank is adequately repaired and, thereafter, a successful pressure test is conducted in accordance with this Section.

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1) Any permanent distortion of the portable tank exceeding that permitted by the applicable specification;
2) Any leakage; or
3) Any deficiencies that would render the portable tank unsafe for transportation.

g) The approval agency shall witness the hydrostatic or pneumatic tests.

h) If the portable tank is damaged or a deficiency is discovered that might render the portable tank unsafe, the tank shall be repaired to a satisfactory condition. This test shall be witnessed by the applicable approval agency. As a minimum, the repair procedures shall include:

1) Retesting to the original pressure test requirements.
2) If the hydrostatic or pneumatic test is successful, the witnessing approval agency shall apply its name, identifying mark, or identifying number on the portable tank's nameplate as required in NBIC Part 2, S6.14.7;

i) All thermal cutting or welding on the shell of IM or UN portable tanks shall be done in accordance with this Section. After completion of the thermal cutting or welding operation, a pressure test shall be performed to the requirements of the portable tank's original test requirements.

**TABLE S6.14.6.4**

"T" CODES

(OMITTED)

### S6.14.7 INSPECTION AND TEST MARKINGS FOR IM OR UN PORTABLE TANKS

a) Each IM or UN portable tank shall be durably and legibly marked, in English, with the date (month and year) of the last pressure test.

b) The identifying agency shall witness the test, when required, and the date of the last visual inspection.

c) The markings required on the portable tank's identification plate shall be identified as follows:

1) Placed on or near the metal identification plate;
2) The size of the letters and numerals on the plate shall be no less than 3 mm (0.1 inches) high; and
3) If the letters and numerals are stamped into the portable tank's shell, they shall be at least 12 mm (0.5 inches) high.

### S6.14.8 INSPECTION AND TEST MARKINGS FOR SPECIFICATION DOT 51, 56, 57, OR 60

a) Each Specification DOT 51, 56, 57, or 60 portable tank shall be durably and legibly marked, in English, with the date (month and year) of the most recent periodic test.

b) The markings shall be placed near the metal certification plate and shall be in accordance with the following:

1) Shall be marked on a non-removable component of the portable tank that identifies the specification markings;

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2) Located in an unobstructed area with letters and numerals identifying the standard or specification, (e.g., UN 1A1, DOT 4B240ET, etc.);
3) Shall identify the name and address or symbol of the portable tank manufacturer or, where specifically authorized, the symbol of the approval agency certifying compliance with the UN standard;
4) The markings shall be stamped, embossed, burned, printed, or otherwise marked on the portable tank to provide adequate accessibility, permanency, contrast, and legibility, so as to be readily apparent and understood; and
5) The letters and numerals shall be at least 3 mm (0.1 inches) high if stamped on a plate, and shall be at least 12.0 mm (0.5 inches) high when stamped on the portable tank's shell.

### S6.14.9 RECORD RETENTION

The owner of each portable tank or his authorized agent shall retain a written report of the date and results of all required inspections and tests, including the following:

a) If applicable, the ASME Manufacturer's Data Report (U-1 or U1A Forms);
b) The name and address of the person performing the inspection and/or test in accordance with the applicable specification;
c) The Manufacturer's Data Report including a certificate(s) signed by the manufacturer;
d) The authorized agency, as applicable, indicating compliance with the applicable specification of the portable tank; and
e) The records shall be retained in the owner's files or should be retained by the owner's authorized agent during the time that the portable tank is used. These records do not have to be maintained for DOT 56 and DOT 57 Specification tanks.

### S6.15 GENERAL REQUIREMENTS FOR DOT SPECIFICATION 106A AND 110A TANK CARS (TON TANKS)

All Specification DOT 106A and DOT 110A multi-unit ton tanks shall be cylindrical, circular in cross-section and shall have heads of an approved design, with all fittings, i.e., couplings, nozzles, etc., located in the heads of the tank.

### S6.15.1 SPECIAL PROVISIONS FOR TON TANKS

49 CFR, Section 179.300, has specific criteria for ton tanks that shall be met to satisfy DOT Specification 106A and 110A. The limitations are as follows:

a) Ton tanks shall have a water containing capacity of at least 0.68 tonne (1500 pounds), but in no case can the water containing capacity of the ton tank exceed 1.18 tonnes (2600 pounds);
b) Ton tanks shall not be insulated;
c) Thickness of plates for DOT Specifications 106A and 110A ton tanks shall be in accordance with NBIC Part 2, Table S6.15.1-a;
d) The maximum carbon content for carbon steel used in the fabrication of ton tanks shall not exceed 0.31%;
e) Permitted materials can be either an ASME, SA material, or an ASTM Material permitted by NBIC Part 2, Table S6.15.1-b;

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f) DOT Specification 106A ton tanks shall only use forged-welded heads, convex to pressure. The forged-welded heads shall be torispherical with an inside radius not greater than the inside diameter of the shell. The heads shall be one piece, hot formed in one heat so as to provide a straight flange at least 100 mm (4 inches) long. The heads must have a snug fit into the shell;

g) DOT Specification 110A ton tanks shall only use fusion-welded heads formed concave to pressure. The fusion-welded heads shall be an ellipsoid of 2:1 ratio and shall be of one piece, hot formed in one heat so as to provide a straight flange at least 38 mm (1-1/2 inches) long;

h) All longitudinal welded joints on DOT Specification 106A and DOT Specification 110A ton tanks shall be a fusion weld. DOT Specification 106A ton tank head-to-shell attachments shall be a forged-welded joint.[1] DOT Specification 110A ton tank head-to-shell attachments shall be a fusion weld;

i) Postweld heat treatment is required after welding for all DOT Specification 106A and Specification 110A ton tanks;

j) DOT Specification 106A and DOT Specification 110A ton tanks shall be of such a design as to afford maximum protection to any fitting or attachment to the head, including loading and unloading valves. The protection housing[5] shall not project beyond the end of the ton tanks and shall be securely fastened to the tank head;

k) If applicable, siphon pipes and their couplings on the inside of the ton tank's head and lugs on the outside of the tank head for attaching valve protection housing shall be fusion welded prior to performing postweld heat treatment;

l) DOT Specification 106A and DOT Specification 110A ton tanks are required to be equipped with one or more approved types of pressure relief devices. The devices shall be made out of metal and the pressure relief devices shall not be subject to rapid deterioration by the lading. The device's inlet fitting to the tank shall be a screw-type fitting and installed or attached directly into the ton tank's head or attached to the head by other approved methods. For thread connections, the following shall apply:

   1) The threaded connections for all openings shall be in compliance with the National Gas Taper Threads (NGT);

   2) Pressure relief devices shall be set for start-to-discharge, and rupture discs shall burst at a pressure not exceeding the pressure identified in NBIC Part 2, Table S6.15.1-a; and

m) Fusible plugs, if used, shall be required to relieve the pressure from the tank at a temperature not exceeding 79°C (175°F) and shall be vapor tight at a temperature not exceeding 54°C (130°F).

**TABLE S6.15.1-a**

THICKNESS OF PLATES AND SAFETY VALVE REQUIREMENTS

(OMITTED)

**TABLE S6.15.1-b**

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1 The forged-welded joint shall be thoroughly hammered or rolled to ensure a sound weld.

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ACCEPTABLE MATERIALS WITH ACCEPTABLE TENSILE STRENGTH AND ELONGATION REQUIREMENTS

(OMITTED)

### S6.15.2 VISUAL INSPECTION OF TON TANKS

Without any regard to any other periodic inspection and test requirements, a ton tank shall be visually inspected for evidence of any:

a) Defects in welds;

b) Abrasions;

c) Corrosion;

d) Cracks;

e) Dents;

f) Distortions; or

g) Any other conditions that might make the ton tank unsafe for transportation.

### S6.15.3 INSPECTION AND TESTS OF DOT SPECIFICATION 106A AND DOT SPECIFICATION 110A TON TANKS

Each ton tank shall be retested by subjecting the ton tank to a hydrostatic test in accordance with NBIC Part 2, Table S6.15.3. The hydrostatic test shall include an evaluation of the tank's permanent expansion. As a minimum, the hydrostatic test and the expansion procedure shall include:

a) The hydrostatic test pressure shall be maintained for a minimum of 30 seconds. This time period may be extended as long as necessary to secure complete expansion of the ton tank.

b) The pressure gage used for the hydrostatic test shall be accurate within 1% of the range of the pressure gage. The accuracy of the pressure gage shall be verified prior to performing the hydrostatic test.

c) The expansion test procedure shall include the following requirements:

   1) The expansion shall be recorded in cubic centimeters;

   2) Permanent volumetric expansion shall not exceed 10% of the total volumetric expansion at the test pressure; and

   3) The expansion gage shall be accurate within one percent of the hydrostatic test pressure.

d) The ton tank shall not show any signs of leakage or stress during the hydrostatic and expansion test.

e) The retest may be made at any time during the calendar year the retest falls due.

**TABLE S6.15.3**

TON TANK PERIODIC INSPECTION AND TEST FREQUENCIES

(OMITTED)

### S6.15.3.1 AIR TESTS

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a) All specification DOT 106A and DOT 110A ton tanks, in addition to the hydrostatic test shall be subjected to an air test at frequencies and pressures specified in NBIC Part 2, Table S6.15.3.

b) The air test shall be under positive control to ensure safety to all inspection and test personnel.

c) Any leakage observed will require the ton tank to be repaired and retested prior to placing the ton tank back into service.

### S6.15.3.2 PRESSURE RELIEF DEVICE TESTING

All pressure relief devices shall be retested by air or gas for the start-to-discharge and vapor tightness requirements at frequencies and pressures specified in NBIC Part 2, Table S6.15.3.

### 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; and

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).

### 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 or user, etc.

### S6.15.3.6 RECORD OF RETEST INSPECTION

The owner or the person performing the required pressure test and visual inspection is required to retain a written record of the results as long as the ton tank is in service. The written report shall identify the following:

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a) Date of the test and inspection;

b) DOT Specification Number of the ton tank;

c) Ton tank identification: registered symbol and serial number, date of manufacture, and ownership symbol;

d) Type of protective coating, i.e., painting, etc.;

e) Statement as to the need for refinishing or recoating the ton tank;

f) Conditions checked for:

   1) Leakage;

   2) Corrosion;

   3) Gouges;

   4) Dents or dings;

   5) Broken or damaged chimes, or protective rings;

   6) Fire damage;

   7) Internal conditions;

   8) Test pressure; and

   9) The written report shall also identify the results of the test:

      a. Disposition of the tank, i.e., returned to service, returned to the manufacturer for repair, or scrapped; and

      b. Identification of the person performing the retest or inspection.

### S6.15.4 STAMPING REQUIREMENTS OF DOT 106A AND DOT 110A TON TANKS

To identify compliance with CFR 179.300-1, each DOT 106A and DOT 110A ton tank shall be plainly and permanently stamped with letters and figures 10 mm (3/8 in.) high on valve end chime of the ton tank's head. The minimum requirements for the stamping are as follows:

a) DOT Specification Number;

b) Material and cladding material, if any. This information shall be stamped directly below the DOT Specification Number;

c) Owner's or builder's identifying symbol and serial number. This information shall be stamped directly below the material identification stamping. The owner's or builder's symbol shall be registered with the Bureau of Explosions (duplications are not authorized);

d) Inspector's official mark. This information shall be stamped directly below the owner's or builder's symbol;

e) Date of the original ton tank test (month and year). Provisions should be made that subsequent tests may easily be added thereto;

f) Water capacity of the ton tank in kilograms (pounds); and

g) A duplicate of the stamping that satisfies a) through f) should be used if the plate is made of brass and is permanently attached to the ton tank's head.

### S6.16 PRESSURE RELIEF DEVICES

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### 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 accumution 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.

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### 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 S6.15.3. 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; and

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

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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; and

   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.

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### 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.

### S6.17 DEFINITIONS

These definitions shall be used in conjunction with those of Section 9 of the NBIC. Where conflicts between the two arise, those listed below shall prevail.

**Approval** — A written authorization, including a competent authority approval from the Associate Administrator or other designated department official, to perform a function for which prior authorization by the Associate Administrator is required.

**Approval Agency** — An organization or a person designated by the DOT to certify packaging as having been designed, manufactured, tested, modified, marked, or maintained in compliance with applicable DOT regulations.

**Approved** — Approval issued or recognized by the department unless otherwise specifically indicated.

**Appurtenance** — Any attachment to a cargo tank that has no lading retention or containment function and provides no structural support to the cargo tank.

**Associate Administrator** — The Associate Administrator for Hazardous Materials Safety, Research, and Special Programs Administration.

**Atmospheric gas** — Air, nitrogen, oxygen, argon, krypton, neon, and xenon.

**Attachments** — Structural members means the suspension sub-frame, accident protection structures, external circumferential reinforcements, support framing, and kingpin sub-frame (upper coupling).

**Attachments, Light Weight** — Welded to a cargo tank wall such as a conduit clip, brake line clip, skirting structure, lamp mounting bracing, or placard holder.

**Authorized Inspector (AI)** — An inspector regularly employed by an ASME-accredited Authorized Inspection Agency (AIA) who has been qualified accordingto ASME developed criteria, to perform inspections under the rules of any Jurisdiction that has adopted the ASME Code.

**Baffle** — A nonliquid-tight transverse partition device that deflects, checks, or regulates fluid motion in a tank.

**Bar** — 1 BAR = 100 kPa (14.5 psi).

**Bottle** — An inner packaging having a neck of relatively smaller cross-section than the body and an opening capable of holding a closure for retention of the contents.

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**Bottom Shell** — That portion of a tank car surface, excluding the head ends of the tank car, that lies within two feet, measured circumferentially, of the bottom longitudinal center line of the tank car tank.

**Bulk Packaging** — A packaging other than the vessel or a barge, including a transport vehicle or freight container, in which hazardous materials are loaded with no intermediate form of containment and which has:

a) A maximum capacity greater than 450 l (119 gallons) as a receptacle for a liquid;

b) A maximum net mass greater than 400 kg (882 pounds) and a maximum capacity greater than 450 l (119 gallons) as a receptacle for a solid; or

c) A water capacity greater than 454 kg (1,000 pounds) as a receptacle for a gas.

**Bulkhead** — A liquid-tight transverse closure at the ends of or between (compartment) cargo tanks.

**Cargo Tank** — A bulk packaging which:

a) Is a tank intended primarily for the carriage of liquids or gases and includes appurtenances, reinforcements, fittings, and closures;

b) Is permanently attached to or forms a part of a motor vehicle, or is not permanently attached to a motor vehicle but which, by reason of its size, construction, or attachment to a motor vehicle is loaded or unloaded without being removed from the motor vehicle; and

c) Is not fabricated under a specification for cylinders, portable tanks, tank cars, or multi-unit tank car tanks.

**Cargo Tank Motor Vehicle** — A motor vehicle with one or more cargo tanks permanently attached to or forming an integral part of the motor vehicle.

**Carrier** — A person engaged in the transportation of passengers or property by:

a) Land or water, as a common, contract, or private carrier; or

b) Civil aircraft.

**Certified Individual** — An individual that is qualified and certified by a manufacturer accredited by ASME to construct Class 3 Section XII Transport Tanks.

**Combination Packaging** — A combination of packaging for transport purposes, consisting of one or more inner packaging secured in a non-bulk outer packaging. It does not include a composite packaging.

**Combustible Liquid** — Any liquid that does not meet the definition of any other hazard class specified in 173.129 of Title 49 and has a flash point above 60.5°C (141.5°F) and below 93°C (100°F).

**Competent Authority** — A national agency responsible under its national law for the control or regulation of a particular aspect of the transportation of hazardous materials. In the United States, the Associate Administrator of the US Department of Transportation is the Competent Authority.

**Composite Packaging** — A packaging consisting of an outer package and an inner receptacle so constructed that the inner receptacle and the outer package are integral. Once assembled, it remains an integrated single unit. It is filled, stored, shipped, and emptied as such.

**Compressed Gas in Solution** — A non-liquefied compressed gas that is dissolved in a solvent.

**Constructed and Certified in Accordance with the ASME Code** — A cargo tank that is constructed and stamped in accordance with the ASME Code and is inspected and certified by an Authorized Inspector, Qualified Inspector, or a Certified Individual.

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**Corrosive Material** — A liquid or solid that causes full thickness destruction of human skin at the site of contact within a specified period of time. A liquid that has a severe corrosion rate on steel or aluminum based on the criteria in 173.173(c) (3) of Title 49 is also a corrosive material.

**Cryogenic Liquid** — A refrigerated liquefied gas having a boiling point colder than -90°C (-130°F) at 101.3 kPa (14.7 psia) absolute.

**Design Certification** — That each cargo tank or cargo tank motor vehicle design type, including its required accident damage protection device, must be certified to conform to the specification requirements by a Design Certifying Engineer who is registered with the department. An accident damage protection device is a rear-end protection, overturn protection, or piping protection.

**Design Certifying Engineer** — A person registerd with the department in accordance with Subpart F of Part 107 of 49 CFR who has the knowledge and ability to perform stress analysis of pressure vessels and otherwise determine whether a cargo tank design and construction meets the applicable DOT specification. In addition, Design Certifiying Engineer means a person who meets, at a minimum, any one of the following:

a) Has an engineering degree and one year of work experience in cargo tank structural or mechanical design;

b) Is currently registered as a professional engineer by the appropriate authority of a state of the United States or a province of Canada; or

c) Has at least three years experience in performing the duties of a Design Certifying Engineer by September 1, 1991, and was registered with the department by December 31, 1995.

**Design Type** — One or more cargo tanks that are made:

a) To the same specification;

b) By the same manufacturer;

c) To the same engineering drawings and calculations, except for minor variations in piping that do not affect the lading retention capabilities of the cargo tank;

d) Of the same materials of constructions;

e) To the same cross-sectional dimensions;

f) To a length varying by no more than 5 percent;

g) With the volume varying by no more than 5 percent (due to the change in length only); and

h) For the purposes of 178.338 of Title 49 only, with the same insulation system.

**DOT or Department** — US Department of Transportation.

**Elevated Temperatures Material** — A material which, when offered for transportation or transported in a bulk packaging:

a) Is in a liquid phase and at a temperature at or above 100°C (212°F);

b) Is in a liquid phase with a flash point at or above 37.8°C (100°F) that is intentionally heated and offered for transportation, or transported at or above the flash point; or

c) Is in a solid phase and at a temperature at or above 240°C (464°F).

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**Extreme Dynamic Loadings** — The maximum loading of a cargo tank motor vehicle may experience during its expected life, excluding accident loadings resulting from an accident, such as overturn or collision.

**Flammable Gas** — Any material that is a gas at 20°C (68°F) or less and 101.3 kPa (14.7 psia) of pressure [a material that has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia)] which:

a) Is ignitable at 101.3kPa (14.7 psia) when in a mixtue of 13% or less by volume with air; or

b) Has a flammable range at 101.3kPa (14.7 psia) with air of at least 12% regardless of the lower limit. Except for aerosols, the limits specified in paragraphs 1) and 2) shall be determined at 101.3kPa (14.7 psia) of pressure and a temperature of 20°C (68°F) in accordance with the ASTM E681-85, *Standard Test Method for Concentration Limits of Flammability of Chemicals*, or other equivalent method approved by the Associate Administrator, Hazardous Material Safety.

**Gas** — A material that has a vapor pressure greater than 300 kPa (43.5 psia) at 50°C (122°F) or is completely gaseous at 20°C (68°F) at a standard pressure of 101.3 kPa (14.7 psia).

**Gross Weight or Gross** — The weight of a packaging plus the weight of its contents.

**Hazardous Class** — The category of hazard assigned to a hazardous material under the definitional criteria of Part 173 of Title 49 and the provisions of the 172.101 Table. A material should meet the defining criteria for more than one hazard class but is assigned to only one hazard class.

**Hazardous Material** — A substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce and has been designated as hazardous under section 5103 of Federal Hazardous Law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Material Table (49 CFR 172.101), and materials that meet the defining criteria for hazard classes and divisions of 173 of subchapter C of 171.8 of Title 49.

**Hazardous Zones** — One of four levels of hazard (Hazard Zones A through D) as assigned to gases, as specified in 173.116(a) of Title 49, and one of two levels of hazard (Hazard Zones A and B) assigned to liquids that are poisonous by inhalation as specified in 173.133(a) of Title 49. A hazard zone is based on the LC 50 value for acute inhalation toxicity of gases and vapors.

**High Pressure Liquefied Gas** — A gas with a critical temperature between -50°C (-58°F) and + 65°C (149°F).

**Inner Packaging** — A packaging for which an outer packaging is required for transport. It does not include the inner receptacle of a composite packaging.

**Inner Receptacle** — A receptacle that requires an outer packaging in order to perform its containment function. The inner receptacle should be an inner packaging of a combination packaging or the inner receptacle of a composite packaging.

**Inspection Pressure** — The pressure used to determine leak tightness of the cargo tank when testing with pneumatic or hydrostatic pressure.

**Lading** — The hazardous material contained in the cargo tank.

**Liquefied Compressed Gas** — a gas which, when packaged under pressure for transportation, is partially liquid at temperatures above -50°C (-58°F).

**Liquid** — A material, other than an elevated temperature material, with a melting point or initial melting point of 20°C (68°F) or lower at a standard pressure of 101.3 kPa (14.7 psig). Liquid Phase means a

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material that meets the definition of liquid when evaluated at the higher of the temperature at which it is offered for transportation or at which it is transported, not at the 37.8°C (100°F) temperature specified in ASTM D 4359-84.

**Low-Pressure Liquefied Gas** — A gas with a critical temperature above + 65°C (149°F).

**Manufacturer** — Any person engaged in the manufacture of a DOT specification cargo tank, cargo tank motor vehicle, or cargo tank equipment that forms part of the cargo tank wall. This term includes attaching a cargo tank to a motor vehicle or to a motor vehicle suspension component that involves welding on a cargo tank wall. A manufacturer must register with the department in accordance Subpart F of Part 107 in Subpart A of 49 CFR.

**Marking** — A descriptive name, identification number, instructions, cautions, weight, specification, or UN marks, or combinations thereof, required by Title 49 on outer packaging or hazardous materials.

**Mode** — Any of the following transportation methods: rail, highway, air, or water.

**Modification** — Any change to the original design and construction of a cargo tank or a cargo tank motor vehicle that affects its structural integrity or lading retention capability including changes to equipment certified as part of an emergency discharge control system. Any modification that involves welding on the cargo tank wall must also meet all requirements for “Repair” as defined in this section. Excluded from this category are the following:

a) A change to motor vehicle equipment such as lights, truck, or tractor power train components, steering, and brake systems, suspension parts, and changes to appurtenances, such as fender attachments, lighting brackets, ladder brackets; and

b) Replacement of components such as valves, vents, and fittings with a component of a similar design and of the same size.

**Motor Vehicle** -— A vehicle, machine, tractor, trailer, or semi-trailer, or any combination thereof, propelled or drawn by mechanical power and used upon the highways in the transportation of passengers or property. It does not include a vehicle operated exclusively on a rail or rails or a trolley bus operated by electric power derived from a fixed overhead wire, furnishing local passenger transportation similar to street-railway service.

**Multi-Specification Cargo Tank Motor Vehicle** -— A cargo tank with two or more cargo tanks fabricated to more than one cargo tank specification.

**Non-Liquefied Compressed Gas** -— When packaged under pressure for transportation is entirely gaseous at -50°C (-58°F) with a critical temperature less than or equal to -50°C (-58°F).

**Normal Operating Loading** -— A cargo tank motor vehicle equipped with two or more cargo tanks fabricated to more than one cargo tank specification.

**Operator** — A person who controls the use of aircraft, vessel, or vehicle.

**Outer Packaging** — The outermost enclosure of a composite or combination packaging together with any absorbent material, cushioning, and any other components necessary to contain and protect inner receptacles or inner packaging.

**Owner** -— The person who owns a cargo tank motor vehicle used for the transportation of hazardous materials, or that person’s authorized agent.

**Packaging** — A receptacle and any other components or materials necessary for the receptacle to perform its containment function in conformance with the minimum packing requirements of Title 49.

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**Packing Group** — A grouping according to the degree of danger present by hazardous materials. Packing Group I indicates great danger; Packing Group II indicates medium danger; Packing Group III indicates minor danger.

**Person** — An individual, firm, co-partnership, corporation, company, association, or joint-stock (including any trustee, receiver, assignee, or similar representative); or any government or Indian tribe (or an agency or instrumentality of any government or Indian tribe) that transports hazardous material to further a commercial enterprise or offers a hazardous material for transportation in commerce.

**Poisonous Gas** — A material that is a gas at 20°C (68°F) or less and a pressure of 101.3 kPa (14.7 psia) a material that has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia) and which:

a) Is known to be so toxic to humans as to pose a hazard to health during transportation; or

b) In the absence of adequate data on human toxicity, is presumed to be toxic to humans because when tested on laboratory animals it has an LC50.

**Poisonous Material** — A material, other than a gas, which is known to be so toxic to humans as to afford a hazard to health during transportation, or which in the absence of adequate data on human toxicity.

**Portable Tanks** — A bulk packaging (except cylinders having a water capacity of 454 kg (1,000 lb) or less) designated primarily to be loaded onto, or on, or temporarily attached to, a transport vehicle or ship and equipped with skids, mountings, or accessories to facilitate handling of the tank by mechanical means. It does not include a cargo tank, tank car, multi-unit tank car tanks, or trailers carrying 3AX, 3AAX, or 3T cylinders.

**psi** — Pounds per square inch.

**psia** — Pounds per square inch absolute.

**psig** — Pounds per square inch gage.

**Qualified Inspector** — An Inspector regularly employed by an ASME Qualified Inspection Organization (QIO) who has been qualified to ASME developed criteria by a written examination, to perfom inspections under the rules of any jurisdiction that has adopted the ASME Code. The QI shall not be in the employ of the manufacturer. See ASME XII, TG-410.

**Rail Car** — A car designed to carry freight or nonpassenger personnel by rail, and includes a box car, flat car, gondola car, hopper car, tank car, and occupied caboose.

**Rebarrelling** — Replacing more than 50% of the combined shell and head material of a cargo tank.

**Receptacle** — A containment vessel for receiving and holding materials, including any means of closing.

**Registered Inspector (RI)** — A person registered with the department in accordance with Subpart F of Part 107 of 49 CFR who has the knowledge and ability to determine whether a cargo tank conforms with the applicable DOT specification. In addition, Registered Inspector means a person who meets, at a minimum, any one of the following:

a) Has an engineering degree and one year of work experience;

b) Has an associate degree in engineering and two years of work experience;

c) Has a high school diploma or General Equivalency Diploma and three years work experience; or

d) Has at least three years experience performing the duties of a Registered Inspector by September 1, 1991, and was registered with the DOT by December 31, 1995.

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**Repair** — Any welding on a cargo tank wall done to return a cargo tank or a cargo tank motor vehicle to its orginial design and construction specification, or to a condition prescribed for a later equivalent specification in effect at the time of the repair. Excluded from this category are the following:

a) A change to motor vehicle equipment such as lights, truck, or tractor power train components. Steering and brake systems, suspension parts, and changes to appurtenances, such as fender attachments, lighting brackets, ladder brackets;

b) Replacement of components such as valves, vents, and fittings with a component of a similar design and of the same size; and

c) Replacement of an appurtenance by welding to a mounting pad.

**Replacement of a Barrel** — To replace the existing tank on a motor vehicle chassis with an unused (new) tank.

**SCF (standard cubic foot)** — One cubic foot of gas measured at 16°C (60°F) and 10 kPa (14.7 psi).

**Single Packaging** — A nonbulk packaging other than a combination packaging.

**Solid** — A material that is not a gas or liquid.

**Solution** — Any homogenous liquid mixture of two or more chemical compounds or elements that will not undergo any segregation under conditions normal to transportation.

**Specification Packaging** — A packaging conforming to one of the specifications or standards for packaging in Part 178 or Part 179 of Title 49.

**Strong Outside Container** — The outermost enclosure that provides protection against the unintentional release of its contents under conditions normally incident to transportation.

**Tanks** — A container, consisting of a shell and heads that form the pressure vessel having opening designed to accept pressure tight fittings or closure, excluding any appurtenances, reinforcements, fittings, or closures.

**Test Pressure** — The pressure to which a tank is subjected to determine structural integrity.

**Top Shell** — The tank car surface, excluding the head ends and bottom shell of the tank car.

**Transport Vehicle** — A cargo-car-carrying vehicle such as an automobile, van, tractor, truck, semi trailer, tank car, or rail car used for the transportation of cargo by any mode. Each cargo-carrying body (trailer, rail car, etc.) is a separate transport vehicle.

**UFC** — Uniform Freight Classification.

**UN** — United Nations.

**UN Portable Tank** — An intermodal tank having a capacity of more than 450 l (119 gal.). It includes a shell fitted with service equipment and structural equipment, including stabilizing members external to the shell and skids, mountings, or accessories to facilitate mechanical handling. A UN portable tank must be capable of being filled and discharged without the removal of its structural equipment and must be capable of being lifted when full. Cargo tanks, rail tank car tanks, nonmetallic tanks, nonspecification tanks, bulk bins, and IBC's and packaging made to cylinder specifications are not UN portable tanks.

**UN Recommendation** — The UN Recommendations on the Transport of Dangerous Goods.

**UN Standard Packaging** — A conforming to standards in the UN Recommendations.

**Vessel** — Includes every description of watercraft, used or capable of being used, as a means of transportation on the water.

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**Viscous Liquid** — A liquid material that has a measured viscosity in excess of 2,500 centistokes at 25°C (77°F), when determined in accordance with the procedures specified in ASTM Method D 445-72 "Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)," or ASTM Method D 1200-70 "Viscosity of Paints, Varnishes, and Lacquers by Ford Viscosity Cup."

### S6.18 TABLES AND FIGURES

a) TABLE S6.13, Periodic Inspections and Tests

b) TABLE S6.13-a, Inservice Minimum Thickness for Steel and Steel Alloys

c) TABLE S6.13-b, Inservice Minimum Thickness for Aluminum and Aluminum Alloys

d) TABLE S6.13.4, Periodic Inspections and Tests

e) TABLE S6.13.6, Pressure Test Requirements

f) TABLE 6.13.11.2-a, Minimum Thickness for Heads

g) TABLE S6.13.11.2-b, Minimum Thickness for Shells, in.

h) TABLE S6.13.11.3-a, Minimum Thickness for Heads, (DOT 407) mm

i) TABLE S6.13.11.3-b, Minimum Thickness for Shells, (DOT407) mm

j) TABLE S6.13.11.4 M-a, Minimum Thickness for Heads (DOT 412)

k) TABLE S6.13.11.4-b, Minimum Thickness for Heads (DOT 412)

l) TABLE S6.13.11.4 M-b, Minimum Thickness for Heads (DOT 412)

m) TABLE S6.14, Inspection Intervals

n) TABLE S6.14.6, Pressure Testing Requirements

o) TABLE S6.14.6.4, "T" Codes

p) TABLE S6.15.1-a, Thickness of Plates and Safety Valve Requirements

q) TABLE S6.15.1b, Acceptable Materials with Acceptable Tensile Strength and Elongation Requirements

r) TABLE S6.15.3, Ton Tank Periodic Inspection and Test Frequencies

File Number: NB11-0204A
Task Group Mike Wahl (PM) J. Larson, F. Johnson, R. Underwood
Subject: Part 2, Supplement 2 & Part 2, Section 9
Pages: See Below
Proposal: Several areas in the repair section for stayed areas need updating for NDE examination.

1. In Part2, Supplement 2, S2.4.4.1 (page 115) add the following text after existing paragraph. These are the same words as found in NBIC Part 3.

**S2.4.4.1 NONDESTRUCTIVE EXAMINATION METHODS**

There are a variety of nondestructive examination methods that may be employed to assess the condition of historical boilers. Skill, experience, and integrity of personnel performing examinations are essential to obtaining meaningful results. Generally, some form of surface preparation will be required prior to the use of examination methods.

The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction for the pressure-retaining item. Weld repairs and alterations shall be subjected to the same nondestructive examination requirements as the original welds. Where this is not possible or practicable, alternative NDE methods acceptable to the Inspector and the Jurisdiction where the pressure-retaining item is installed, where required, may be used.

2. In Part2, Supplement 2, Section 9 (page 322) add definition for volumetric to Glossary of Terms. Definition used is from ASME Section 1 PW-11.2.

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

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

***INSERT HERE***

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

Volumetric NDE- A method capable of detecting imperfections that may be located anywhere within the examined volume. Volumetric NDE is limited to radiographic (RT) and ultrasonic (UT) examination methods.

**Supplement SX**
**Inspector Review Guidelines for Finite Element Analysis (FEA)**

Revision date: July 15, 2015 ~~January 7, 2015~~ ~~July 14, 2014~~

NB 13-1301 FEA Task Group

PART 2, SECTION 4

INSPECTION – EXAMINATIONS, TEST METHODS, AND EVALUATIONS

4.6 QUANTITATIVE ENGINEERING ASSESSEMENTS INCLUDING FINITE ELEMENT ANALYSIS (FEA)

4.6.1 CALCULATIONS

This Section describes **criteria to be considered** ~~review~~ by the Inspector **in the review** of calculations prior to acceptance of quantitative engineering assessments per industry standards (such as fitness-for-service) for in-service equipment, ~~and~~ repairs and alterations.

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4.6.~~1~~2 ENGINEER EXPERIENCE

For quantitative engineering **used ~~for~~in** assessments, repairs and alterations, all calculations shall be completed prior to the start of any physical work or fitness-for-service acceptance. All design calculations shall be completed by an engineer (as designated by the manufacturer, R-stamp organization, owner or user) experienced in the design portion of the ~~standard~~code used for construction of the item. Refer to NBIC Part 3, ~~Sections~~ Paragraphs 3.2.4, 3.2.5, and 3.2.6 for design and calculations requirements for repairs and alterations.

**Comment [ss1]:** Consider adding "used for"

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4.6.3~~1.2~~ FINITE ELEMENT ANALYSIS (FEA) ENGINEER EXPERIENCE

Finite Element Analysis (FEA) may be used to support quantitative engineering assessments or design for repairs and alterations as follows.

a) When quantitative engineering analysis is used to demonstrate the structural integrity of an in-service component containing a flaw or damage.

b) Where the configuration is not covered by the available rules in the ~~standard~~code used for construction.

c) When there are complicated loading conditions or when a thermal analysis is required.

Because the FEA method requires more extensive knowledge of, and experience with, pressure equipment design and the FEA software package involved, the analysis and report submitted to the Inspector for review shall be completed and certified by a Professional Engineer (PE) licensed and registered as required by the manufacturer, R-stamp organization, owner or user and the jurisdiction if applicable.

The Inspector may require an initial explanation of why the FEA is applicable before the analysis is performed. The I~~i~~nspector ~~shall~~ should verify ~~that~~ the validity of the FEA report:~~,~~ that it has been certified by a licensed and registered Professional Engineer:~~,~~ and that it is available for review by the manufacturer, R-stamp organization, owner or user and the jurisdiction. Owing to the specialized nature of FEA, the report must be clear and concise. Further guidelines are found in NBIC Part 2 Sx. INSPECTOR REVIEW GUIDELINES FOR FINETE ELEMENT ANALYSIS (FEA).

**Supplement SX**
**Inspector Review Guidelines for Finite Element Analysis (FEA)**

Revision date: July 15, 2015 ~~January 7, 2015~~ ~~July 14, 2014~~

NB 13-1301 FEA Task Group

## SX.1 SCOPE

This Supplement provides guidelines to be followed when a finite element analysis (FEA) is submitted as part of a quantitative engineering assessment for in-service equipment, or a repair or alteration ~~package~~ for a pressure retaining item for review by the Inspector, and the ~~local~~ jurisdiction if required. Refer to NBIC Part 2, ~~Section~~ Paragraph 4.6.

Comment [ss2]: Suggest deleting "Local"

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## SX.2 TERMINOLOGY

a) Finite element analysis (FEA) as applied in engineering is a computational tool for performing engineering analysis. It includes the use of mesh generation techniques for dividing a complex problem into small elements for simulation, as well as the use of software program coded with finite element method algorithms.

b) Quantitative engineering assessment refers to methodologies whereby flaws contained within a pressure retaining item are assessed in order to determine the adequacy of the structure for continued service without failure. The result of the assessment provides guidance on structural integrity, inspection methods and intervals, and shapes decisions to operate, repair, monitor or replace the structure/pressure retaining item.

Comment [ss3]: Should this be PRI Pressure retaining Item or at least mention it as part of the Structure.

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## SX.3 CHECKLIST

The following ~~presents~~is a ~~thought-provoking~~ checklist of areas to consider and discuss with the FEA practitioner engineer performing the analysis and may be used to familiarize the Inspector with the FEA approach and method~~-~~ as part of validating the FEA report.~~and aid in preparing an analysis specification~~.

### SX.3.1 PRESSURE RETAINING ITEM INFORMATION

a) Vessel type, size, region/section and component(s) under FEA consideration
b) Materials of construction and materials properties (including those as a function of temperature)
c) Original code of construction
d) Repair and alteration history
e) Known extent of degradation and associated damage mechanisms ( if available/any )
f) Operating conditions (temperature and heat flux, pressure including vacuum, cyclical service, etc.)
g) Other loads (seismic, earthquake, etc.)

### SX.3.2 SCOPE OF THE FEA

a) The objective of the FEA analysis (to be used to support quantitative engineering analysis, repair, alteration, etc.)
b) The justification for use of FEA rather than rules in the code of construction. Refer to NBIC PART 2 4.6.1.2

### SX.3.3 FEA SOFTWARE AND MODELLING

a) The software version to be used for the analysis

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b) The type of analysis (~~i.e~~e.g.,. stress, static, dynamic, elastic, plastic, small or large deformations, heat transfer, etc.)
c) The modelling approach that will be used (e.g., solids, shells, simplification of geometry, mesh generation, solver technique, division into elements and element size, boundary restraints, etc.)
d) The geometries to be modeled (e.g., non-corroded, corroded and future corrosion allowance, bulge, dent, groove, crack, etc.)

## SX.4 REPORT REQUIREMENTS

The following checklist of areas to consider and discuss with the FEA practitioner engineer completing the certified report may be used to define what should be included in the report. An alternate useful reference is the following presentation: Proceedings of the ASME 2014 Pressure Vessels & Piping Conference, PVP2014-28958, Writing and Reviewing FEA Reports Supporting ASME Section VIII, Division 1 and 2 Designs – Practical Considerations and Recommended Good Practice.

### SX.4.1 SECTIONS TO BE INCLUDED IN THE REPORT

a) An introduction and/or executive summary
b) A description of the model
c) A presentation of the results
d) An analysis of the results and conclusions

### SX.4.2 LISTING OF INFORMATION THAT MAY BE INCLUDED IN THE FEA REPORT

#### SX.4.2.1 ANALYSIS METHOD

a) State the scope of the FEA and the justification for using it; give the program and version
b) Note whether or not the problem is linear.
c) Give an overview of how the analysis is conducted, for example:
    1) Calculations are done to simplify radiation boundary conditions so that the problem is linear.
    2) Thermal loads are applied to the FEA model and temperatures generated
    3) Temperatures at select locations are compared to the radiation simplification calculations
    4) Mechanical loads are added
    5) Stresses are generated
    6) Stress classification results are generated
    7) Results are verified by comparison to something (e.g., ~~for example~~ BPVVC Section VIII Division 2 Part 5 Design by Analysis)
    8) Results are compared to the construction code
d) Note if any of the geometry is not included in the stress model

#### SX.4.2.2 STRUCTURAL DESCRIPTION / MESH / STRESS CLASSIFICATION LINE LOCATIONS

a) Reference the geometry source or show a drawing or sketch with dimensions that relate the model geometry to the actual structure in the FEA analysis
b) Name all the parts, usually best done with a sketch
c) Note any symmetry
d) Give the type of element used for each component
e) Describe the mesh type (e.g., h, p , 2D, 3D), shape, and order ($2^{nd}$ order or above) and show plots of the mesh

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f) Show the top and bottom of shells or beam orientations and indicate if they are thick or thin elements
g) Show the cross sections with stress recovery points for beams
h) Describe any boundary conditions such as supports, restraints, loads, and forces as well as the method of restraining the model to prevent rigid body motion.
i) Describe parts that are connected by node sharing or contact and tell whether the connections are thermal, mechanical, or both
j) Give the stress classification line locations (usually best done with a sketch)

### SX-4.2.3 Material Properties

a) List properties used for every component, references to other sources are not sufficient. They must be explicitly listed. Show the values of any properties modified for the sake of the model. For example, the model density is often modeled.
b) Show calculations for properties that are modified for the sake of the model.
c) Discuss any given artificial properties for the analysis (~~for example~~e.g., the modulus was set to 1000 psi so that the component would not influence the mechanical model. Or, above 1200°F the properties are assumed to be constant).
d) Reference the source for all material properties.

### SX-4.2.4 Restraints and loads

a) Show all restraints and loads
b) Discuss the justification for all restraints and loads, and give calculations if they were done to determine the restraints or loads (~~for example~~e.g., end pressure).
c) Discuss any contact regions.
d) Give initial or default temperatures.

### SX-4.2.5 Validation

a) Describe how the model was validated.
b) Describe the accuracy of the model digitization either by use of convergence or to the accuracy of previous successful models.

### SX-4,2,6 Results

For each model the following should be presented

a) Give temperature plots.
b) Give deformed geometry plots
c) Give stress classification line results and comparison to Code allowable.
d) Relate the results of the model to the defined allowable stresses of the original Code of construction.
e) Refer to ASME Section VIII, Division 2, Part 2, ~~Section~~ Paragraph 2.3.3.1(c)(2) Documentation requirements of design-by-analysis calculations in Part 5.

### SX-4.2.7 Reference Documents Used:

Typical reference documents could include:

a) ASME BPVC II-D
b) ASME BPVC Section VIII Division 1
c) ASME BPVC Section VIII Division 2

d) ASME/API-579
e) Drawings
f) User Design Specification (UDS)
~~g)~~ ASCE ~~7-05~~

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**Supplement SX**
**Inspector Review Guidelines for Finite Element Analysis (FEA)**

Revision date: July 1, 2014

NB FEA Task Group

## NB 13-1302

## 2.3.6.9 Inspection of Static Vacuum Insulated Cryogenic Vessels

a) This section covers the periodic inspection and testing of static vacuum insulated cryogenic pressure vessels used in the storage of cryogenic liquefied gases. Owner-users should inspect static cryogenic vacuum-insulated storage tanks to ensure that the equipment is in safe ~~serviceable~~ operable condition.

b) A static vacuum insulated cryogenic vessel is a vessel that is thermally insulated for use with one or more cryogenic ~~fluids~~liquid, consisting of: 1) an inner vessel holding the cryogenic ~~fluid~~liquid, 2) an outer jacket that serves as an air tight enclosure which supports the inner vessel, holds the insulation and enables the vacuum to be established, and 3) the associated piping system.

c) Check that the following conditions or safeguards are adequate prior to doing a periodic external inspection of the vessel:

1) Surface water drainage is directed away from the location of installation. Proximity of storage tank to sewer inlets shall comply with local fire jurisdictional requirements.
2) Protective measures are in place for the vessels and components from mechanical impact damage (such as barricades, safe set-back distances, poles and bars.
3) Any fire proofing for external supports is in acceptable condition. Any gas from pressure relief devices or vents is discharged to a safe point of discharge. Relief valve discharges are not aimed directly at external supports or the outer jacket wall.
4) There is sufficient ventilation to avoid the formation of explosive gas-air mixtures or an oxygen deficient/enriched atmosphere.

d) A periodic external visual inspection of the vessel and equipment should be made to ensure that the vacuum between the inner vessel and outer jacket has not been compromised. If the vessel has lost vacuum, the owner-user of the cryogenic storage vessel shall immediately investigate the cause. Any loss of vacuum should be investigated as this could affect the integrity of the vessel and support system. If the cause is due to an internal pipe failure as evidenced by vapor escaping from the vacuum relief device, the pressure should be immediately reduced to atmospheric pressure followed by emptying of all of the cryogenic liquid in a safe manner.

e) External visual inspections are possible at all accessible parts of the vessel and piping. The following inspections should be included as part of the periodic external visual inspection.

1) A functional check of essential and critical valves and their operability.
2) Leak tests under operating conditions of the vessel and piping.
3) Assessing if there have been any significant changes in the operational conditions of the installation and its surroundings.
4) Check that there is no excessive out-of-roundness or deformation of the outer jacket
5) Check all nozzles for corrosion or damage.
6) Check the vessel supports for structural damage.
7) Check that any attachments to the outer jacket are not damaged or affecting the vessel condition.
8) Verification of periodic testing and repair (or replacement) of the pressure relief device(s)
9) Check that the pressure relief device(s) are not continually venting. PRD's may vent periodically under normal circumstances but should be reported for maintenance testing and repair if venting continually.
10) Checking the condition of the outer jacket, piping and accessories

11) Check for abnormal frosting on outer jacket surface. Under normal usage, frost and ice will develop around pipes, valves, controls and vaporizers
12) Inspect the outer skin of the outer jacket for any new or abnormal signs of excessive frosting.
13) Confirm that the duplicate ASME nameplate is attached to the outer jacket, tank leg or other permanent location affixed to the vessel.

## Update Current Glossary

**Cryogenic** ~~**Liquid**~~ ~~— A refrigerated liquefied gas having a boiling point colder than -90°C (-130°F) at 101.3 kPa (14.7 psia) absolute.~~ Products stored at or below -238 °F (-150°C)

## 1.2- Administration

Add to end of Part 2, Section 1.2

Unless otherwise specifically required by the jurisdiction, the duties of the Inspector do not include inspection to other standards and requirements (e.g., environmental, construction, electrical, operational, undefined industry standards, etc) for which other regulatory agencies have authority and responsibility to oversee.



**Proposed New Supplement for Part 2**

**Inspection of Biomass Fired Boiler Installations (Section 6, Supplement 9)**

## S9.1 - Scope

a) This supplement provides ~~rules~~ guidelines for continued inspection of biomass fired boilers and the additional equipment utilized in these installations. In this context Biomass is intended to mean various types of ~~wood~~ wastes, or ~~wood~~ byproducts.

organic fiber organic fiber

b) Many of the requirements of the earlier Sections of Part 2 are common to all boiler installations irrespective of the fuel being fired; therefore this supplement will address the differences that occur when solid fuels, such as Biomass, are being used. Thus the primary thrust of this section will be directed toward the inspection of the fuel handling and distribution systems, and the impact these systems may have on the pressure vessel itself.

## S9.2 – Assessment of Installation

including

a) A general assessment of the complete installation shall be undertaken, ~~in terms of~~ observable results of operating and maintenance practices. ~~Indicators include the general boiler room cleanliness~~, ~~for example significant quantities of fuel particles (dust) should not be apparent in the boiler room,~~ including rafters and beams.

The assessment includes the general cleanliness of the boiler room,

b) The combustion air inlet shall be free of any debris or dust particle build up, and where moveable louvered intakes exist, the actuating mechanisms shall be clean and operate freely. Corrective action is required when non-compliance is noted.

c) The flue gas venting system shall be checked for tightness, with no observable signs of leakage. Corrective action is required if leakage is noted.

d) The intakes of the various fans or blowers shall be free of fuel particle build up or signs of other debris. Corrective action in terms of cleaning is required when discrepancies are noted.

e) The fuel metering equipment and the fuel transportation system shall be free from signs of particulate or dust leakage. Corrective action in terms of cleaning and repair work is required as necessary.

f) Electrical equipment and controls shall be properly protected from the ingress of dust, by ensuring that all cover plates are properly installed and all panel doors are intact, operable and closed.

g) Verify that all guards for rotating equipment (shafts, bearings, drives) are correctly installed and fan inlet screens are in place.

h) On the boiler, generally check for signs of potential problems, including but not limited to;

- Water leaks
- Ash Leaks
- Condition of insulation and lagging.
- Casing leaks or cracks

do not have a

remove "and" and create new bullet points for each.

- ~~Check a~~All safety valves ~~for~~ bypass ~~and~~ ensure the inspection plugs are capped ~~and~~ the drain lines are piped ~~away from traffic areas~~. to a safe point of discharge
- Missing or misaligned pieces or parts ~~(ie~~ e.g., twisted, misaligned or bound up buck stays, missing linkage bolting).
- Condition of support systems
- Provision of “Danger” or “Caution” signs
- Excess vibration
- Excess noise.

i) Verify that the Owner/User has established function test, inspection, requirements, maintenance and testing of all controls and safety devices in accordance with the manufacturer’s recommendations. Verify that these activities are conducted at assigned intervals in accordance with written procedures, non-conformances which impact continued safe operation of the boiler are corrected and the results are properly documented. These activities shall be at a frequency recommended by the manufacturer, or frequency required by the jurisdiction. Where no frequencies are recommended, or prescribed, the activity should be conducted at least annually

## S9.3 – Boiler Room Cleanliness

a) While boiler room cleanliness is of primary importance in all boiler rooms it is of particular importance in biomass fired boiler rooms. Biomass can contain fine particulate, which if allowed to leak from the transportation system into the surrounding boiler room, will eventually be drawn into fans, resulting in the possibility of combustion air systems becoming plugged.

b) Boiler rooms containing quantities of fine dusts are susceptible to fire or explosion, again emphasizing the need for high standards of cleanliness.

## S9.4 – Emission Control Requirements

a) Emission control is dependent upon the fuel being fired and the emission requirements prevailing at the location of the boiler installation. As such they are a part of the initial design and installation process, and apart from ensuring that they are kept in top working condition, so that emission requirements are not violated; there is little that can be done from the inspector's point of view.

b) When Continuous Emissions Monitors (CEM's) are in use, they should be demonstrated to be functioning properly and have a current calibration sticker.

c) Delta-P pressure gauges which measure the pressure drop across the various elements of the emission control system should all be functioning correctly.

d) There should be no sign of erosion caused by entrained particulate matter, in any part of the breaching, ductwork, stack or the individual emission control elements.

e) On systems in which the emissions control system incorporates a baghouse, appropriate fire detection and suppression systems shall be incorporated and functioning properly.

## 2.3.6.6 INSPECTION OF WIRE WOUND PRESSURE VESSELS

(a) This section provides guidelines for inspection of wire wound pressure vessels typically designed for 10,000 psi or greater service. The scope of inspection of these vessels should include components affected by repeated opening and closing, such as the frame, yolk and cylinder inner diameter surface, or alignment of the yolk with the cylinder, lack of maintenance and a check for inoperable or bypassed safety and warning devices.

(b) These vessels consist of four parts, a wire wound cylinder, two end closures and a frame to retain the closures in the cylinder. The wire is one continuous piece and is wound in tension. On the cylinder, the wire can only carry circumferential or radial loading. The cylinder is typically not of sufficient thickness to carry axial load which requires the end closures have no threads or retaining grooves and requires a frame to retain the pressure vessel axial load imposed on the closures. The purpose for this design is to minimize weight of the containment cylinder using thinner wall materials and using external wound wire to induce a compressive preload. This design also provides increased resistance to damage from fatigue loading.

Note that some vessels may be monoblock cylinders (no winding) with wire wound frame and some vessels may be wire wound cylinder with a forged or welded plate frame (not wire wound). Use of a frame to retain the end closures removes the sharp transitions in shape (threads or grooves) associated with monoblock cylinder failures. The design of high pressure vessels is typically based on fatigue life criteria. The majority of operating wire wound vessels in North America today were fabricated under the rules of ASME BPVC Section VIII Division 3, Alternative Rules for Construction of High Pressure Vessels. Some inservice vessels may have been constructed the ASME BPVC Section VIII Division 1 or Division 2 rules, and others installed as “State Specials” that still require fatigue life analysis to determine a safe operating life. The primary failure mode is fatigue cracking. Early detection of any damage to the cylinder, closures or frame is essential to avoid catastrophic failure

High pressure design requires use of high strength materials, which have relatively low ductility. The material thickness required for reasonable fatigue life is greatly reduced by the pre-tensioned wire wound design. Typical winding design provides compression sufficient that at vessel design conditions there is no circumferential stress in the cylinder. These vessels have been used in various industrial applications, including foods and drinks processing, ceramic or refractory processing and powdered metal processing utilizing a liquid compressing fluid at ambient or slightly elevated temperature. The most frequent of these are isostatic pressing and hydrostatic extrusion. ~~Isostatic pressing can be performed at either cold temperatures, at room temperature, with liquid as the pressure medium, or hot, at temperatures of 2000 to 3300°F with gas as the pressure medium.~~ In hot isostatic presses, the vessel wall is separated from the hot space by insulation, which keeps the vessel wall operating at a low temperature of approximately 120 to 180°F.
Cold pressing is used for regular production at pressures up to 87,000 psi. Ceramic, refractory and metal processing is also performed at elevated temperature, up to 3632°F (2000°C). The “hot” processes utilize an inert gas fluid pressure up to 45,000 psi (310

Isostatic pressing can be performed at temperatures at or less than ambient with liquid as the pressure medium. When temperatures are between 2000F and 3300F, gas is used as the pressure medium.

Hydrostatic extrusion is generally performed at temperatures at or less than ambient to 1100F, with liquid as the pressure medium.

MPa). Continuous cooling is necessary for the hot process and may contribute to corrosion damage of the cylinder of closures. ~~Hydrostatic extrusion is generally performed either cold, at room temperature, or warm, at temperatures up to 1110°F, in both cases with liquid as the pressure medium.~~ Hydrostatic extrusion is used for regular production at pressures up to 200,000 psi. ~~Both~~ cold and hot processes are commonly found in research facilities and in universities.

(c) Record keeping

(1) Since these vessels have a finite fatigue life, it is essential a record be maintained of each operating cycle, recording both temperature and pressure. Deviation beyond design limits is cause for suspending operation and reevaluation of remaining fatigue life. Vessels having no operating record should be inspected and a fracture mechanics evaluation with a fatigue analysis test be performed to establish remaining life before resuming operation.

(2) Operating data should be recorded and include the following whenever the vessel is operating:

a. Number of cycles
b. Maximum pressure
c. Maximum temperature

add:

d. any unusual conditions
e. Duration of the cycle
f. Date & time of cycle start

(d) ~~Any unusual conditions (d)~~ Any damage to the cylinder or closures can lead to premature failure. Frequent visual inspection should be made of internal and external surfaces of the cylinder, frame and closures. A thorough examination should be completed if any visually apparent damage is identified or if any excursion beyond design temperature or pressure occurs.

In addition, surfaces of the cylinder and closures should be examined by dye penetrant or magnetic particle method at intervals based on vessel remaining life. Closures may require ultrasonic examination of passageways.

Following is an example of what the results of such a study might reveal as allowable cycles for a particular wire wound vessel:

| | | |
|---|---|---|
| Columns | > $10^6$ Cycles | "Columns" are beams on either side of frame, between the yokes. |
| Yokes | > $10^6$ Cycles | "Yokes" are the circular ends of the frame. |
| Wires of frames | > $10^6$Cycles | "Wires" place frame in compression |
| Cylinder | 100 X $10^3$ cycles | |
| Wires of Cylinder | 60 X $10^3$ cycles | "Wires" place cylinder in compression. |
| Closures | 30 X $10^3$ cycles | All connections to the vessel are through the closures. These passageways create stress raisers, as do grooves for sealing system. |

The vessel design life in this example is thus limited by the closure. The calculated design life is 30,000 cycles at design pressure and temperature.

An acceptable factor of safety for vessel fatigue inspection interval varies between 0.25 and 0.5 of the remaining design life. The inspection interval for the above example is therefore ~~10,000 to 20,000~~ 7,500 to 15,000 cycles, but should not exceed five years.

In addition to scope of frequent inspection, the fatigue inspection should include measurement of the cylinder inside diameter and frame inside length to detect reduced tension in the wire windings. Note that monoblock cylinders and plate frames require additional inspection due to differing construction.

If a crack or flaw is detected during any inspection, an immediate evaluation, repair and study of impact on remaining fatigue life should be completed by a National Board authorized repair agency. Using the results of this study, and application of safety factor 0.25 (due to known damage), the number of cycles of operation to the next fatigue inspection is established.

As part of the frequent inspection, the following items should be reviewed:

(1) Verify no change in the process, such as the processing fluid, that might adversely impact vessel integrity.

(2) Review the vessel manufacturer's inspection recommendations for vessel, closures and frame. If manufacturer's recommendations are not available, obtain recommendations from a recognized wire wound vessel service provider.

(3) Verify any repair to pressure retaining items has been completed by National Board authorized service provider having wire wound vessel expertise.

(4) Verify overpressure protection with appropriate set pressure and capacity is provided. Rupture discs are commonly used for pressures exceeding 14,500 psi (100 MPa) to avoid valve seat leakage. Overpressure protection devices are frequently replaced to avoid premature operation.

(e) Additional Inspection Criteria

(1) If there are no manufacturer's recommendations available for the vessel, the following are additional recommended inspections that should be conducted to ensure vessel integrity and safety

a. Conduct annual visual and dimensional vessel inspections with liquid penetrant examination of maximum stressed areas to ensure that the surfaces are free of defects. Conduct ultrasonic examination of the vessel after every 25% of the design cycle life or every five years, whichever comes first, to detect subsurface cracks. Special attention Should be given to the roots of threads and closures using threaded head retention construction. Other geometric discontinuities that are inherent in the design or irregularities resulting from localized corrosion, erosion, or mechanical damage should be carefully examined. This is particularly important for units of monoblock construction.

If pitting, cracks, corrosion or other defects are found during an inspection, an evaluation using fracture mechanics techniques shall be performed.

b. The closure mechanism of the vessel end-closure is opened and closed frequently during operation. It should be closely inspected for freedom of movement and proper contact with its locking elements. Wire wound vessels must have yoke-type closures so the yoke frame will need to be closely inspected on a regular basis

c. ~~Should pitting, cracks, corrosion, or other defects are found during scheduled inspection; verify that an evaluation using fracture mechanics techniques is performed.~~ This is to determine MAWP, cyclic life and extent of NDE frequency based on crack growth rate.

(2) Gages, Safety Devices, and Controls

a. Verify that the vessel is provided control and monitoring of the pressure, temperature, electrical system, fluid flow, liquid levels, and all variables that are essential for the safe operation of the system. If the vessel is automatically controlled, manual override should be available. Also, safety interlocks should be provided on the vessel closure to prevent vessel pressurization if the vessel closure is not complete and locked.

b. Verify that all safety device isolation valves are locked open if used.

the lowest pressure possible,

c. Verify appropriate pressure relief device is installed with relief setpoint at ~~low a pressure as possible~~, consistent with the normal operating pressure but in no case higher than the design operating pressure of the vessel. Rupture discs are normally considered more suitable for these types of applications since spring loaded pressure relief devices operating at pressures above 14500 psi may tend to leak by their seat.

d. Verify that pressure and temperature of the vessel coolant and vessel wall is controlled and monitored. Interlock devices associated with these monitoring devices that will deenergize or depressurize the vessel are strongly recommended due to the potential significant damage that can be caused by release of energy in the event of overpressurization due to excess pressure or temperature in the vessel.

e. Verify audible and visual alarms are installed and operable to indicate unsafe conditions.

Comment: Metric SI conversion factors to be used throughout this document. (Administrative)

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# PART 2, SECTION 5
# INSPECTION — STAMPING, DOCUMENTATION, AND FORMS

## 5.1 SCOPE

This section provides guidelines and requirements for stamping and documentation (forms) for inservice inspections of PRIs. This section also describes evaluation of inspection results and assessment methodologies.

## 5.2 REPLACEMENT OF STAMPING OR NAMEPLATE

### 5.2.1 AUTHORIZATION

a) When the stamping on a pressure-retaining item becomes indistinct or the nameplate is lost, illegible, or detached, but traceability to the original pressure-retaining item is still possible, the Inspector shall instruct the owner or user to have the nameplate or stamped data replaced. All re-stamping shall be done in accordance with the original code of construction, except as modified herein. Requests for permission to re-stamp data or replace nameplates shall be made to the Jurisdiction in which the nameplate or stamping is reapplied. Application ~~must~~ shall be made on the *Replacement of Stamped Data Form*, NB-136 (see NBIC Part 2, 5.3.2). Proof of traceability to the original nameplate or stamping and other such data, as is available, shall be furnished with the request. Permission from the Jurisdiction is not required for the reattachment of nameplates that are partially attached. When traceability cannot be established, the Jurisdiction shall be contacted ~~.~~ for approval prior to replacing a nameplate or re-applying a stamping. ~~The completed Form NB-136 (see 5.3.2) shall be submitted to the National Board.~~ The owner or user shall retain all documentation provided for traceability with the completed form NB-136 for as long as the pressure-retaining item is in their ownership or use. If the pressure-retaining item is sold, Form NB-136 along with the supporting documentation shall be provided to the new owner. The manufacturer of the pressure-retaining item, if available, ~~should~~shall be contacted prior to replacing a nameplate or stamped data in order to verify applicable code requirements.

b) When there is no Jurisdiction, ~~the~~ documentation used for traceability shall be ~~accepted~~ verified and the replacement of the nameplate or stamped data shall be authorized and witnessed by a National Board Commissioned Inspector. ~~The completed Form NB-136 shall be submitted to the National Board.~~

### 5.2.2 REPLACEMENT OF NAMEPLATE OR STAMPED DATA

a) The re-stamping or replacement of data shall be witnessed by a National Board Commissioned Inspector.

b) The re-stamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

c) Replacement nameplates or stamped data shall be clearly marked "replacement."

### 5.2.3 REPORTING

The completed Form NB-136 with a facsimile of the replacement stamping or nameplate as applied and appropriate signatures shall be filed with the Jurisdiction, if applicable, and the National Board by the owner or user ~~(if required) and the National Board~~ or by the "R" Stamp Holder if work was performed. ~~bearing a facsimile of the replacement stamping or nameplate, as applied, and shall also bear the signature of the "R" Stamp holder that performed the replacement and the National Board Commissioned Inspector who authorized and witnessed the replacement.~~

### 5.2.4 REPLACEMENT OF DUPLICATE NAMEPLATES

Replacement or re-attachment of duplicate nameplates is exempt from meeting the requirements above provided the information on the nameplate is identical to the original data existing on the pressure-retaining item. The duplicate nameplate shall be marked duplicate. The jurisdiction where the pressure-retaining item is located and the original manufacturer of the item ~~should~~shall be contacted for additional guidance and direction. When the Code symbol stamp cannot be applied, Form NB-136 shall be completed, signed by a National Board Commissioned Inspector, retained and a copy submitted to the National Board by the owner or user as described in 5.2.1 a).

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## 5.3 NATIONAL BOARD INSPECTION FORMS

### 5.3.1 SCOPE

~~The following f~~Forms specified in 5.3.2 may be used for documenting specific requirements as indicated on the top of each form.

**Note**: Jurisdictions may have adopted other forms for the same purpose and may not accept these forms.

# REPLACEMENT OF STAMPED DATA FORM, NB-136

in accordance with provisions of the *National Board Inspection Code*

| Submitted to: | Submitted by: |
|---|---|
| ______ (name of jurisdiction) | ______ (name of owner, user, or certificate holder) |
| ______ (address) | ______ (address) |
| ______ | ______ |
| ______ (telephone no.) | ______ (telephone no.) |

1. Manufactured by ______ (name and address)
2. Manufactured for ______ (name and address)
3. Location of installation ______ (address)
4. Date installed ______
5. Previously installed at ______
6. Manufacturer’s Data Report attached ☐ No ☐ Yes
7. Item registered with National Board ☐ No ☐ Yes, NB Number ______
8. Item identification Year built ______

   Type ______ Dimensions ______

   Mfg. serial no. ______ Jurisdiction no. ______

   MAWP ______ psi Safety relief valve set at ______ psi
9. Complete the reverse side of this report with a true facsimile of the legible portion of the nameplate.
10. If nameplate is lost or illegible, traceability documentation, verified by the Inspector shall be attached to this report.

11. I request authorization to replace the stamped data and/or nameplate on the above described pressure-retaining item in accordance with the rules of the *National Board Inspection Code* (NBIC).

    "R" Certificate Holder/Owner User

    ~~“R” Certificate Holder’s~~ Name: ______ Number ______

    Signature ______ Date ______

    Verification of Traceability ______ (Name of inspector) NB Commission ______

12. Authorization is granted to replace the stamped data or to replace the nameplate of the above described pressure-retaining item.

    Signature ______ (chief inspector or authorized representative) Date ______

    Jurisdiction (if available) or NB Commission no. ______

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-136 Rev.7

The following is a true facsimile of the legible portion of the item’s original nameplate (if available). Please print. Where possible, also attach a rubbing or picture of the nameplate.

The following is a true facsimile of the item’s replacement stamping or nameplate.

I certify that to the best of my knowledge and belief, the statements in this report are correct, and that the replacement information, data, and identification numbers are correct and in accordance with provisions of the *National Board Inspection Code*.

"R" Certificate Holder/Owner User

~~“R” Certificate Holder~~ ______________________ Number ______________________

Signature ______________________ Date ______________________
(authorized representative)

Witnessed by ______________________ Employer ______________________
(name of inspector)

Signature ______________________ Date ____________ NB Commission ______________________
(inspector)

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-136 Rev.7(Back)

**NB15-0801 – Part 2, S10 - & NB15-0901**
(PM) Mooney, Newton, Welch, Barker

Commenter Name: **Kenneth A. Stoller - American Insurance Association (AIA)**

Commenter Address: **2101 L Street NW, Suite 400**

**Washington, DC 20037**

Commenter Phone: **202-828-7167**

Commenter Fax: **202-495-7866**

Commenter Email: **kstoller@aiadc.org**

Section/Subsection Referenced: **Supplement 10, Inspection of Liquid Carbon Dioxide Storage Vessels**

Comment/Recommendation: *Proposed Solution:* ☐ New Text ☒ Revise Text ☒ Delete Text

**AIA believes that several aspects of the proposed requirements are either undefined or otherwise beyond the normal scope and training of National Board Commissioned Inspectors. Imposing these requirements on Special Inspectors may also place them in the untenable position of assuming liability beyond the limits of the insurance policies under which they perform inspections. Items of concern include the failure to define the terms "sufficient clearance" (S10.2b), "safely supported" (S10.2d), "guarded (S10.2f); and "permanent" (S10.3a). We recommend either defining or deleting these terms. Furthermore, Commissioned Inspectors are not qualified to (i) determine whether a CO2 detector is set to alarm at any particular concentration (S10.5); (ii) verify the posting of warning signs and determine the setpoint of any alarms (S10.6); or (iii) determine the length of safety relief/vent lines or verify that the materials selected for valves, piping, tubing, hoses and fittings used in the LCDSV system meet certain requirements. We recommend deleting these sections.**

## SUPPLEMENT 10 INSPECTION OF LIQUID CARBON DIOXIDE STORAGE VESSELS

### S10.1 SCOPE

This supplement provides ~~requirements~~ guidelines for owners or users ~~when inspecting~~for the inspection of Liquid Carbon Dioxide Storage Vessels (LCDSVs), fill boxes, fill lines and pressure relief discharge/vent circuits used for carbonated beverage systems, swimming pool pH control systems and other fill in place systems storing liquid $CO_2$.

### S10.2 GENERAL REQUIREMENTS (ENCLOSED AND UNENCLOSED AREAS)

The ~~Inspector~~ inspection ~~shall~~ should verify that LCDSVs are:

a) ~~are~~ not ~~be~~ located within 10 feet (3050 mm) of elevators, unprotected platform ledges or other areas where falling would result in dropping distances exceeding half the container height;

b) ~~are~~ installed with ~~sufficient~~ clearance to satisfactorily allow for~~for~~ filling, operation, maintenance, inspection and replacement of the vessel parts or appurtenances;

c) ~~are~~ not ~~installed~~ located on roofs;

d) ~~are safely~~ adequately supported ~~as~~ to prevent the vessel from tipping or falling, and to meet seismic requirements as required by design~~as needed.~~;

e) ~~are~~ not located within 36 in. (915 mm) of electrical panels; and

f) located outdoors in areas in the vicinity of vehicular traffic are protected with barriers designed to ~~guarded to~~ prevent accidental impact by vehicles.

### S10.3 ENCLOSED AREA LCDSV INSTALLATIONS

The ~~Inspector~~ inspection ~~shall~~ should verify that:

a) ~~Permanent~~ LCDSV installations that are not periodically removed with remote fill connections:

1) Are equipped with a gas detection system installed in accordance with ~~NBIC Part 2,~~paragraph S10.5 of this supplement;

2) Have signage posted in accordance with ~~NBIC Part 2,~~paragraph S10.6 of this supplement; and

3) Are equipped with fill boxes, fill lines and safety relief/vent valve circuits installed in accordance with ~~NBIC Part 2, S10.4.~~paragraph S10.4 of this supplement.

b) Portable LCDSV installations with no permanent remote fill connection:

Warning: LCDSVs shall not be filled indoors or in enclosed areas under any circumstances. Tanks must always be moved to the outside to an unenclosed, free airflow area for filling.

1) Are equipped with a gas detection system installed in accordance with paragraph S10.5 of this supplement~~NBIC Part 2, S10.5~~;

2) Have signage posted in accordance with paragraph S10.6 of this supplement~~NBIC Part 2, S10.6~~.

3) Have a safety relief/vent valve circuit connected at all times except when the tank is being removed for filling. Connections may be fitted with quick disconnect fittings meeting the requirements of paragraph S10.4 of this supplement~~NBIC Part 2, S10.4~~.

4) Are provided with a pathway that provides a smooth rolling surface to the outdoor, unenclosed fill area. There shall not be any stairs or other than minimal inclines in the pathway.

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### S10.4 FILL BOX LOCATION /SAFETY RELIEF/VENT VALVE CIRCUIT TERMINATION

The ~~Inspector~~ inspection ~~shall~~ should verify that fill boxes and/or vent valve terminations are installed above grade, outdoors in an unenclosed, free airflow area, and that the fill connection is located so not to impede means of egress or the operation of sidewalk cellar entrance doors, including during the delivery process and that they are:

a) At least three (3) feet (915 mm) from any door or operable windows;*

b) At least three (3) feet (915 mm) above grade;*

c) Not located within ten (10) feet (3050 mm) from side to side at the same level or below, from any air intakes;*

d) Not located within ten (10) feet (3050 mm) from stair wells that go below grade.*

* Note: Many systems installed prior to 1/1/2014 do not meet the above requirements and the local Jurisdiction should be consulted for guidance.

### S10.5 GAS DETECTION SYSTEMS

Rooms or areas where carbon dioxide storage vessel(s) are located indoors or in enclosed or below grade outdoor locations shall be provided with a gas detection and alarm system for general area monitoring that is capable of detecting and notifying building occupants of a $CO_2$ gas release. Alarms will be designed to activate a low level pre-alarm at 1.5% concentration of $CO_2$ and a full high alarm at 3% concentration of $CO_2$ which is the NIOSH & ACGIH 15 minute Short Term Exposure Limit for $CO_2$. These systems are not designed for employee personal exposure monitoring. Gas detection systems shall be installed and tested in accordance with manufactures installation instructions and the following requirements:

a) The ~~Inspector~~ inspection ~~shall~~ should verify that the gas detection system and audible alarm is operational and tested in accordance with manufacturer's guidelines.

b) The ~~Inspector~~ inspection ~~shall~~ should verify that audible alarms are placed at the entrance(s) to the room or area where the carbon dioxide storage vessel and/ or fill box is located to notify anyone who might try to enter the area of a potential problem.

## S10.6 SIGNAGE

The ~~Inspector~~ inspection ~~shall~~ should verify that warning signs are posted at the entrance to the building, room, enclosure, or enclosed area where the container is located. The warning sign shall be at least 8 in (200mm) wide and 6 in. (150mm) high. The wording shall be concise and easy to read and the upper portion of the sign must be orange as shown in figure NBIC Part 2, Figure S10.6. The size of the lettering must be as large as possible for the intended viewing distance and in accordance with jurisdictional requirements. When no jurisdictional requirements exist, the minimum letter height shall be in accordance with NEMA American National Standard for Environmental and Facility Safety Signs (ANSI Z535.2). The warning signs shall be as shown in figure S10.6.

Figure S10.6

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

a) Carbon dioxide monitors for general area monitoring (not employee personal exposure monitoring) are provided in
this area. These monitors are set to alarm at 5,000 ppm(1.5% concentration) for the low level alarm and at 30,000 ppm (3% concentration) for high level alarm.

b) Low Level Alarm (5,000 ppm) – Provide appropriate cross ventilation to the area. Personnel may enter area for short periods of time (not to exceed 15 minutes at a time) in order to identify and repair potential leaks.

c) High Level Alarm (30,000 ppm) – Personnel should evacuate the area and nobody should enter the affected area without proper self-contained breathing apparatus until the area is adequately ventilated and the concentration of $CO_2$ is reduced below the high alarm limit.

## S10.7 VALVES, PIPING, TUBING AND FITTINGS

a) Materials – The ~~Inspector~~ inspection should ~~shall~~ verify that the materials selected for valves, piping, tubing, hoses and fittings used in the LCDSV system meet following requirements:

1) Components shall be rated for the operational temperatures and pressures encountered in the applicable circuit of the system.

2) All valves and fittings used on the LCDSV shall be rated for the maximum allowable working pressure(MAWP) stamped on the tank.

3) All piping, hoses and tubing used in the LCDSV system shall be rated for the working pressure of the applicable circuit in the system and have a burst pressure rating of at least four times the MAWP of the piping, hose or tubing.

b) Relief Valves – The ~~Inspector shall~~inspection should verify that each LCDSV shall have at least one ASME/NB stamped & certified relief valve with a pressure setting at or below the MAWP of the tank. The relief valve shall be suitable for the temperatures and flows experienced during relief valve operation. The minimum relief valve capacity shall be designated by the manufacturer. Additional relief valves that do not require ASME stamps may be added per Compressed Gas Association pamphlet, CGA S-1.3 Pressure Relief Device Standards Part 3, Stationary Storage Containers for Compressed Gases,

recommendations. Discharge lines from the relief valves shall be sized in accordance with NBIC Part 2, Tables S10-a and S10-b.
Note: Due to the design of the LCDSV the discharge line may be smaller in diameter than the relief valve outlet size.
Caution: Company's and or individuals filling or refilling LCDSV's shall be responsible for utilizing fill equipment that is acceptable to the manufacturer to prevent over pressurization of the vessel.

c) Isolation Valves – The ~~Inspector shall~~inspection should verify that each LCDSV shall have an isolation valve installed on the fill line and tank discharge, or gas supply line in accordance with the following requirements:

1) Isolation valves shall be located on the tank or at an accessible point as near to the storage tank a possible.
2) All valves shall be designed or marked to indicate clearly whether they are open or closed.
3) All valves shall be capable of being locked or tagged in the closed position for servicing.
4) Gas supply and liquid $CO_2$ fill valves shall be clearly marked for easy identification.

d) Safety Relief/Vent Lines – The ~~Inspector~~inspection, where possible, ~~shall~~ should verify the integrity of the pressure relief/vent line from the pressure relief valve to outside vent line discharge fitting. All connections shall be securely fastened to the LCDSV. The minimum size and length of the lines shall be in accordance with NBIC Part 2, Tables S2 10-a and S2 10-b. Fittings or other connections may result in a localized reduction in diameter have been factored into the lengths given by the NBIC Part 2, Tables S2 10-a and S2 10-b.

### Table S10-a Minimum LCDSV System Pressure Relief/Vent Line Requirements (Metallic)

Tank Size
(Pounds)
Fire Flow Rate
Requirements
(Pounds per Minute)
Maximum Length of
3/8 inch ID Nominal
Metallic Tube Allowed
Maximum Length of 1/2
inch ID Nominal
Metallic Tube
Allowed
Less than 500 2.60 maximum 80 feet 100 feet
500-750 3.85 maximum 55 feet 100 feet
Over 750-1000 5.51 maximum 18 feet 100 feet

### Table S10-b Minimum LCDSV System Pressure Relief/Vent Line Requirements (Plastic/Polymer)

Tank Size
(Pounds)
Fire Flow Rate
Requirements (Pounds
per Minute)
Maximum Length of

3/8 inch ID
Plastic/Polymer
Materials Tube Allowed
Maximum Length of ½
inch ID Plastic/Polymer
Materials
Tube Allowed
Less than 500 2.60 maximum 100 feet 100 feet
500-750 3.85 maximum 100 feet 100 feet
Over 750-1000 5.51 maximum N/A see ½ inch 100 feet

**Table S10-a Metric Minimum LCDSV System Pressure Relief /Vent Line Requirements (Metallic)**

Tank Size
(Kilograms)
Fire Flow Rate
Requirements
(Kilograms per Minute)
Maximum Length of
10mm ID Nominal
Metallic Tube Allowed
Maximum Length of
13mm ID Nominal
Metallic Tube Allowed
Less than 227 1.8 maximum 24 m 30.5 m
227-340 1.75 maximum 17 m 30.5 m
340-454 2.50 maximum 5.5 m 30.5 m

**Table S10-b Metric Minimum LCDSV System Pressure Relief/Vent Line Requirements (Plastic/Polymer)**

Tank size
(kg)
Fire Flow Rate (kg per
Minute)
Maximum Length of 10
mm ID Nominal Metallic
Tube Allowed
Maximum Length of 10
mm ID Plastic/Polymer
Materials Tube Allowed
Less than 227 1.18 maximum 30.5 m 30.5 m
227-340 1.75 maximum 30.5 m 30.5 m
Over 340-454 2.5 maximum N/A see 13 mm 30.5 m
Note: Due to the design of the LCDSV the discharge line may be smaller in diameter than the pressure relief valve outlet size but shall not be smaller than that shown in tables NBIC Part 2, S10-a and S10-b.

NFPA 58 contains the following language regarding conversion of tanks for LP-Gas fuel service from ammonia service:

5.2.1.5 Except for containers used in cargo tank vehicle service, ASME containers of 3000 gal (11.4 m3) water capacity or less used to store anhydrous ammonia shall not be converted to LP-Gas fuel service.

Therefore, the following are proposed edits (**in bold red**) to S9.4 and S7.8.6 address NB15-2103. No edits required to S7.9:

**S9.4 SOME EXAMPLES FOR CHANGE OF SERVICE**

Table S9.4 lists examples of what constitutes a change in service and some factors to consider. Note: This list is not all inclusive. There may be other service changes not mentioned.
The listing of “Factors to Consider” is also not all inclusive. There may be other elements that can influence the safe and reliable operation of the pressure retaining item.
The owner shall check with the Jurisdiction where the pressure retaining item is to operate in the new environment, and review local building codes, laws, and regulations for additional requirements or prohibitions against a change of service.

**TABLE S9.4**
EXAMPLES OF CHANGE OF SERVICE CONDITIONS

**Change Some Factors to Consider**

LP Gas to Ammonia
- PWHT of Vessel During Construction Wet-fluorescent magnetic particle testing (WFMT) on all internal surfaces
- Internal access of vessel is necessary, may need to install manhole
- NFPA 58 should be consulted

Ammonia to LP gas
- NFPA-58 ~~**5.2**~~ should be consulted **for restrictions**. ~~Refer i.e. restriction on maximum volume~~
- Wet-fluorescent magnetic particle testing (WFMT) on all internal surfaces
- Internal access of vessel is necessary, may need to install manhole
- Also see, NBIC Part 2, 2.3.6.4**, S7.8.6, S7.9**

LP gas service: from above ground to underground
- Requires alterations (additional

**S7.8.6 ANHYDROUS AMMONIA SERVICE**

**ASME containers of 3000 gal (11.4 m3) water capacity or less used to store anhydrous ammonia, except for containers used in cargo tank vehicle service, shall not be converted to LP-Gas service.**

**Cargo tank containers less than 3000 gal (11.4 m3) water capacity to be converted from ammonia to LP-gas service shall be wet-fluorescent magnetic particle tested (WFMT) on all internal surfaces (see NBIC Part 2, 2.3.6.4).**~~**Containers that have been previously used in anhydrous ammonia service shall not be converted to LPG service.**~~

~~Any b~~Blue coloring of the brass valves ~~indicates~~ is one indication that the container has been in anhydrous ammonia service.

**S7.9 ASME LPG CONTAINERS LESS THAN 2000 GALLONS BEING REFURBISHED BY A COMMERCIAL SOURCE.**

Commercially refurbished containers are used containers that are temporarily taken out of service for repair and or renewal and sent to a company which specializes in this type of work. Because the history of some of these containers is unknown, special attention shall be given to inspection and repair before returning any of these containers back to service. ASME LPG containers less than 2,000 gal. (7,570 l) may be refurbished subject to the following conditions:

a) A complete external inspection shall be completed under the guidelines of this supplement. If any defects are found, as defined in S7.8.1 through S7.8.5, the defect shall be repaired under NBIC Part 3,Repairs and Alterations, by qualified personnel or permanently removed from service;
b) Containers **of this size** that have been previously used in anhydrous ammonia service shall not be converted to LPG service. See NBIC Part 2, S7.8.6;

## CHANGES TO SUPPLEMENT 10

### S10.1 SCOPE

This supplement provides specific guidelines for inspection of high-pressure composite pressure vessels, hereafter referred to as vessels. This supplement is applicable to pressure vessels with a design pressure that exceeds 3,000 psi (21 MPa) but not greater than 15,000 psi (103 MPa), and is applicable to the following four types of pressure vessels:

a) Metallic vessel with a hoop Fiber Reinforced Plastic (FRP) wrap over the ~~straight shell~~ cylindrical part of the vessel (both load sharing).

b) Fully wrapped FRP vessel with a non-load sharing metallic liner.

c) Fully wrapped FRP vessel with a non-load sharing non-metallic liner.

d) Fully wrapped FRP vessel with load sharing metallic liner.

This supplement is intended for inspection of ASME Section X, Class III, vessels and ASME Section VIII, Division 3, Composite Reinforced Pressure Vessels (CRPVs). However, it may be used for inspection of similar vessels manufactured to other construction codes with approval of the jurisdiction in which the vessels are installed.

### S10.3 INSPECTOR QUALIFICATIONS

a) The Inspector referenced in this supplement is a National Board Commissioned Inspector.

b) The Inspector shall be familiar with FRP vessel construction and qualified by training and experience to conduct such inspections. The Inspector ~~should~~ shall have a thorough understanding of all required inspections, tests, test apparatus, inspection procedures, and inspection techniques and equipment applicable to the types of vessels to be inspected. The Inspector ~~should~~ shall have basic knowledge of the vessel material types and properties. Refer to NBIC Part 2, S4.2 and S4.5.

**Move S10.3 c) to S10.10.2**

~~c) The acoustic emission technician conducting the examination required per S10.5(c) and in accordance with S10.10 shall be certified per the guidelines of ASNT SNT-TC-1A or CP-189 AE Level II or III. A technician performing this test shall have training in and experience with measuring $C_e$ and $C_f$ in composites and identifying wave modes.~~

### S10.6 ASSESSMENT OF INSTALLATION

*a) not shown*

b) The visual examination of the vessel requires that the identity of the vessel ~~must~~ shall be verified. This ~~should~~ shall include the construction code (ASME) to which the vessel was constructed, vessel serial number, maximum allowable operating pressure, date of manufacture, vessel manufacturer, date of expiration of the service life of the vessel, and any other pertinent information shown on the vessel or available from vessel documents. The overall condition of the vessel ~~should~~ shall be noted.

## S10.8 EXTERNAL INSPECTION

a) Vessel Service Life

Vessels have been designed and manufactured for a limited lifetime; this is indicated on the vessel marking. This marking ~~should~~ shall first be checked to ensure that such vessels are within their designated service lifetime.

b) Identification of External Damage

The external surface ~~should~~ shall be inspected for damage to the laminate. Damage is classified into two levels as shown in Table S10.7-a or Table S10.7-b of this supplement. The acceptance/rejection criteria shown in Table S10.7-a or Table S10.7-b of this supplement shall be followed, as a minimum.

The external surface of the vessel is subject to mechanical, thermal, and environmental damage. The external surface of a vessel may show damage from impacts, gouging, abrasion, scratching, temperature excursions, etc. Areas of the surface that are exposed to sunlight may be degraded by ultraviolet light which results in change in the color of the surface and may make the fibers more visible. This discoloration does not indicate a loss in physical properties of the fibers. Overheating may also cause a change in color. The size (area or length and depth) and location of all external damage shall be noted. Vessel support structures and attachments ~~should~~ shall be examined for damage such as cracks, deformation, or structural failure.

## S10.9 INTERNAL EXAMINATION

a) Requirements for Internal Visual Examination

Internal visual examination is normally not required. When vessels have been filled only with pure fluids, corrosion of the interior of the liner should not occur. Internal visual examination of the tanks ~~should~~ shall only be carried out when:

1) There is evidence that any commodity except a pure fluid has been introduced into the tank. In particular, any evidence that water, moisture, compressor cleaning solvents, or other corrosive agents have been introduced into the vessel ~~will~~ shall require an internal visual examination.

2) There is evidence of structural damage to the vessel, such as denting or bulging.

3) The vessel valve is removed for maintenance or other reason. Internal examination in this case is limited to examination of the threads and sealing surface. When an internal visual examination is conducted, the following procedures ~~should~~ shall be followed.

b) Identification of Internal Damage

1) Vessels with Metallic Liners

For vessels with metallic liners, the objective of the internal visual examination is primarily to detect the presence of any corrosion or corrosion cracks.

The internal surface of the vessel shall be examined with adequate illumination to identify any degradation or defects present. Any foreign matter or corrosion products ~~should~~ shall be removed from the interior of the vessel to facilitate inspection. Any chemical solutions used in the interior of the vessel ~~should~~ shall be selected to ensure that they do not adversely affect the liner or composite overwrap materials. After cleaning the vessel ~~should~~ shall be thoroughly dried before it is examined.

All interior surfaces of the vessel ~~should~~ shall be examined for any color differences, stains, wetness, roughness, or cracks. The location of any degradation should be noted.

Any vessel showing significant internal corrosion, dents or cracks ~~should~~ shall be removed from service.

2) Vessels with Non-metallic Liners or No Liners

Vessels with non-metallic liners may show corrosion on the plastic liner or metal boss ends. Vessels with non-metallic liners or no liners may also show internal degradation in the form of cracks, pitting, exposed laminate, or porosity.

The internal surface of vessels ~~should~~ shall be examined with adequate illumination to identify any degradation or defects present. Any foreign matter or corrosion products ~~should~~ shall be removed from the interior of the vessel to facilitate examination. Chemical solutions used in the interior of the vessel ~~should~~ shall be selected to ensure they do not adversely affect the liner or composite overwrap materials. After cleaning the vessel ~~should~~ shall be thoroughly dried before it is examined.

The Inspector ~~should~~ shall look for cracks, porosity, indentations, exposed fibers, blisters, and any other indication of degradation of the liner and/or laminate. Deterioration of the liner may include softening of the matrix or exposed fibers.

## S10.10 ACOUSTIC EMISSION EXAMINATION

### *S10.10.1 NOT SHOWN*

### S10.10.2 AE TECHNICIAN REQUIREMENTS

The acoustic emission technician conducting the examination required per S10.5(c) and in accordance with S10.10 shall be certified per the guidelines of ASNT SNT-TC-1A or CP-189 AE Level II or III. A technician performing this test shall have training in and experience with measuring $C_e$ and $C_f$ in composites and identifying wave modes.

### S10.10.~~2~~3 TEST PROCEDURE

AE transducers shall be acoustically coupled to the vessel under test and connected to waveform recording equipment. Waveforms shall be recorded and stored on digital media as the vessel is pressurized. All analysis shall be done on the waveforms. The waveforms of interest are the E (Extensional Mode) and F (Flexural Mode) plate waves.

Prior to pressurization, the velocities of the earliest arriving frequency in the E wave and the latest arriving frequency in the F wave shall be measured in the circumferential direction in order to characterize the material and set the sample time (the length of the wave window).

The E and F waves ~~must~~ shall be digitized and stored for analysis. The test pressure shall be recorded simultaneously with the AE events. Permanent storage of the waveforms is required for the life of the vessel.

### S10.10.~~3~~4 EQUIPMENT

a) Testing System

A testing system shall consist of:

1) sensors;

2) preamplifiers;

3) high pass and low pass filters;

4) amplifier;

5) A/D (analog-to-digital) converters;

6) a computer program for the collection of data;

7) computer and monitor for the display of data; and

8) a computer program for analysis of data.

Examination of the waveforms event by event ~~must~~ shall always be possible and the waveforms for each event ~~must~~ shall correspond precisely with the pressure and time data during the test. The computer program shall be capable of detecting the first arrival channel. This is critical to the acceptance criteria below.

Sensors and recording equipment shall be checked for a current calibration sticker or a current certificate of calibration.

b) Sensor Calibration

Sensors shall have a flat frequency response from 50 kHz to 400 kHz. Deviation from flat response (signal coloration) shall be corrected by using a sensitivity curve obtained with a Michelson interferometer calibration system similar to the apparatus used by NIST (National Institute for Standards and Technology). Sensors shall have a diameter no greater than 0.5 in. (13 mm) for the active part of the sensor face. The aperture effect ~~must~~ shall be taken into account. Sensor sensitivity shall be at least 0.1 V/nm.

c) Scaling Fiber Break Energy

The wave energy shall be computed by the formula:

*(Table S10.10.3 not shown)*

which is the formula for computing energy in the AE signal, where V is the voltage in volts (V) and Z is the input impedance in ohms (Ω). A rolling ball impactor shall be used to create an acoustical impulse in an aluminum plate. The measured energy in the wave shall be used to scale the fiber break energy. This scaling is illustrated later on.

The impact setup, an example of which is shown in Figure S10.10, shall be arranged as follows. The steel ball shall be ½ inch (13 mm) in diameter. The steel ball is a type typically used in machine shops for measuring taper and is commercially available. The ball shall be made of chrome steel alloy hardened to R/C 63, ground and lapped to a surface finish of 1.5 micro-inch (0.0000381 mm), within 0.0001 inch (0.0025 mm) of actual size and sphericity within 0.000025 inch (0.00064 mm). The plate shall be made of 7075 T6 aluminum, be at least 4 ft x 4 ft (1200 mm X 1200 mm) in size, the larger the better to avoid reflections, be 1/8 inch (3.2 mm) in thickness and be simply supported by steel blocks. The inclined plane shall be aluminum with a machined square groove 3/8 inch (9.5 mm) wide which supports the ball and guides it to the impact point. The top surface of the inclined plane shall be positioned next to the edge of the plate and stationed below the lower edge of the plate such that the ball impacts with equal parts of the ball projecting above and below the plane of the plate. A mechanical release mechanism shall be used to release the ball down the plane.

***S10.10.~~4~~ 5***

***S10.10.~~5~~ 6***

***S10.10.~~6~~ 7***

***S10.10.~~6.1~~7.1***

***S10.10.~~7~~ 8***

***S10.10.~~8~~ 9***

***S10.10.~~9~~ 10***

***S10.10.~~10~~ 11***

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

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

## ACCREDITATION PROGRAMS

The National Board administers and accredits three specific repair programs[1] as shown below:

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

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

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

<u>New Construction</u>
Criteria for Acceptance of Authorized Inspection Agencies for New Construction (NB-360)
<u>Inservice</u>
Qualifications and Duties for Authorized Inspection Agencies (AIAs) Performing Inservice Inspection Activities and Qualifications for Inspectors of Boilers and Pressure Vessels (NB-369)
<u>Owner-User</u>
Accreditation of Owner-User Inspection Organizations (OUIO) (NB-371) Owners or users may be accredited for both a repair and inspection program provided the requirements for each accreditation program are met.
<u>Federal Government</u>
Qualifications and Duties for Federal Inspection Agencies Performing Inservice Inspection Activities (FIAs) (NB-390)

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

## CERTIFICATES OF AUTHORIZATION FOR ACCREDITATION PROGRAMS

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

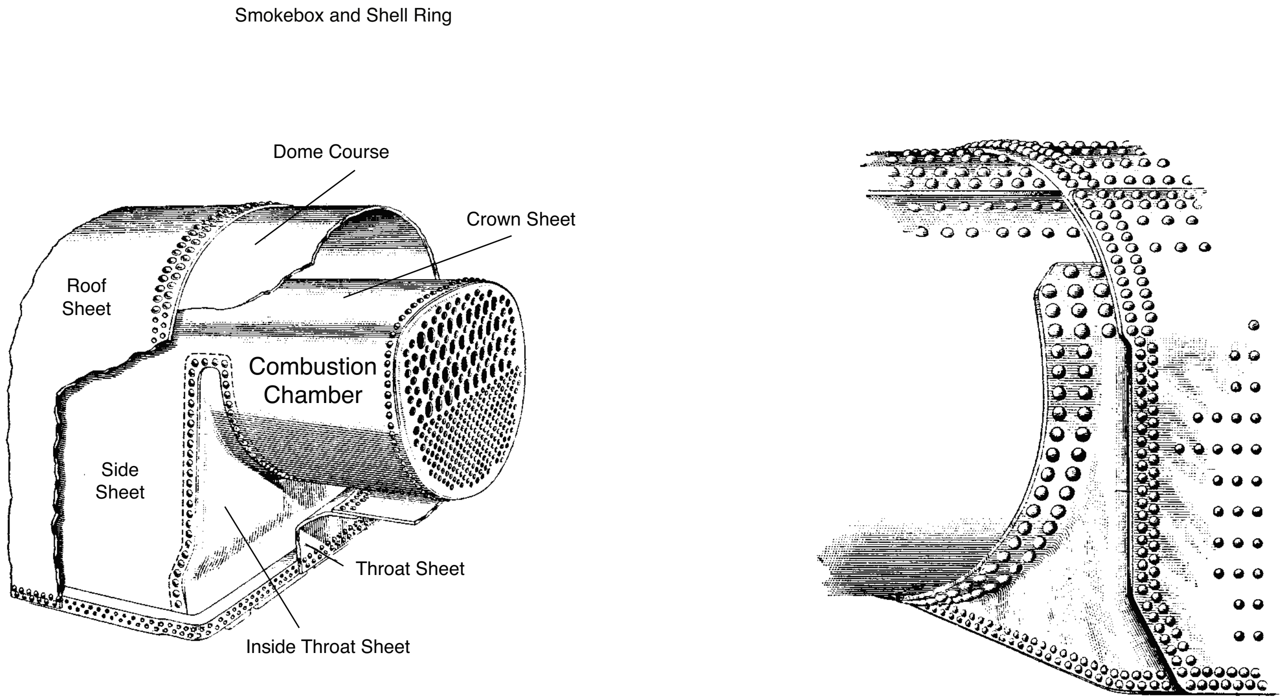
Certificate of Authorization scope, issuance, and revisions for National Board accreditation programs are specified in the applicable National Board procedures. When the quality system requirements of the appropriate accreditation program have been met, a Certificate of Authorization and appropriate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

Some

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

**FIGURE S1.1-b**

ARRANGEMENT OF FIREBOX SHEETS (STAYBOLTS DELETED FOR CLARITY)




## S1.2 SPECIAL JURISDICTIONAL REQUIREMENTS

Many Jurisdictions have special requirements for locomotive boilers. Such requirements shall be considered in addition to those in this supplement.

## S1.3 FEDERAL RAILROAD ADMINISTRATION (FRA)

The FRA rules for steam locomotive boilers are published in the *Code of Federal Regulations* (CFR) 49CFR Part 230, dated November 17,1999.~~[2]~~ All locomotives under FRA Jurisdiction are documented on FRA Form 4 as defined in 49CFR Part 230. This document is the formal documentation of the steam locomotive boiler and is required to be completed prior to the boiler being placed in service. This document shall be used as the data report for the boiler, applicable to all repairs and alterations performed. National Board "R" Certificate Holders shall document their repairs and/or alterations on National Board Forms R-1 or R-2. These reports shall be distributed to the owner or user of the boiler, who is required to incorporate them into the FRA Form 19, which becomes an attachment to the FRA Form 4. The design margin for all such repairs or alterations shall not be less than four, based on ultimate tensile strength of the material.

## S1.4 LOCOMOTIVE FIRETUBE BOILER INSPECTION

### S1.4.1 INSPECTION METHODS

a) Plate thickness and depth of corrosion may be determined by use of the ultrasonic thickness testing process.

~~2 Steam locomotive inspection and maintenance standards, which are now codified at 49CFR Part 230, may be obtained at the FRA Website.~~

acceptable for use. The use of malleable iron class 150 is not recommended. Forged threaded fittings per ASME B16.11 classes 2,000-6,000 are acceptable for use;

d) The blowdown line shall be piped to a safe point of discharge during the time the boiler is operating;

e) Piping shall be properly supported;

f) Valves shall be used in the manner for which they were designed, and shall be used within the specified pressure-temperature ratings. Valves shall be rated at or above the pressure setting of the boiler safety valve, denoted by the general or primary pressure class identification on the valve body and/or by the initials “WSP” or “S” to indicate working steam pressure or steam rating. Valves in cold-water service may be designated by the initials “WOG” to indicate water, oil, or gas rating and/or by the pressure class identification on the valve body; and

g) The boiler shall be equipped with two means of supplying feedwater while the boiler is under pressure.

### S2.9.1 PIPING, FITTINGS, AND VALVE REPLACEMENTS

The installation date should be stamped or stenciled on the replaced boiler piping. Alternatively, the installation date may be documented in permanent boiler records, such as the operator log book.

## S2.10 MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)

The MAWP of a boiler shall be determined by computing the strength of each boiler component. The computed strength of the weakest component using the factor of safety allowed by these rules shall determine the MAWP.

**Note**: The rules of ASME Section I 1971 Edition, Part “PR” and “PFT” may be used for determining specific requirements of design and construction of boilers and parts fabricated by riveting.~~[3]~~

### S2.10.1 STRENGTH

a) In calculating the MAWP, when the tensile strength of the steel or wrought iron is known, that value shall be used. When the tensile strength of the steel or wrought iron is not known, the values to be used are 55,000 psi (379 MPa) for steel and 45,000 psi (310 MPa) for wrought iron. Original steel stamp marks, original material certifications, or current laboratory tests are acceptable sources for verification of tensile strength. Catalogs and advertising literature are not acceptable sources for tensile strength values.

b) In computing the ultimate strength of rivets in shear, the following values shall be used:

| | | |
|---|---|---|
| 1) | Iron rivets in single shear | 38,000 psi (262 MPa) |
| 2) | Iron rivets in double shear | 76,000 psi (524 MPa) |
| 3) | Steel rivets in single shear | 44,000 psi (303 MPa) |
| 4) | Steel rivets in double shear | 88,000 psi (607 MPa) |

c) The resistance to crushing of mild steel shall be taken as 95,000 psi (655 MPa) unless otherwise known.

d) S = TS/FS. See definitions of nomenclature in NBIC Part 2,S2.10.6.

~~3 Copies of ASME Section I 1971 Edition Part “PR” and “PFT” referenced section may be obtained by contacting the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229.~~

e) Remove gage glass and valves, and inspect these connections for lime deposits and clean if necessary. This should be done once a year; more often if conditions warrant it.

f) After inspection, replace glass (clean if necessary). Also inspect gage glass sealing washers and replace if necessary.

g) During cold weather, the historical boiler should be moved into a heated area and the boiler allowed to warm up in the air for several days until it is the same temperature as the air.

h) The initial fire-up should be done slowly to allow even heating of the boiler.

i) Before movement, the cylinder(s) should be warmed up by allowing a small quantity of steam to blow through them and out the cylinder cocks and exhaust passage(s). This is necessary to reduce the stress in the casting from thermal expansion of the metal.

j) Steam should be discharged through the cylinder cocks for several minutes to aid removal of any solvent, debris, or rust that may have formed in the steam pipes, cylinder, valve chest, and dry pipe.

k) All appliances should be tested under steam pressure before the historical boiler is moved or put under load.

## S2.14 SAFETY PROCEDURES~~[4]~~ [2]

This chapter of text covers procedures in certain situations or emergencies that may occur.

### S2.14.1 EXPERIENCE

a) Reading check lists and procedures can be of some value to get you thinking about what you are doing, but nothing can replace the experience gained by working beside conscientious and knowledgeable engineers. Ask questions, observe, read, listen, study, and think.

b) Safe operations depend upon thorough attention to detailed routines. Having procedures thought out, planned, and practiced before they are needed could minimize accidents and improve public safety. Know your abilities as well as the limitations of the machine that you are operating. In most cases knowing and keeping your machine in top operating condition can prevent most emergency situations from occurring. However, sometimes problems or situations beyond your control do occur. In any situation the first rule to remember is to keep a cool head. Haste and panic can never solve any emergency.

c) Don’t be afraid to ask for help or advice. A lot of shows and public demonstrations have a designated individual in the area to ensure safe operation and assistance should a problem arise.

### 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 it is 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.

2 ~~4~~ Copyright © 2004 Wisconsin Historical Steam Engine Association. All rights reserved. The material in this text written by the Wisconsin Historical Steam Engine Association may not be reproduced in any form without written permission of the author and the Wisconsin Historical Steam Engine Association.

## SUPPLEMENT 5
## INSPECTION OF YANKEE DRYERS (ROTATING CAST-IRON PRESSURE VESSELS) WITH FINISHED SHELL OUTER SURFACES

### S5.1 SCOPE

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

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

c) The dryer is typically manufactured in a range of outside diameters from 8 to 23 ft. (2.4 m to 7 m), widths from 8 to 28 ft. (2.4 m to 8.5 m), pressurized and heated with steam up to 160 psi (1,100 kPa), and rotated at speeds up to 7,000 ft./min (2,135 m/min). Typical pressure roll loads against the Yankee dryer are up to 600 pounds per linear inch (105 kN/m). A thermal load results from the drying process due to difference in temperature between internal and external shell surfaces. The dryer has an internal system to remove steam and condensate. These vessels can weigh up to 220 tons (200 tonnes).

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

### S5.2 ASSESSMENT OF INSTALLATION

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

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

   1) Pressure load due to internal steam pressure;

   2) Inertial load due to dryer rotation;

   3) Thermal gradient load due to the drying of the web; and

   4) Pressure roll load (line or nip load)~~[5]~~ due to pressing the wet web onto the dryer.

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

~~5 Pressure roll load, line load, and nip load are terms that are used interchangeably to refer to the interaction between the pressure roll(s) and the Yankee dryer. It is called "nip" load because the pressure roll is rubber-covered and is pressed up against the Yankee with enough force to create a nip (or pinch) that forces the paper into line contact between the rolls and provides some mechanical dewatering. The paper then sticks onto the Yankee surface and follows the Yankee dryer for thermal dewatering by the steam-heated Yankee surface. This "nip load" is called a "line load" because the units are load (force) per length of line contact. The units are pounds per linear inch (PLI) and kilonewtons per meter (kN/m).~~

Add the definition of Nip Load to the Glossary

"FOR COMMITTEE USE ONLY"

SUPPL. 5

e) Permitted materials can be either an ASME, SA material, or an ASTM Material permitted by NBIC Part 2, Table S6.15.1-b;

f) DOT Specification 106A ton tanks shall only use forged-welded heads, convex to pressure. The forged-welded heads shall be torispherical with an inside radius not greater than the inside diameter of the shell. The heads shall be one piece, hot formed in one heat so as to provide a straight flange at least 100 mm (4 inches) long. The heads must have a snug fit into the shell;

g) DOT Specification 110A ton tanks shall only use fusion-welded heads formed concave to pressure. The fusion-welded heads shall be an ellipsoid of 2:1 ratio and shall be of one piece, hot formed in one heat so as to provide a straight flange at least 38 mm (1-1/2 inches) long;

h) All longitudinal welded joints on DOT Specification 106A and DOT Specification 110A ton tanks shall be a fusion weld. DOT Specification 106A ton tank head-to-shell attachments shall be a forged-welded joint.[6] DOT Specification 110A ton tank head-to-shell attachments shall be a fusion weld;

i) Postweld heat treatment is required after welding for all DOT Specification 106A and Specification 110A ton tanks;

j) DOT Specification 106A and DOT Specification 110A ton tanks shall be of such a design as to afford maximum protection to any fitting or attachment to the head, including loading and unloading valves. The protection housing[5] shall not project beyond the end of the ton tanks and shall be securely fastened to the tank head;

k) If applicable, siphon pipes and their couplings on the inside of the ton tank's head and lugs on the outside of the tank head for attaching valve protection housing shall be fusion welded prior to performing postweld heat treatment;

l) DOT Specification 106A and DOT Specification 110A ton tanks are required to be equipped with one or more approved types of pressure relief devices. The devices shall be made out of metal and the pressure relief devices shall not be subject to rapid deterioration by the lading. The device's inlet fitting to the tank shall be a screw-type fitting and installed or attached directly into the ton tank's head or attached to the head by other approved methods. For thread connections, the following shall apply:

   1) The threaded connections for all openings shall be in compliance with the National Gas Taper Threads (NGT);

   2) Pressure relief devices shall be set for start-to-discharge, and rupture discs shall burst at a pressure not exceeding the pressure identified in NBIC Part 2, Table S6.15.1-a; and

m) Fusible plugs, if used, shall be required to relieve the pressure from the tank at a temperature not exceeding 79°C (175°F) and shall be vapor tight at a temperature not exceeding 54°C (130°F).





~~6 The forged-welded joint shall be thoroughly hammered or rolled to ensure a sound weld.~~

| | |
|---|---|
| **Inquiry** | **IN15-0201** |
| **Source** | **We Energies** |
| **Subject** | Quality Control System responsibilities, Part 3, 1.6.1 |
| **Edition** | 2013 |
| **Inquirer's Question** | **Question 1**; Is it permissible to amend or revise the content or implementation of the Quality System, including the written Quality System Manual, without the direct involvement of the titled individual designated as responsible to ensure compliance as given in the Statement of Authority and Responsibility?<br><br>**Question 2**; Is it permissible for a single immediate supervisor to manage both quality and non-quality related work assigned to the titled individual designated as responsible for Quality System? |
| **Inquirer's Reply** | **Reply 1**; No – The titled individual designated as responsible for Quality System shall be fully involved in the preparation, planning and implementation of any and all amendments or revisions to the Quality System, including the written Quality System Manual. The Statement of Authority and Responsibility is required to grant the freedom and authority to carry out this responsibility.<br><br>**Reply 2**; No – Quality related functions shall follow the administrative relationship structure between the titled individual designated as responsible for Quality System and the officer of the organization who signed the Statement of Authority and Responsibility. The structure of the quality related system shall follow the Quality System organization chart, which addresses functions that affect quality. A single immediate supervisor managing both quality and non-quality related work details performed by the titled individual may be viewed as a conflict of interest. |
| **Committee's Question** | **Question 1: In an "R" Certificate Holder's Quality Control system, is it permissible for one individual to have dual responsibilities for management functions, such as Quality control functions and non-quality control functions, such as production?**<br><br>**Question 2: Is approval of revisions to the Quality Control Manual permitted to be made by someone other than the individual designated in the manual as responsible for approval of the revisions?** |
| **Committee's Reply** | **Reply 1: Yes, provided there is no conflict in enforcement of the quality control system and the functional responsibilities and duties are clearly described in the quality control manual.**<br><br>**Reply 2: No.** |
| **Rationale** | |
| **Prepared by:** | R. V. Wielgoszinski |
| **Revised by:** | |

| | |
|---|---|
| **Task Group** | |
| **NBIC** | |

**Interpretation IN15-0701**
**Proposed Interpretation**

| | |
|---|---|
| **Inquiry:** | IN15-0701 |
| **Source:** | Mr. Stephen Williams |
| **Subject:** | NBIC Part 3 Section 4 |
| **Edition:** | 2013 |
| **Question 1:** | If the original code of construction required a hydro test and the installer chose to do NDE in lieu of hydro and chose RT and the R stamp holder doing a repair on this section said they can't do a hydro and chooses to Liquid Penetrant test full penetration welds Does that mean they have to do RT in lieu of hydro? |
| **Reply 1:** | No proposed reply given |
| **Committee's Question:** | When the Inspector and, when required, the Jurisdiction agree that penetrant examination will provide meaningful results to verify the integrity of a weld repair, may penetrant examination of the repair be performed in lieu of a hydrostatic test? |
| **Committee's Reply:** | Yes. |
| **Rationale:** | Based on the nature and scope of the repair, the NBIC Part 3, Section 4, 4.4.1(e), allows use of NDE to verify the integrity of a repair. |
| **SC Vote** | |
| **NBIC Vote** | |

NB14-0203

**1.2 CONSTRUCTION STANDARDS FOR PRESSURE RETAINING ITEMS**

b) If the pressure-retaining item was not constructed to a construction code or standard, or when the standard governing the original construction is not the ASME Code or ASME RTP-1, repairs or alterations
shall conform, insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practicable, it is permissible to use other codes, standards, or specifications, including the ASME Code or ASME RTP-1, provided the "R" or "NR" Certificate Holder has the concurrence of the Inspector and the Jurisdiction where the pressure-retaining item is installed.

## 1.4 ACCREDITATION

a) Organizations performing repairs or alterations to pressure-retaining items shall be accredited as described in this section, as appropriate for the scope of work to be performed.

b) Organizations performing repairs outside the scope of the NBIC may be accredited and shall meet any additional requirements of the Jurisdiction where the work is performed.

## 1.5.1 ACCREDITATION PROCESS

a) The National Board administers accreditation programs for authorization of organizations performing repairs and alterations to pressure-retaining items in accordance with NB-415, Accreditation of "R" Repair Organizations ~~and/or pressure relief valves~~ ~~in accordance with NB-514~~

b) Any organization may apply to the National Board to obtain a *Certificate of Authorization* for the requested scope of activities. A review shall be conducted to evaluate the organization's quality system. The individual assigned to conduct the evaluation shall meet the qualification requirements prescribed by the National Board. Upon completion of the evaluation, any deficiencies within the organization's quality system will be documented and a recommendation will be made to the National Board regarding issuance of a *Certificate of Authorization*.

c) As part of the accreditation process, an applicant's quality system is subject to a review. National Board pro- cedures provide for the confidential review resulting in recommendations to issue or not issue a *Certificate of Authorization*.

d) The accreditation programs provide requirements for organizations performing repairs and alterations to pressure-retaining items. ~~Depending upon the expected scope of activities at the time of review, organiza- tions may be authorized to perform design only, metallic or non-metallic repairs, and/or alterations either in the shop only, field only,~~

~~or shop and field. Repairs and/or alterations to metallic and non-metallic pressure- retaining items are made by welding, bonding and/or mechanical assembly.~~

~~e) Organizations desiring to renew or obtain a National Board *Certificate of Authorization* shall apply to the National Board using forms obtained from the National Board. Application for renewal shall be made prior to the expiration date of the *Certificate of Authorization*.~~

~~f)~~e) ~~When an organization has plants or shops in more than one location, the organization shall submit separate applications for each plant or shop.~~ The organization may perform repairs or alterations in its plants, shops, or in the field, provided such operations are described in the organization's Quality System.

~~g)~~f) The Jurisdiction~~[2] m~~, as defined in Part 3, Section 9, may audit the Quality System and activities of an organization upon a valid request from

~~2 Jurisdiction: The National Board member jurisdiction where the organization is located. Alternatively, where the Jurisdiction elects not to~~

an owner, user, inspection agency, or the National Board.

~~h)~~g) The NBIC Committee may at any time change the rules for the issuance of Certificates of Authorization and use of the "R" Symbol Stamp. These rules shall become binding on all certificate holders.

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### 1.5.2 NATIONAL BOARD "R" SYMBOL STAMP

~~a) All "R" Symbol Stamps shall be obtained from the National Board of Boiler and Pressure Vessel Inspec- tors. Authorization to use the "R" Symbol Stamp may be granted by the National Board at its absolute discretion to the certificate holder.~~

~~b)~~a) The "R" Symbol Stamp is furnished on loan by the National Board for a nominal fee. ~~Each organization shall agree if authorization to use the "R" Symbol Stamp is granted, that the "R" Symbol Stamp is at all times the property of the National Board and will be promptly returned upon demand. If the organization discontinues the use of the "R" Symbol Stamp, inspection agreement with an Authorized Inspection Agency, or if the Certificate of Authorization has expired and no new certificate has been issued, the "R" Symbol Stamp shall be returned to the National Board.~~

~~c)~~b) ~~The organization's Quality System shall provide for adequate control of the "R" Symbol Stamp.~~ Provisions may be made for the issuance of the "R" Symbol Stamp for use at various field locations.

d) ~~The holder of a Certificate of Authorization may obtain more than one "R" Symbol Stamp provided the organization's Quality System describes how the use of such stamps is controlled from the location shown on the certificate.~~

e) ~~An organization shall not permit others to use the "R" Symbol Stamp loaned to it by the National Board.~~

c) Additional requirements shall be met in accordance with NB-415 Accreditation of "R" Repair Organizations. ~~and/or NB-514 as applicable.~~

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## 1.6 QUALITY SYSTEM

A holder of a National Board Certificate of Authorization shall have and maintain a written Quality System. The System shall satisfactorily meet the requirements of the NBIC and shall be available for review. The Quality System may be brief or voluminous, depending on the projected scope of work. It shall be treated confidentially by the National Board.

### 1.6.1 OUTLINE OF REQUIREMENTS FOR A QUALITY SYSTEM FOR QUALIFICATION FOR THE NATIONAL BOARD "R" *CERTIFICATE OF AUTHORIZATION*

The following is a guide for required features of a Quality System which shall be included in the organization's Quality System Manual. As a minimum, each organization shall address the required features relative to the scope of work to be performed. Organizations shall explain their intent, capability and applicability for each required feature outlined in this section. Work may be subcontracted provided controls are clearly defined for maintaining full responsibility for code compliance by the National Board repair organization certifying the work.

a) **Title Page**

The name and complete address of the company to which the National Board *Certificate of Authorization*
is issued shall be included on the Title Page of the Quality System Manual.

b) **Contents Page**

~~perform the review or where there is no Jurisdiction or where the Jurisdiction is the organization's Authorized Inspection Agency, the National Board of Boiler and Pressure Vessel Inspectors will represent the Jurisdiction. At the Jurisdiction's discretion, the Jurisdiction may choose to be a member of the review team if the Jurisdiction chooses not to be the team leader.~~

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The manual should contain a page listing the contents of the manual by subject, number (if applicable), and revision number of each document.

c) **Scope of Work**

The manual shall clearly indicate the scope and type of repairs or alterations the organization is capable of and intends to carry out.

d) **Statement of Authority and Responsibility**

A dated *Statement of Authority*, signed by an officer of the organization, shall be included in the manual.
Further, the *Statement of Authority* shall include:

1) A statement that all repairs or alterations carried out by the organization shall meet the requirements of the NBIC and the Jurisdiction, as applicable;

2) A statement that if there is a disagreement in the implementation of the Quality System, the matter is to be referred for resolution to a higher authority in the company;

3) The title of the individual who will be responsible to ensure that 1) above is followed and has the freedom and authority to carry out the responsibility.

e) **Manual Control**

The manual shall include the necessary provisions for revising and issuing documents to keep the manual current. The title of the individual authorized to approve revisions shall be included in the manual. Revi- sions must be accepted by the Authorized Inspection Agency prior to issuance of the manual and its implementation.

f) **Organization**

An organizational chart shall be included in the manual. It shall include the title of the heads of all depart- ments or divisions that perform functions that can affect the quality of the repair or alteration, and it shall show the relationship between each department or division.

The manual shall identify the title of those individuals responsible for preparation, implementation, or veri- fication of the Quality System. The responsibilities shall be clearly defined and the individuals shall have the organizational freedom and authority to fulfill those responsibilities.

g) **Drawings, Design and Specifications**

The manual shall contain controls to ensure that all design information, applicable drawings, design calcula- tions, specifications, and instructions are prepared or obtained, controlled, and interpreted in accordance with the original code of construction.

h) **Repair and Alteration Methods**

The manual shall include controls for repairs and alterations, including mechanical assembly procedures, materials, nondestructive examination methods, pre-heat, and postweld heat treatment, as applicable. Special requirements such as nonmetallic repairs and alterations to graphite and fiber-reinforced thermo- setting plastic pressure-retaining items including bonding or mechanical assembly procedures shall be addressed, if applicable.

i) **Materials**

The manual shall describe the method used to ensure that only acceptable materials (including welding material) are used for repairs and alterations. The manual shall include a description of how existing material is identified and new material is ordered, verified, and identified. The manual shall identify the title of the individual(s) responsible for each function and a brief description of how the function is to be performed.

j) **Method of Performing Work**

The manual shall describe the methods for performing and documenting repairs and alterations in suf- ficient detail to permit the Inspector to determine at what stages specific inspections are to be performed. The method of repair or alteration must have prior acceptance of the Inspector.

k) **Welding, NDE and Heat Treatment**

The manual shall describe controls for welding, nondestructive examination, and heat treatment. The manual is to indicate the title of the individual(s) responsible for the welding procedure specification (WPS) and its qualification, and the qualification of welders and welding operators. It is essential that only welding procedure specifications and welders or welding operators qualified, as required by the NBIC, be used in the repair or alteration of pressure-retaining items. It is also essential that welders and welding operators maintain their proficiency as required by the NBIC, while engaged in the repair or alteration of pressure- retaining items. The manual shall also describe controls for ensuring that the required WPS or Standard Welding Procedure Specification (SWPS) is available to the welder or welding operator prior to welding. Similar responsibility for nondestructive examination and heat treatment shall be described in the manual.

l) **Examinations and Tests**

Reference shall be made in the manual for examinations and tests upon completion of the repair or alteration.

m) **Calibration**

The manual shall describe a system for the calibration of examination, measuring, and test equipment used in the performance of repairs and alterations.

n) **Acceptance and Inspection of Repair or Alteration**

The manual shall specifically indicate that before the work is started, acceptance of the repair/alteration shall be obtained from an Inspector who will make the required inspections and confirm NBIC compliance by signing and dating the applicable NBIC Report Form [3] upon completion of the work.

The manual shall specifically address allowance for acceptance of the inspector for application of the “R” symbol stamp to a pressure retaining item.

The manual shall provide for adequate control of the “R” Symbol Stamp.

o) **Inspections**

The manual shall make provisions for the Inspector to have access to all drawings, design calculations, specifications, procedures, process sheets, repair or alteration procedures, test results, and other docu- ments as necessary to ensure compliance with the NBIC. A copy of the current manual shall be available to the inspector.

p) **Report of Repair or Alteration Form**

The manual shall indicate the title of the individuals responsible for preparing, signing, and presenting the

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NBIC Report Forms to the Inspector. The distribution of the NBIC Report Forms[3] shall be described in the manual.

q) **Exhibits**

Any forms referenced in the manual shall be included. The form may be a part of the referencing docu- ment or included as an appendix. For clarity, the forms may be completed and identified as examples. The name and accepted abbreviations of the “R” Certificate Holder shall be included in the manual.

r) **Construction Code**

The manual shall include provisions for addressing the requirements that pertain to the specific construc- tion code for the equipment being repaired or altered.

s) **Nonconforming Items**

There shall be a system acceptable to the Inspector for the correction of nonconformities. A nonconfor- mance is any condition that does not comply with the applicable rules of the NBIC, construction code, jurisdictional requirements, or the quality system. Nonconformance must be corrected or eliminated before the repaired or altered component can be considered in compliance with the NBIC.

t) **Records Retention**

The quality manual shall describe a system for filing, maintaining, and easily retrieving records support- ing or substantiating the administration of the Quality System within the scope of the “R” Certificate of Authorization.

1) Records may represent any information used to further substantiate the statements used to describe the scope of work completed to a pressure-retaining item (PRI), and documented on a Form “R” report.

2) Records are not limited to those depicting or calculating an acceptable design, material compliance or certifications, NDE-reports, PWHT-charts, a WPS used, a welder, bonder, or cementing technician’s process continuity records, drawings,

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sketches, or photographs.

3) The record retention schedule described in the Quality System Manual is to follow the instructions identified in NBIC Part 3, Table 1.6.5.1.

**Table 1.6.5.1**

| Form "R" Reports, Records, or Documents | Instructions | Minimum Retention Period |
|---|---|---|
| a) Form "R" Reports and supporting records and documentation | The organization performing repairs and alterations shall retain a copy of the completed "R" Form report on file, and all records substantiating the summary of work described in NBIC Part 3, 5.13.4.1, Item 12, for a minimum of 5 years. When the method of repair described in NBIC Part 3, 3.3.4.8 is used, the record retention period shall be described in b) | 5 years |
| b) Form "R" Report with REPORT OF FITNESS FOR SERVICE ASSESSMENT FORM (NB-403) attached. | When the method of repair described in NBIC Part 3,3.3.4.8 is used, the record retention period shall be for the duration described on the FITNESS FOR SERVICE ASSESSMENT (FFSA) Form required by the repair method and as described in NBIC Part 2, 4.4<br><br>Notes:<br><br>1. The "R" Certificate Holder should be aware that when used, some of the referenced codes and standards identified in NBIC Part 2,, 1.3 describe requirements for permanent record retention throughout the service life of each equipment item.<br>2. When the "R" Certificate Holder is not the owner or user of the equipment, the record retention period is limited to the FFSA-results described on line 8 of the Report of Fitness for Service Assessment Form (NB-403) | 5 years or as described on line 8 as reported on Form NB-403; whichever period is longer |

~~3~~2 NBIC Report Form: National Board Form R-1 for Repair, Form R-2 for Alterations, Form R-3 for Fabricated Parts, or Form R-4 Report Supple mentary Sheet.

| | | |
|---|---|---|
| c) Continuity records for a welder, welding operator, bonder, or cementing technician | Minimally, continuity records for a welder, bonder, or cementing technician within the Certificate Holder's quality system shall be described and established at the time of the applicant's initial certificate review and demonstrated at each triennial review required thereafter. | As applicable to the scope of work identified on the Certificate of Authorization, the continuity records are subject to review during each National Board triennial certificate review. |
| d) Administrative record review of the "R" Certificate Holder's administrative processes. | Records supporting completed administrative reviews or audits of procedures or processes required by the "R" Certificate Holder's Quality System Manual, or in combination with the applicable part of the NBIC Part 3, Supplementary Section 6 as it applies to the identified scope listed on the "R" Certificate of Authorization. | Subject to review during the triennial evaluation of the certificate holder's Quality System. |

1.7 ACCREDITATION OF "VR" REPAIR ORGANIZATIONS

1.7.1 Scope

~~These administrative rules and procedures are provided by the National Board for those who wish to obtain National Board Authorization for use of the "VR" (Repair of Pressure Relief Valves) symbol stamp. It should be noted that the issuance of the "VR" stamp is not restricted to companies whose primary business is the repair of pressure relief valves, nor to manufacturers or assemblers that hold and ASME "V", "HV", "UV", or "NV" Code Symbol Stamp. Owners and users of boilers and pressure vessels and other organizations that qualify in accordance with the National Board Rules may also obtain the "VR" Certification and stamp.~~

a) This section provides requirements that must be met for an organization to obtain a National Board *Certificate of Authorization* to use the "VR" Symbol Stamp for repair activates of pressure relief devices constructed in accordance with the requirements of the ASME Code.

b) For administrative requirements to obtain or renew a National Board "VR" Certificate of Authorization and "VR" Symbol Stamp, refer to National Board Procedure NB-514, Accreditation of "VR" Repair Organizations.

Footnote: Requirements for Accreditation of "VR" Repair Organizations NB-514, may be found on the NB website www.nationalboard.org under the "Stamps and Marks" tab.

# FORM R-1 REPORT OF REPAIR

in accordance with provisions of the *National Board Inspection Code*

(Authorized Rep. initials)

(Inspectors initials)

(Form **"R"** Registration no.)

(P.O. no., job no., etc.)

1. WORK PERFORMED BY: ______________________
(name of repair organization)

______________________
(address)

2. OWNER: ______________________
(name)

______________________
(address)

3. LOCATION OF INSTALLATION: ______________________
(name)

______________________
(address)

4. ITEM IDENTIFICATION: ______________ NAME OF ORIGINAL MANUFACTURER: ______________
(boiler, pressure vessel, or piping)

5. IDENTIFYING NOS: ______________ ______________ ______________ ______________ ______________
(mfg. serial no.) (National Board no.) (jurisdiction no.) (other) (year built)

6. NBIC EDITION/ADDENDA: ______________ ______________
(edition) (addenda)

Original Code of Construction for Item: ______________ ______________
(name / section / division) (edition / addenda)

Construction Code Used for Repair Performed: ______________ ______________
(name / section / division) (edition / addenda)

7. REPAIR TYPE: ☐ welded ☐ graphite pressure equipment ☐ FRP pressure equipment ☐ DOT

8. DESCRIPTION OF WORK: ☐ Form R-4, Report Supplementary Sheet is attached ☐ FFSA Form (NB-403) is attached
(use Form R-4, of neccessary))

______________ Pressure Test, if applied ______________ psi MAWP ______________ psi

9. REPLACEMENT PARTS: (Attached are Manufacturer's Partial Data Reports or Form R-3's properly completed for the following items of this report):
(name of part, item number, data report type or certificate of Compliance, mfg's. name and identifying stamp)

10. REMARKS:

(Form **"R"** Registration no.)

(P.O. no., job no., etc.)

**CERTIFICATE OF COMPLIANCE**

I, ____________________, certify that to the best of my knowledge and belief the statements made in this report are correct and that all material, construction, and workmanship on this Repair conforms to the *National Board Inspection Code*. National Board "**R**" *Certificate of Authorization* No. ____________________ expires on ____________, ____________

Date ____________, ____________________ Signed ____________________

(name of repair organization) (authorized representative)

**CERTIFICATE OF INSPECTION**

I, ____________________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of ________________ and employed by ____________________ of ____________________ have inspected the work described in this report on ____________, ________________ and state that to the best of my knowledge and belief, this work complies with the applicable requirements of the National Board Inspection Code. By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Date ____________ Signed ____________________ ____________________

(inspector) (National Board and Jurisdiction no.)


Attachment Page 157

NB15-1201

Part 3, Paragraph 5.6

### 5.5 REGISTRATION OF ~~"R"~~ FORMS — GENERAL

a) When registration of the ~~f~~Forms ~~"R" Report~~ is required, the ~~"R"~~ Certificate Holder performing a repair or alteration shall submit the completed ~~Form "R" Report~~form, meeting the requirements of the ~~code~~NBIC, to the National Board.

b) When registration of the ~~Form "R" Report~~forms is not required ~~by the code~~, the ~~"R"~~ Certificate Holder may register the completed ~~Form "R" Report ,~~form, meeting the requirements of the ~~code~~NBIC, with the National Board.

c) The "R", "NR", and "VR Certificate Holder should be aware that some Jurisdictions may require registration of repairs and alterations with the National Board.

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### 5.5.4 REGISTRATION FOR NUCLEAR REPAIR/REPLACEMENT ACTIVITIES

Organizations performing repair/replacement activities under the "NR" or "NVR" stamp program shall register forms with the National Board.

### 5.6 ~~FORM "R" LOG~~FORM REGISTRATION LOG

~~The~~ "R", "NR", and "VR" Certificate Holders shall maintain a ~~single~~ log or multiple logs documenting unique and sequentially numbered Form "R" Reports ~~(e.g., R-1, R-2, and R-3)~~ that are registered with the National Board. The logs shall include, as a minimum, form type (R-1, R-2, NR-1, etc.), description of work performed, date completed, and date report sent to the National Board.

# Item NB15-1403 Rev 10

# NBIC Part 3 PROPOSED SUPPLEMENT

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## Supplement X

## WELD AND POST REPAIR INSPECTION OF CREEP STRENGTH ENHANCED FERRITIC STEELS

### SX.1 SCOPE

The technical information provided in this supplement pertains to weld repair and post repair inspection of ~~heavy wall~~ creep strength enhanced ferritic steel (CSEF) pressure retaining items. This Supplement provides guidance for full penetration and partial penetration weld repairs not covered under Welding Method 6 (2.5.3.6).

Creep Strength Enhanced Ferritic alloys (CSEF's) are a collection of ferritic steels whose creep strength is enhanced by the creation of a precise condition of micro-structure, specifically martensite or bainite, which is stabilized during tempering by controlled precipitation of temper-resistant carbides, carbo-nitrides, or other stable and/or meta-stable phases. Careful consideration shall be given to pressure-retaining items that are fabricated from CSEF's. The behavior of these materials in low temperature (i.e. fracture toughness and/or fatigue) and in high temperature (i.e. creep and/or creep-fatigue) components can be degraded by not adhering to the welding procedures and improper application of post-weld heat treatment (PWHT).

Post Construction access and in-service operation may not allow the practicable application of PWHT following original construction fabrication requirements and repair weld joint design. This supplement provides guidelines for weld repair options and post repair inspection using a well-engineered approach for CSEF steels. The user is cautioned to seek technical guidance for welding and selection of heat treating requirements.

### SX.2 WELD REPAIR OF GRADE 91 STEEL

#### SX.2.1 Weld Repair Options

**SX.2.1.1 9Cr-1Mo-VNbN Filler Metal (i.e. matching to Grade 91) + Controlled Fill + Low PWHT (Minimum temperature is 1250°F, 675°C).** Acceptable filler materials are referenced in Table 1. The minimum time and maximum heat treatment temperature shall be in accordance with the original code of construction. For reference, where the Ni+Mn content of the filler metal *is not* *known*, the maximum PWHT temperature shall be 1425°F (775°C). As general best practice, this maximum should be enforced to avoid over-tempering or exceeding the absolute maximum PWHT temperature. PWHT hold times at temperature shall be as follows;

a. Minimum holding time at PWHT temperature is specified as 1 hour per 1.0 inch (25 mm) of thickness, 30 minute minimum provided the component < 0.5 inches (12.5 mm) in thickness;

b. Minimum holding time at PWHT temperature is specified as 5 hours plus 15 minutes for each additional 1.0 inch (25 mm) over 5.0 inches (125 mm);

**SX.2.1.2 9Cr-1Mo Filler Metal + Controlled Fill and No PWHT.** Acceptable filler materials are detailed in Table 1.

**SX.2.1.3 Ni-base Filler Metal + Controlled Fill and No PWHT.** Acceptable nickel base consumables include selected ASME F No. 43 filler metals as detailed in Table 1.

**Table 1. Alternative Weld Repair Methods, Filler Metals and Welding Processes for Grade 91 Steel.**

| Acceptable Weld Repair Method | | Welding Process and Filler Metal AWS Classification |
|---|---|---|
| **Filler Metal** | **Welding Procedure** | |
| Matching (9Cr-1Mo-VNbN) | Controlled Fill + Low PWHT | • SMAW – E9015-B9, E9016-B9, E9018-B9 or E9015-B91[A], E9016-B91[A] or E9018-B91[A]<br>• FCAW – E91T1-B9 or E91T1-B91[A]<br>• GTAW – ER90S-B9 or ER90S-B91[A] |
| 9Cr-1Mo | Controlled Fill | • SMAW – E8015-B8, E8016-B8 or E8018-B8<br>• FCAW – E81T1-B8<br>• GTAW – ER80S-B8 |
| Ni-base | Controlled Fill | • SMAW – EPRI P87[B], ENiCrFe-2, ENiCrFe-3<br>• FCAW – None available<br>• GTAW – EPRI P87[C], ERNiCr-3 |

[A] –B91 AWS classification is pending for the various Grade 91 filler metal product forms (currently –B9)
[B] Incorporated by ASME B&PV Code as Code Case 2734 for classification as an F No. 43 filler material
[C] Incorporated by ASME B&PV Code as Code Case 2733 for classification as an F No. 43 filler material

**SX.2.2 Application of Controlled Fill Welding Procedure**

SX.2.2.1 The minimum preheat for the repair procedure shall be 300 $^{o}$F (150 $^{o}$C). The preheat temperature shall be checked to ensure the minimum preheat temperature is maintained during all welding and until welding is completed. The maximum interpass temperature shall be 550 $^{o}$F (290 $^{o}$C). At the completion of welding, a post weld hydrogen bake-out is not required nor prohibited.

SX.2.2.2 In general, to control heat input, it is recommended to weld the repair groove using a “controlled fill” technique. In this technique, the first layer in contact with the repair groove can be identical or smaller in diameter than the fill passes, as shown in Figure 1.

SA2.2.3 Figures 2 through 4 illustrate the various types of recommended weld joint details using the controlled fill technique for full penetration weld repairs.

SX.2.2.4~~3~~ The bead-to-bead overlap should be ~50% or greater. The fill passes should be deposited working from the bevel towards the center of the excavation with a minimum overlap of 25% and ideally 50%. As a rule of thumb, if the welder aims for the toe of the previously deposited weld bead, an overlap of at least 40% will be achieved.

SX.2.2.5~~4~~ When the SMAW process is specified using ferrous filler metals for an initial fill pass layer as a controlled fill welding technique, the electrode diameter is restricted to a maximum size of 1/8 in. (3.2 mm), as shown in Figure 1. The remaining passes to fill this excavation using this technique and SMAW process are limited to an electrode diameter of 5/32 in. (4.0mm). When the GTAW process is specified, any limits for filler metal size shall be reflected in the qualified PQR and WPS.

***Notes:***

1. *The excavation must have rounded corners to prevent lack of fusion. It may be advisable to use a smaller diameter electrode (such as 2.5 mm or 3/32 in.) to ensure good tie in.*
2. *The repair cavity width must be excavated at least 10 mm (3/8 in.) beyond the fusion line of the original weld*
3. *The fill passes along the bevel shall be restricted in height so as to not reduce access to the bottom of the excavation for the welder*

***Additional Instructions:***

- *Deposit fill passes working "outside-in", whereby the fill passes are first deposited on each side of the excavation and additional fill passes are deposited welding towards the center of excavation*
- *~50% overlap is desirable for all welding passes either in contact with the bevel or fill. This is accomplished by positioning the electrode at the toe of the previously deposited weld bead.*
- *Stringer beads only for all welding passes either in contact with the bevel or fill*
- *A 2.5 mm (3/32 in.) diameter electrode may be utilized for the weld passes in contact with the bevel but is not mandated nor required for acceptable performance*

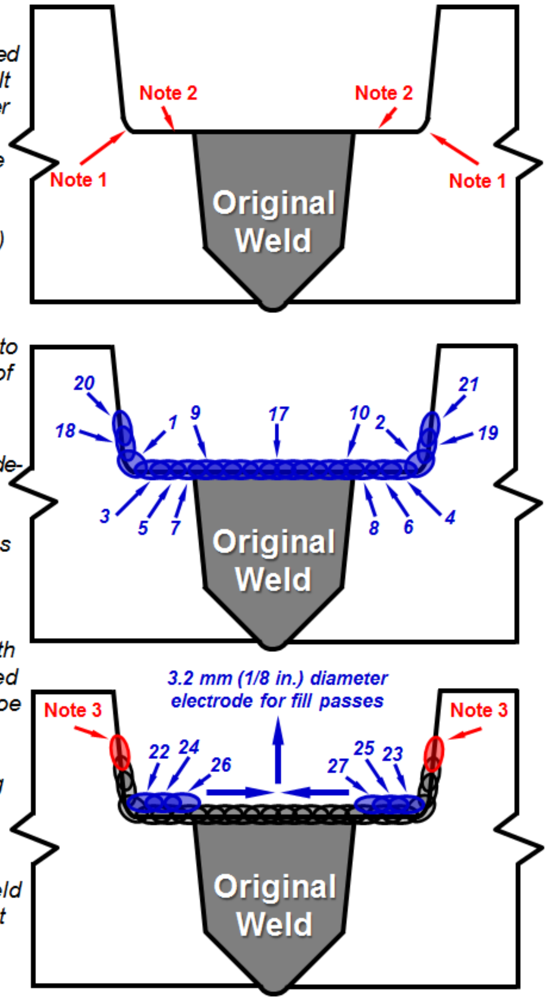
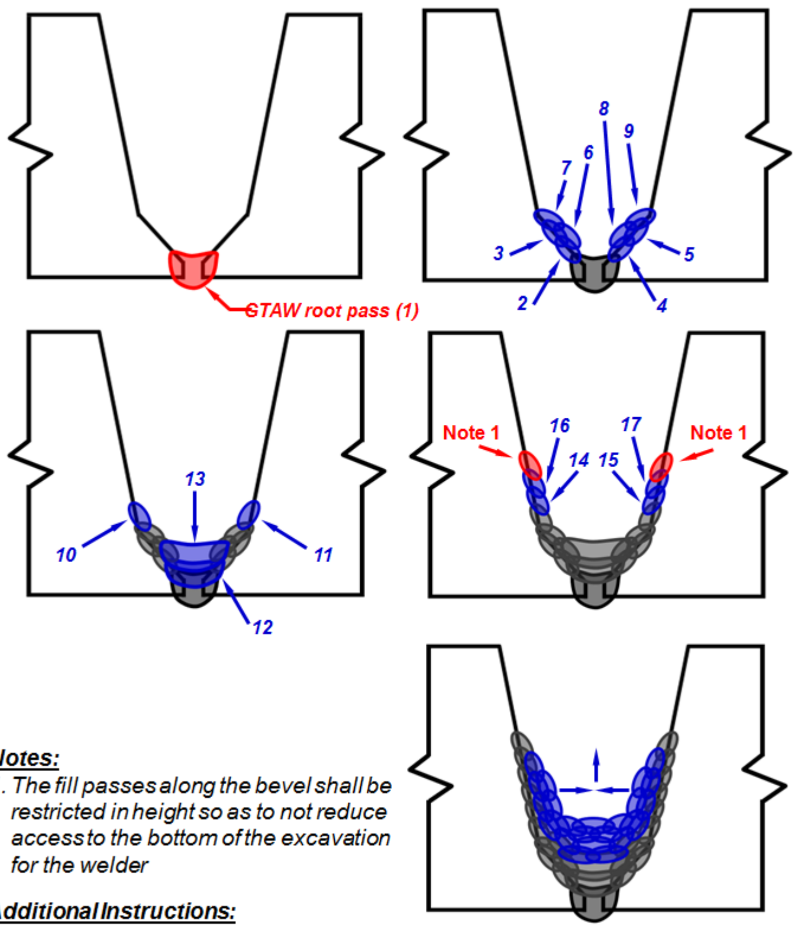



**Figure 1. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for a Partial Penetration Weld Repair ~~of a Circumferential Girth Weld~~.**




***Notes:***

*1. The fill passes along the bevel shall be restricted in height so as to not reduce access to the bottom of the excavation for the welder*

***Additional Instructions:***

*• Deposit fill passes working "outside-in", whereby the fill passes are first deposited on each side of the excavation and additional fill passes are deposited welding towards the center of excavation*

*• ~50% overlap is desirable for all welding passes either in contact with the bevel or fill. This is accomplished by positioning the electrode at the toe of the previously deposited weld bead.*

*• Stringer beads only for all welding passes either in contact with the bevel or fill*

*• A 2.5 mm (3/32 in.) diameter electrode may be utilized for the weld passes in contact with the bevel but is not mandated nor required for acceptable performance*

**Figure 2. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for a Full Penetration Weld Repair Using a Compound Bevel.**

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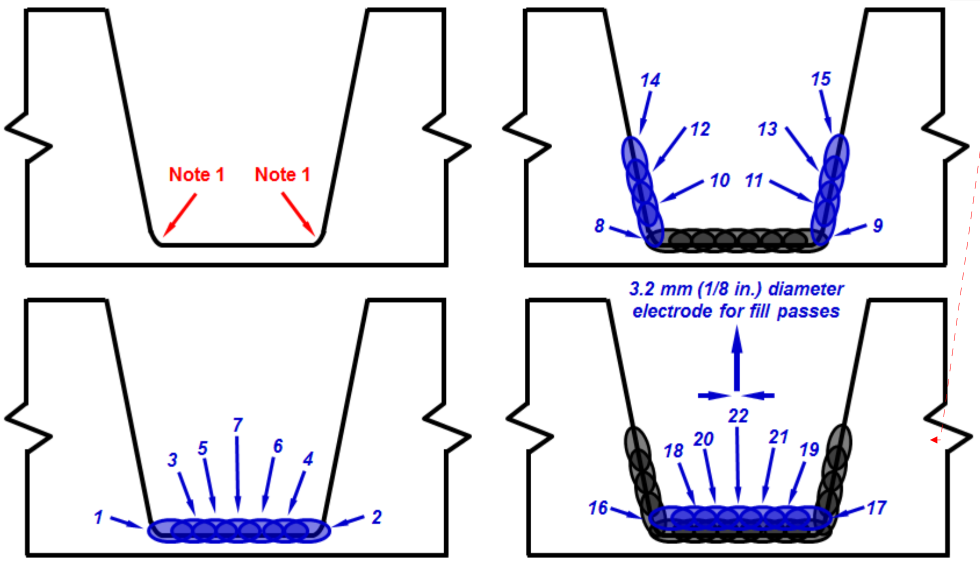


***Notes:***

*1. The excavation must have rounded corners to prevent lack of fusion. It may be advisable to use a smaller diameter electrode (such as 2.5 mm or 3/32 in.) to ensure good tie in.*

***Additional Instructions:***

- *Deposit fill passes working "outside-in", whereby the fill passes are first deposited on each side of the excavation and additional fill passes are deposited welding towards the center of excavation*
- *~50% overlap is desirable for all welding passes either in contact with the bevel or fill. This is accomplished by positioning the electrode at the toe of the previously deposited weld bead.*
- *Stringer beads only for all welding passes either in contact with the bevel or fill*
- *A 2.5 mm (3/32 in.) diameter electrode may be utilized for the weld passes in contact with the bevel but is not mandated nor required for acceptable performance*

**Figure 3. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for Full Penetration Weld Repair Using a Land.**

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***Notes:***

1. *The excavation must have rounded corners to prevent lack of fusion. It may be advisable to use a smaller diameter electrode (such as 2.5 mm or 3/32 in.) to ensure good tie in.*
2. *The repair cavity width must be excavated at least 10 mm (3/8 in.) beyond the fusion line of the original weld*
3. *The fill passes along the bevel shall be restricted in height so as to not reduce access to the bottom of the excavation for the welder*

***Additional Instructions:***

- *Deposit fill passes working "outside-in", whereby the fill passes are first deposited on each side of the excavation and additional fill passes are deposited welding towards the center of excavation*
- *~50% overlap is desirable for all welding passes either in contact with the bevel or fill. This is accomplished by positioning the electrode at the toe of the previously deposited weld bead.*
- *Stringer beads only for all welding passes either in contact with the bevel or fill*
- *A 2.5 mm (3/32 in.) diameter electrode may be utilized for the weld passes in contact with the bevel but is not mandated nor required for acceptable performance*

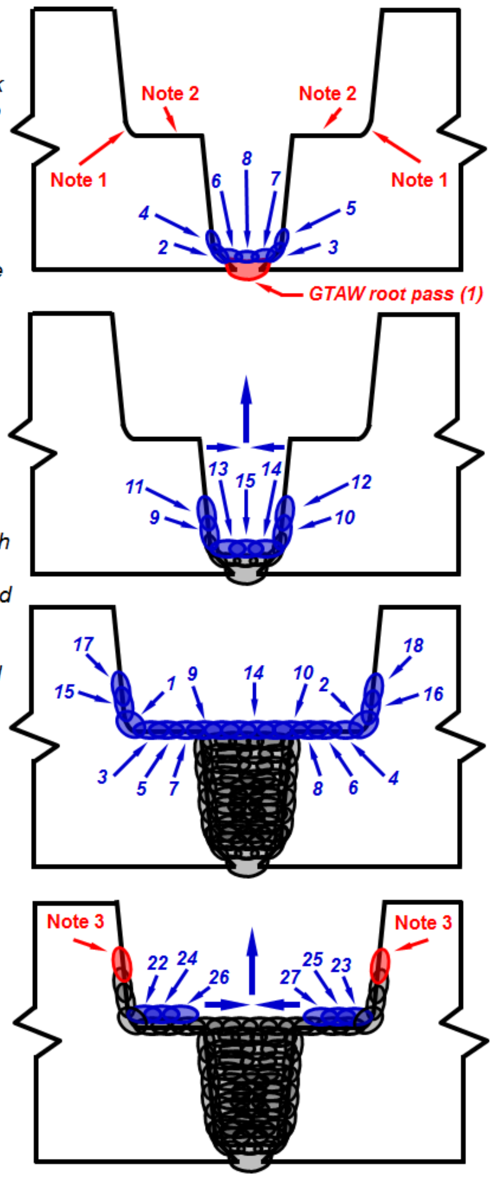


**Figure 4. Schematic of the Controlled Fill Welding Procedure for Grade 91 Steel for a Full Penetration Weld repair Using a Step Weld Preparation.**

**SX.2.3 Qualification of Controlled Fill Welding Procedure**

SX.2.3.1 The test material for the welding procedure qualification shall be P-No 15E, Group 1, Grade 91.

SX.2.3.2 Qualification thickness for the test plates and repair groove depths shall be in accordance with ASME Section IX.

SX.2.3.3 The Welding Procedure Specification (WPS) shall be qualified in accordance with requirements of ASME Section IX. If qualifying the WPS with PWHT, the PWHT is to be low temperature PWHT, i.e., a minimum temperature of 1250 deg F (675 deg C) and a maximum temperature of 1445 deg F(785 deg C).

SX.2.3.4 For qualification of weld repair procedures using 9Cr-1Mo filler metal and in the as-welded condition, the requirements for the bend test shall be performed using a bend radius which achieves a minimum of 14% elongation in the outer fibers.

**SX.3 POST REPAIR INSPECTION**

X.3.1 After the completion of weld repairs to CSEF steels, post inspection requirements shall be developed and implemented based on acceptance from the Inspector, and if applicable, the Jurisdiction.

X.3.2 Post-repair i~~I~~nspection ~~method and~~ intervals and methods of examination shall be implemented to ensure safe operation and margin to locate and monitor defect growth in the weld repair~~ed~~ area~~s~~. The selected non-destructive examination method ~~evaluation method~~ shall provide meaningful results and shall follow NBIC Part 3, Section 4.~~concerning the integrity of the repair weld~~.

X.3.3 Post repair inspection shall be on-going until the component reaches end of life or is replaced. A recommended re-inspection interval is every other planned major outage or six years, whichever is less. The Owner/User may revise the re-inspection interval based on inspection results from previous inspections.

**For NBIC Committee use only**

NB15-1404

# Glossary of Terms

**9.1 DEFINITIONS**

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

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

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

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

**ADD**

**Existing Material--- The actual material of the pressure retaining item at the location where the repair or alteration is to be performed.**

## *NBIC Sub-Group Repairs & Alterations*

| | |
|---|---|
| ***Subject:*** | Leak tightness by seal welding a designed inspection or maintenance access opening |

| | |
|---|---|
| ***NB-Item number:*** | NB15-1801 |

| | |
|---|---|
| ***Explanation of assignment needed:*** | Is it reasonable to add as a routine repair activity, the replacement of a seal weld when the pressure retaining item's design and leak tightness are derived in combination from using a seal weld of limited size? |

| | |
|---|---|
| ***Assigned to:*** | M. Webb |

| | |
|---|---|
| ***Background:*** | Inspection and maintenance openings are routinely designed to allow access to assess equipment condition and exercise maintenance activities in concert with reliability and safety. By design, pressure retention is assured by mechanical interface.<br><br>By design, some openings include a seal weld to assure leak tightness and the weld is not considered to add strength or to enhance the item's pressure retaining capability. Routinely, the Manufacturer provides time-proven instruction for their replacement, routinely following the governing rules from the original code of construction, exempting the seal weld and weldment from PWHT and citing VT-examination throughout the installation, both within the established parameters of a routine repair.<br><br>*See the Interpretations 07-10, 01-09, PCC-2, Article 2.3 (2011) on pg-2, and an example of Instructions on pg-3 supporting this proposed action as a routine activity …* |

| | |
|---|---|
| ***Current Wording:*** | NBIC, Part 3, paragraph 3.3.2 (e) items 1-4: *Not recognized currently as a routine repair.* |

| | |
|---|---|
| ***Proposal:***<br>***double underline*** | New paragraph 3.3.2. (e) 5):<br>5) Seal welding a mechanical connection for leak tightness where by-design, the pressure retaining capability is not contingent on the weld for strength and requires no PWHT.<br><br>(B. Wiegoszinski's original proposal, 1-21-15: Seal welding of mechanical connections provided postweld heat treatment is not required by the Code of construction.") |

## *NBIC Sub-Group Repairs & Alterations*

**INTERPRETATION 11-01**

**Subject:** Part 3, 3.3.2

**Edition:** 2011

**Question:** In Part 3, 3.3.2 d), is the replacement scope or the number of valves, fittings, tubes, or pipe NPS 5 in diameter and smaller, or sections thereof, a consideration when determining if the work is a routine repair?

**Reply:** No. The NBIC does not address the magnitude of work or scope in qualifying repairs as routine but rather addresses the exceptions representing routine repairs as noted within Part 3, 3.3.2 d) 1).

**INTERPRETATION 07-10**

**Subject:** Part 3, 3.3.2 and 3.3.3

2007 Edition with 2009 Addendum

**Question:** Is it the intent of the NBIC that weld build-up of a damaged gasket surface on a flange where neither PWHT no NDT is required by the code of construction considered a routine repair?

**Reply:** Yes, provided the "R" Certificate Holder's quality system program describes the process for identifying, controlling and implementing routine repairs.

**INTERPRETATION 01-09**

**Subject:** RC-2031(a)(1) Routine Repairs

1998 Edition with 2000 Addendum

**Question:** Is the seal welding of tubes which are five NPS in diameter and less considered a routine repair?

**Reply:** Yes.

NBIC Part-3,
3.2.6 REFERENCE TO OTHER CODES AND STANDARDS (can provide useful guidance)
(c) ASME PCC-2, Repair of Pressure Equipment and Piping-

ASME PCC-2, Article 2.3, (2011)- seal welded threaded connections and seal weld repairs
3.1 (a) The seal weld shall only be used to provide the hermetic seal, not the mechanical strength to the joint.

## INSTRUCTION EXAMPLE:

**B&W** babcock & wilcox power generation group

**Plant Service Bulletin**

### *Master Hand Hole (MHH) Plug Welding Recommendations*

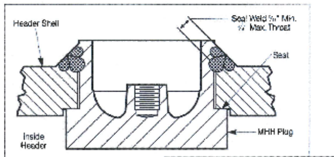


**Figure 1** ***Master Hand Hole plug welding.***

***Purpose***

This plant service bulletin advises owners and operators of B&W equipment on the recommended seal welding procedure for Master Hand Hole (MHH) plugs.

***Problem***

MHH plugs are available in carbon steel (SA-181-70) or 2¼Cr-1Mo (SA-182 F22 CL3) for installation in various header and piping materials. Some seal welding methods have resulted in weld failure.

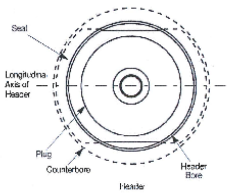


**Figure 2** ***Orientation of MHH plug shear bars to axis of header.***

***Recommendation***

The recommended welding procedure for the installation of a new MHH plug or the re-use of an old plug is the same. Plug material identification is stamped on the bottom (rounded) surface. Carbon-steel MHH plugs are stamped 80MM, SM17, SM16 or SM70SI. 2¼Cr-1Mo MHH plugs are stamped 78MM, AM17, AM16 or AM70SI.

It is acceptable to re-use an old MHH plug if it can be cleaned up and weld metal can replace any removed MHH plug material, while providing the required fillet weld throat (Figure 1). If the MHH seat is damaged, it can be weld repaired and machined. **(Caution: Machining must not enlarge diameter of hole.)**

MHH plugs should be installed and seal welded using the following procedure:

1. Repair any damage to the header, including any necessary weld repair and PWHT. Do not attempt any weld repair to the header while welding in the hand hole cap.

2. Thoroughly clean the MHH plug shaft and seat, as well as the header seat, bore and welding surfaces, by removing all weld spatter, debris, oxides, paint and preservatives.

3. Install hand hole plug into header, align the MHH plug shear lugs with the axis of the header (Figure 2) and pull the plug snugly against the header seat with a mechanical device.

4. Experience has shown that a 1/8"-diameter electrode is satisfactory. Electrode material selection is based on the material of the MHH and header and is shown in Table 1. The electrode should be heated to 250°– 400°F for at least two hours prior to using.

5. Preheat the header and plug to the temperature listed in Table 1, and maintain preheated temperature during the entire welding process, including the time

*(continued on reverse side)*

EXAMPLE:
Page 1 and 2 of instructions offered by Babcock & Wilcox for installing Master Hands Hold illustrating a seal weld of limited size;

"6. Seal weld with three passes (reference Figure 1) checking the root pass visually for cracks …The seal weld throat dimension should be a minimum of 5/16" and maximum of 3/8"."

"7. Immediately following welding, visually inspect…"
The above procedure eliminates the need for stress relieving the seal weld in any of the material grades and is the reason a seal weld, rather than a strength weld, is recommended. The maximum throat dimension of the seal weld is 3/8" to comply with the post-weld heat treatment exemptions listed in ASME Section I PW-39. "

between weld passes. The base header material should be preheated for a distance equal to the thickness of the header, but not less than 3" in all directions from the point prior to welding.

6. Seal weld with three passes (reference Figure 1), checking the root pass visually for cracks before proceeding. Small tack welds are not advised due to the tendency for cracking. Do not remove the mechanical device until after completion of all fillet weld passes. The seal weld throat dimension should be a minimum of 5/16" and a maximum of 3/8".

7. Immediately following welding, visually inspect and remove the mechanical device, cover the area with an insulating blanket, and allow to cool to ambient temperature.

The above procedure eliminates the need for stress relieving the seal weld in any of the material grades and is the reason a seal weld, rather than a strength weld, is recommended. The maximum throat dimension of the seal weld is 3/8" to comply with the post-weld heat treatment exemptions listed in ASME Section I PW-39. A weld throat dimension in excess of 3/8" is possible, but this would violate the ASME Section I rules for exemption from post-weld heat treatment.

***Support***

Contact Field Service Engineering through your local B&W district service office to coordinate your inspection and repair efforts, and to answer any questions.

**Table 1**
**Electrode Material Selection and Preheat Temperature**

| Items | | Carbon-Steel Header (P1) | 1¼Cr-½Mo Header (P4) | 2¼Cr-1Mo Header (P5) |
|---|---|---|---|---|
| Carbon-Steel MHH Plug | Electrode | E7015-A1<br>E7016-A1<br>E7018-A1 | Unacceptable Header/Cap Material Combination | Unacceptable Header/Cap Material Combination |
| | Preheat Temperature | 200°F Minimum | | |
| 2¼ Cr-1Mo MHH Plug | Electrode | E7015-A1<br>E7016-A1<br>E7018-A1 | E8015-B2<br>E8016-B2<br>E8018-B2 | E9015-B3<br>E9016-B3<br>E9018-B3 |
| | Preheat Temperature | 550° F +/- 50° F | 550° F +/- 50° F | 550° F +/- 50° F |

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PSB-32 4MDSH



**Additional Background-pg-4**

## *NBIC Sub-Group Repairs & Alterations*

**Initially presented by Bob Wielgoszinski, 1-21-15:**
During the inspection activity of some high pressure header type boilers, it is necessary to remove handhole covers or handhole plugs to access the inside of the header for inspection of tubes. The subsequent closure of the handholes by reinstalling the handhole covers or plugs sometimes necessitates the cover or plug being seal welded to its seat.

The seal weld is solely for the purpose of preventing leakage at the seat. The strength of the connection is based on back pressure applied to the cover or plug from boiler internal pressure. This seal welding constitutes a repair by welding as defined in the NBIC, and therefore requires inspection by a NB Commissioned Inspector, completion of an R-1 form, and attachment of a repair nameplate by the R stamp holder.

This repair activity has been interpreted as a routine repair, which would allow for the NB Inspector to waive in-process inspection and rule out the attachment of a repair nameplate by the R stamp holder (if permitted by the Inspector and the Jurisdiction). It would still, of course, require the completion of an R-1 form for the work performed. Although this seal welding process seems inconsequential to the structural integrity of the boiler, the problem here is that this type of repair is not mentioned specifically in "the list of 4" categories allowed by the NBIC, Part 3, 3.3.2(e). In fact, seal welding is not mentioned at all for routine repairs, even though interpretation 01-09 specifically addresses it for seal welding of tubes. Also, interpretation 95-35 addresses seal welding of tubes and confirms that it is a repair.

So, as a result of this, it would be helpful to the industry if the NBIC Committee could provide an interpretation of the rules to address seal welding of handhole covers or plugs as a routine repair. And if the Committee were to determine that such a repair is permitted as a routine repair, then a revision to the rules to address it would be equally as helpful to the public. Included below is a proposed question and reply for an interpretation.

IN15-0101-
Subject: Seal welding of handhole covers
Question: Is seal welding of inspection opening covers, such as handhole plates or plugs, considered a routine repair in accordance with NBIC, Part 3, paragraph 3.3.2 (e)?
Reply: No.

If the Committee feels that a repair such as described herein SHOULD be considered as a routine repair, then I will offer the following revision to the NBIC to clarify it. If the Committee does not believe it should be considered as a routine repair, then no revision would be necessary since the interpretation confirms that it is not permitted.

(Proposed 1-21-15) New paragraph 3.3.2. (e) 5):
5) Seal welding of mechanical connections provided postweld heat treatment is not required by the Code of construction."

h) All other requirements of Part 3, as applicable, and jurisdictional requirements shall be met;

i) Use of this paragraph shall be documented in the "Remarks" section

NB15-1901
**Alteration by PWHT**
**01/10/16**

### 3.4.3 EXAMPLES OF ALTERATIONS

a) An increase in the maximum allowable working pressure (internal or external) or temperature of a pressure-retaining item regardless of whether or not a physical change was made to the pressure-retaining item;

b) A decrease in the minimum temperature;

c) The addition of new nozzles or openings in a boiler or pressure vessel except those classified as repairs;

d) A change in the dimensions or contour of a pressure-retaining item;

e) In a boiler, an increase in the heating surface or steaming capacity as described on the original Manufacturer's Data Report;

f) The addition of a pressurized jacket to a pressure vessel;

g) Except as permitted in NBIC Part 3, 3.3.3 s); replacement of a pressure retaining part in a pressure retaining item with a material of different allowable stress or nominal composition from that used in the original design;

h) The addition of a bracket or an increase in loading on an existing bracket that affects the design of the pressure-retaining item to which it is attached;

i) The replacement of a pressure relieving device (PRD) as a result of work completed on a pressure-retaining item (PRI) that changes the resultant capacity to exceed the minimum requiredrelieving capacity (MRRC) required by the original code of construction as described on the original Manufacturer's Data Report.

**j) performing postweld heat treatment where none was originally performed on the pressure retaining item.**

### 3.4.4 Al… V…

### 3.4.4.1 ALTERATION PLAN

a) Engineer Review and Certification

# Request for NBIC Revision

Robert V. Wielgoszinski
Hartford Steam Boiler of CT
Rev 2, 011016

| | |
|---|---|
| **Purpose** | To provide minimum radius dimension for corners of a flush patch |
| **Scope:** | Repairs and alterations to pressure retaining items that contain a flush patch, 3.3.4.6 a)2). |
| **Background** | In the performance of repairs by installation a flush patch, the treatment of the corners often becomes controversial because of the lack of specificity in the NBIC. The Code (Part 3 – 3.3.4.6 a)2), says in part, simply that "… If the patch is rectangular, an adequate radius should be provided at the corners. Square corners should be avoided…"<br>The issue is the guidance "should be provided". Usually most R stamp holders provide an ample radius at these corners. A radius helps to avoid any undue stresses at the corner by eliminating a potential stress riser of a sharp right angle weld configuration. At a recent flush patch repair, it was reported that a radius was not provided and the subsequent pressure test revealed leaks at three of the four corners of the patch. Further investigation with LP examination discovered cracks at all three corners. This situation was clearly the result of poor application of the repair method, but could have been prevented by applying a radius at the corner, which was the corrective action in this case. So, the recommendation here is to revise the NBIC by requiring a minimum radius at corners of square or rectangular flush patches. A prescribed minimum, of say ½", would not cause any hardship on an R stamp holder that performs such repairs. And it does not preclude providing a larger radius if necessary. If there is a question of measurement, I also don't think this is a problem. A US quarter has about a ½" radius.<br><br>UPDATE: 07/14/15: At the SG meeting it was pointed out that Supplement 1 of Part 3 already has some criteria for a minimum radius for patches in paragraph S1.2.11.2 d). This requires a 3x the plate thickness minimum radius. This is more conservative than ½". The SG voted to accept this revision with ½" changed to 3x the plate thickness.<br><br>UPDATE: 01/10/16: The MC ballot resulted in 13 approved and 12 not voting. One significant comment was received in support of the revision but with a a proposed modification to more clearly state what the expectation are. Also, to remove any restriction to plate product form. The proposal was revised to address these comments. |
| **Proposed Revision** | Revise NBIC, Part 3, Paragraph 3.3.4.6 a) 2) to require a minimum of 3 times the plate thickness radius at the corners of square or rectangular flush patches.<br><br>Before installing a flush patch, the defective material should be removed until sound material is reached. The patch should be rolled to the proper shape or curvature. The edges should align without overlap. In stayed |

| | |
|---|---|
| | areas, the weld seams should come between staybolt rows or riveted seams. Patches shall be made from a material whose composition and thickness meet the intended service. Patches may be any shape or size. If the patch is rectangular, a minimum radius of not less than 3 times the material thickness shall be provided at the corners. Square corners are not permitted. The completed welds shall meet the requirements of the original code of construction. |

NB15-1202

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## SUPPLEMENT 6
## REPAIR, ALTERATION, AND MODIFICATION OF DOT TRANSPORT TANKS

### S6.1 SCOPE

This supplement provides general requirements that apply to the repairs, alterations, or modifications to DOT Transport Tanks used for the transportation of dangerous goods via highway, rail, air, or water.

### S6.2 DEFINITIONS

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The definitions specified in NBIC Part 3, Section 9, *Glossary*, shall be used in conjunction with those specified in NBIC Part 2, S6.17. Where conflicts between definitions exist, those identified in NBIC Part 2, S6.17 shall take precedence.

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### S6.3~~2~~ CONSTRUCTION STANDARDS

When the standard governing the original construction is the ASME Code or other regulations of the Competent Authority, repairs, alterations, or modifications shall conform, insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practical, it is permissible to use other codes, standards or specifications, including the ASME Code provided the "~~T~~R" Certificate Holder has the concurrence of the Inspector and, if required,~~or~~ the Competent Authority.

### S6.4~~3~~ ACCREDITATION AND REGISTRATION

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Organizations performing repairs, alterations, or modifications shall be accredited ~~as~~ in accordance with the National Board "~~T~~R" Accreditation Program. In addition repair organizations performing repairs, alterations, or modifications to transport tanks shall be registered with DOT as required by 49 CFR PART 180.

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### S6.5~~4~~ MATERIALS

The materials used in making repairs, alterations, or modifications shall conform to the original code of construction including the material specification requirements. Carbon or alloy steel having a carbon content of more than 0.35% (0.30% for ton tanks) shall not be welded unless permitted by the original code of construction. The "~~T~~R" Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the material to be installed. Additional material requirements are provided in NBIC Part 3, Section 3.

### S6.6~~5~~ REPLACEMENT PARTS

a) Replacement parts that will be subject to internal or external pressure that consist of new material which may be formed to the required shape by spinning, forging, die forming, and on which no fabrication welding is performed shall be supplied as material. Such parts shall be marked with the material and part identification and the name or trademark of the parts manufactured. In lieu of full identification marking on the material or part, the part manufacturer may use a coded marking system traceable to the original marking. Such markings shall be considered as the part manufacturer's certification that the part complies with the original code of construction. Examples include seamless or welded tube or pipe, forged nozzles, heads or subassemblies attached mechanically.

b) Replacement parts that will be subject to internal or external pressure, that are preassembled by attachment welds, shall have the welding performed in accordance with the original code of construction. This certificate shall be supplied in the form of a bill of material or drawings with statement of certification.

c) Replacement parts subject to internal or external pressure fabricated by welding that require shop inspection by an Authorized Inspector shall be fabricated by an organization having an appropriate ASME *Certificate of Authorization*. The item shall be inspected and stamped as required by the applicable section of the ASME Code and DOT specification requirements. A completed ASME *Manufacturer's Partial Data Report* shall be supplied by the manufacturer.

d) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure fabricated by welding shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification ~~to~~ as required by the original code of construction ~~as required by the original code of construction or equivalent~~ shall be supplied with the item. When this is not possible or practicable the organization fabricating the part may have a National Board *Certificate of Authorization*. Replacement parts fabricated by an "R" stamp holder shall be documented on Form ~~TR-1~~R-3 and the "~~T~~R" Stamp applied as described in NBIC Part 3, S6.~~14~~15.

### S6.7~~6~~ AUTHORIZATION

The Inspector's written authorization to perform a repair, alteration, or modification shall be obtained prior to initiation of the ~~repair or modification~~work to be performed on ~~to~~ a transport tank. Additional requirements are specified in NBIC Part 3, 1.3.1 and 1.3.2.

### S6.8~~7~~ INSPECTION

Inspection and certification shall be made by an Inspector holding an appropriate National Board Commission ~~employed by one of the following:~~

~~a) An organization authorized and recognized by the Competent Authority.~~

~~b) The Authorized Inspection Agency of the "TR" Certificate Holder making the repair or modification.~~as required by NBIC Part 3, 1.3 and shall be a Registered Inspector meeting the requirements of the Competent Authority.

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### S6.8~~7~~.1 INSPECTOR DUTIES FOR REPAIRS, ALTERATIONS, AND MODIFICATIONS

~~a) Repair Organizations that possess the National Board "TR" *Certificate of Authorization* and DOT's Cargo Tank Registration (CTR) number when applicable shall use inspection services of a Registered Inspector while performing repairs, or Modifications of Transport Tanks. The Registered Inspector must have satisfied the following requirements:~~

~~1) Has satisfied DOT requirements as a Registered Inspector.~~

~~2) Has successfully completed the National Board's Web-based training program for Registered Inspectors and has been issued a National Board *Certificate of Completion*.~~

~~3) Has received authorization from DOT as a Registered Inspector.~~

~~4) Has been registered by DOT for the Classification(s) of Transport Tanks to be inspected.~~

~~b)~~a) Inspectors performing repair, alteration, or modification inspections under the requirements of this supplement shall satisfy the requirements of S6.~~7~~8.1 to be authorized to sign the Form ~~T~~R-1, *Repairs*~~, or Modifications~~ and Form ~~T~~R-2, *Alterations*~~*Supplemental Form*~~.

~~c)~~b) For repairs, alterations, and modifications of transport tanks, the duties of the Registered Inspector performing inspections are detailed in Part 2, S6.10 through S6.15, as required by the Competent Authority.

~~d)~~c) ~~In addition, the~~The ~~duties of the Registered Inspector are summarized below~~Registered Inspector shall meet the rules of NB-263, RCI-1, Rules for Commissioned Inspectors. Additional duties are summarized below:

1) Verify the organization performing the repair, alteration or modification activity is properly accredited and in possession of a current valid *Certificate of Authorization* to apply the "~~T~~R" Stamp issued by the National Board and is working to an ~~approved~~ accepted Quality Control System;

2) Verify that the design, if required, for the modification of the vessel is approved by a Design Certifying Engineer, or Designated Approval Agency or other applicable individual;

3) Verify the materials to be used to make the repair, alteration, or modification are approved for use and comply with applicable code requirements;

4) Verify the welding procedures and welders or welding operators are properly qualified;

5) Verify that all heat treatments, if required, including PWHT have been performed in accordance with the applicable standards and that the results are acceptable;

6) Verify that all NDE, impact tests, and other tests have been performed when required, and that the results are acceptable;

7) Make a visual inspection of the work performed to confirm there are no visible defects or deviations from code requirements;

8) Perform external and internal visual inspections, if the vessel is equipped with a manway, and witness the hydrostatic or pneumatic pressure test and/or leak tightness test when they are required;

9) Verify the correct nameplate is properly attached to the vessel and that the current test and inspection markings are properly attached and displayed on the proper vessel;

10) Sign the Form ~~T~~R-1 and, as appropriate, form ~~T~~R-2 when work is completed.

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### S6.~~9~~8 WELDING

a) Welding shall be performed in accordance with the requirements of the original code of construction used for the fabrication of the pressure vessel. For hydrogen control when low alloy steel filler metals are used, the filler metal classification shall include an H4 supplemental diffusible hydrogen designator (maximum 4 ml [H2]/100 g deposited metal) for each of the following welding processes:

1) electrodes for shielded metal arc welding (SMAW) conforming to SFA-5.5;
2) electrodes and fluxes for submerged arc welding (SAW) conforming to SFA-5.26;
3) electrodes and rods for gas shielded metal arc welding (GMAW) conforming to SFA-5.28;
4) electrodes for flux-cored arc welding (FCAW) conforming to SFA 5.29.

b) Practices used for controlling storage and exposure of filler metals shall be those developed by the "~~T~~R" Certificate Holder or those recommended by the filler metal manufacturer.

**S6.9~~8~~.1 WELDING PROCEDURE SPECIFICATION**

Welding shall be performed in accordance with a Welding Procedure Specification (WPS) qualified in accordance with the original code of construction. When this is not possible or practicable, the WPS may be qualified in accordance with ASME Section IX.

**S6.9~~8~~.2 STANDARD WELDING PROCEDURE SPECIFICATIONS**

A "~~T~~R" Certificate Holder may use one or more applicable *Standard Welding Procedure Specifications* shown in NBIC Part 3, 2.3 without supporting *Procedure Qualification Records* (PQRs) since SWPS are pre-qualified and the PQR will not be supplied.

**S6.9~~8~~.3 PERFORMANCE QUALIFICATION**

Welders or welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction or ASME Section IX. Use of Standard Welding Procedures Specification shown in NBIC Part 3, ~~-~~2.3 is permitted for performance qualification testing.

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**S6.9~~8~~.4 WELDING RECORDS**

The "~~T~~R" Certificate Holder shall maintain a record of the results obtained in welding procedure qualification, except for those qualifications for which the provisions of NBIC Part 3, S6.~~8~~9.2 are used and of the results obtained in welding performance qualifications. These records shall be certified by the "~~T~~R" Certificate Holder and shall be available to the inspector.

**S6.9~~8~~.5 WELDERS' IDENTIFICATION**

The "~~T~~R" Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The "~~T~~R" Certificate Holder shall also establish a written procedure whereby all welded joints can be identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and be acceptable to the Inspector. The welder's or welding operator's identification mark may be stamped (low stress stamp) adjacent to all welded joints made by the individual or, in lieu of stamping, the "~~T~~R" Certificate Holder may keep a record of the welded joints and the welders or welding operators used in making the joints.

**S6.9~~8~~.6 WELDERS' CONTINUITY**

The performance qualification of a welder or welding operator shall be affected when one of the following conditions occurs:

a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire;

b) When there is specific reason to question their ability to make welds that meet the specification, the qualification which supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.

**S6.10~~9~~ HEAT TREATMENT**

**S6.10~~9~~.1 PREHEATING**

Preheating may be employed during welding to assist in completion of the welded joint (see NBIC Part 3, 2.5.1). The need for and the temperature of preheat are dependent on a number of factors such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties of the base metals being joined. The Welding Procedure Specification for the material being welded shall specify the preheat temperature requirements.

**S6.10~~9~~.2 POSTWELD HEAT TREATMENT**

Postweld heat treatment may be performed as required by the original code of construction in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment. Local PWHT that is not specified by the original code of construction may be performed in accordance with an Alternative Postweld Heat Treatment Method described in NBIC Part 3, 2.5.3 with acceptance by the Inspector and required by the Competent Authority.

**S6.10~~9~~.3 ALTERNATIVES TO POSTWELD HEAT TREATMENT**

a) Under certain conditions, postweld heat treatment in accordance with the original code of construction may be inadvisable or impractical. In such instances, alternative methods of postweld heat treatment or special welding methods acceptable to the Inspector and Competent Authority may be used.

b) When the standard governing the original construction is the Code of Federal regulation for DOT/MC 331 cargo tanks for propane, butane, anhydrous ammonia, and other DOT permitted commodities, and the tanks are made to the ASME Code, Section VIII, Division 1, Part UHT, repairs, alterations, or modifications shall conform insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practicable, it is permissible to use other codes, standards, or specifications provided the "~~T~~R" Certificate Holder has the concurrence of the DOT. Shells and heads of MC 331 cargo tanks were made from quenched and tempered alloy steel plate, SA517, Grade E (originally Code Case 1298) and Grade F (originally Code Case 1204) prior to 1994.

c) The 1994 ASME Code Addenda revised UHT-5(b) to permit the joining of UHT materials to UCS or UHA materials in head and shell sections. Propane, butane, and anhydrous ammonia are the most common transported commodities and the shipper is required by DOT to comply with certain composition limitations. Propane and butane transported must have sufficiently low hydrogen sulfide content so as not to exceed the limitations for Classification One of the ASTM D1838-74 copper strip test, and the anhydrous ammonia transported must be inhibited with a minimum water content of 0.2% by weight. In addition, such cargo tanks made for propane, butane, and anhydrous ammonia service must be postweld heat treated, unless specifically exempted by a DOT special permit that exempts PWHT.

**S6.11~~0~~ NONDESTRUCTIVE EXAMINATION**

a) The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction used for the pressure vessel, and repairs, alterations, and modifications shall be subjected to the same nondestructive examination requirements as the original welds. Where this is not possible or practicable, alternative NDE methods acceptable to the Inspector and the Competent Authority may be used on a case-by-case basis.

b) NDE personnel shall be qualified and certified in accordance with the requirements of the original code of construction. When this is not possible or practicable, NDE personnel may be qualified and certified in accordance with their employer's written practice. ASNT SNT-TC-1A, *Recommended Practice for Nondestructive Testing Personnel Qualification and Certification (2006 edition)*, or ACCP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel (2006 edition)*, may be used to fulfill the examination and demonstration requirements of SNT-TC-1A and the employer's written practice. Provisions for training, qualification, and certification of NDE personnel shall be described in the "~~T~~R" Certificate Holder's written quality system.

**S6.12~~1~~ COATINGS AND LININGS**

When coatings or linings are to be inspected, such inspections shall be done in accordance with the Structural Steel Painting Council, SSPC publication, No. 91-12, *Coating and Lining Inspection Manual*.

**S6.13~~2~~ MEASUREMENT, EXAMINATION, AND TEST EQUIPMENT**

~~There shall be a system for~~ The calibration of pressure gages, measurement, examination, and test equipment, and documentation of calibration shall be performed, as required, by the applicable standard used for construction. This system shall be documented.

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**S6.14~~3~~ ACCEPTANCE INSPECTION**

The Inspector making the acceptance inspection shall be the same Inspector who authorized the repairs, alterations, or modifications. Where this is not possible or practical, another Inspector may perform the acceptance inspection; however, in all cases, the Inspector who performs the acceptance inspection shall be an employee of the same organization as the Inspector who authorized the repairs, alterations, or modifications.

**S6.15~~4~~ GENERAL STAMPING REQUIREMENTS**

The stamping of or attaching of a nameplate to a pressure-retaining item shall indicate that the work was performed in accordance with the requirements of this code and any requirements of the

Competent Authority. Such stamping or attaching of a nameplate shall be done only with the knowledge and authorization of the Inspector and Competent Authority. The “~~T~~R” Certificate Holder responsible for the repair or the construction portion of the modification/alteration shall apply the stamping. For a re-rating where no physical changes are made to the pressure-retaining item, the “~~T~~R” Certificate Holder responsible for the design shall apply the stamping. Requirements for stamping and nameplate information are shown in NBIC Part 3, Section 5.

### S6.15~~4~~.1 SPECIFIC “~~T~~R” STAMPING AND NAMEPLATE REQUIREMENTS

The holder of a “~~T~~R” Certificate of Authorization is required to affix a stamping or nameplate on the Transport Tank that indicates, the repair, alteration, or modification has been performed in accordance with the requirements of NBIC Part 3, Supplement 6 and the additional requirements of the code of construction. All repairs, alterations, and modifications, after acceptance by the Registered Inspector, shall have the “~~T~~R” Symbol affixed to the stamping or the nameplate. The stamping or nameplate information shall satisfy the requirements of a) thru g) below:

a) The required data shall be in characters at least 4 mm (5/32 in.) high;

b) The markings may be produced by casting, etching, embossing, debossing, stamping, or engraving;

c) The selected method shall not result in any harmful contamination or sharp discontinuities to the pressure- retaining boundary of the Transport Tank;

d) Stamping directly on the Transport Tank, when used, shall be done with blunt-nose continuous or blunt- nose interrupted dot die stamps. If direct stamping would be detrimental to the item, required markings and the embossed Code Symbol stamping may appear on a nameplate affixed to the Transport Tank;

e) The “~~T~~R” Certificate Holder shall use its full name as shown on the Certificate of Authorization or use an approved abbreviation acceptable to the National Board;

f) The non-embossed Code Symbol stamping, when directly applied on the item or when a nameplate is used shall be applied adjacent to the original manufacturer’s stamping or nameplate. A single repair~~, alteration, or modification~~ stamping or nameplate may be used for ~~more than one repair to a Transport Tank~~additional activities performed, provided the repair~~, alteration, or modification~~ activity is carried out by the same ~~certificate holder~~”R” Certificate Holder;

g) The date of each repair, alteration, or modification corresponding with the date on the applicable “R” form ~~Form TR-1~~ shall be ~~stamped on the nameplate~~applied to the exiting stamping or nameplate.

### S6.15~~4~~.2 REMOVAL OF ORIGINAL STAMPING OR NAMEPLATE

If it becomes necessary to remove the original stamping, the Inspector shall, subject to the approval of the Competent Authority, witness the making of a facsimile of the stamping, the obliteration of the old stamping, and the transfer of the stamping. When the stamping is on a nameplate, the Inspector shall witness the transfer of the nameplate to the new location. Any relocation shall be described on the applicable NBIC “~~T~~R” Form. The restamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

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**Comment [BB3]:** This change addresses NB15-1410 and PR15-0122

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## S6.16~~5~~ “~~T~~R” FORMS

### S6.16~~5~~.1 DOCUMENTATION

Repairs, alterations, or modifications that have been performed in accordance with the NBIC shall be documented on Form ~~T~~R-1, *Report of Repair* or ~~From~~ Form R-2, *Report of Alteration*~~*, Alteration, or Modification,*~~ as shown in NBIC Part 3, Section 5. Form ~~T~~R-~~2~~4, *Report Supplementary Sheet*, shall be used to record additional data when space is insufficient on Form ~~T~~R-1 or R-2.

### S6.16~~15~~.2 PREPARATION OF “~~T~~R” FORMS

Preparation of “~~T~~R” Forms shall be the responsibility of the “~~T~~R” Certificate Holder performing the repairs, alterations, or modifications. An Inspector shall indicate acceptance by signing the appropriate “~~T~~R” form.

### S6.16~~5~~.3 DISTRIBUTION

a) Legible copies of the completed ~~Form TR-1~~”R” forms together with attachments shall be distributed to the owner or user, the Inspector, ~~and~~ the Competent Authority~~,~~ as required, ~~and~~ the Authorized Inspection Agency responsible for the inspection, and the National Board for registration.

b) Distribution of the ~~Form TR-1~~ “R” forms and attachments shall be the responsibility of the ~~organization~~ “R” Certificate Holder performing the ~~repair~~work.

### S6.16~~5~~.4 REGISTRATION OF FORM ~~T~~R-1 AND FORM ~~T~~R-2

a) Organizations performing repairs, alterations, or modifications ~~under the “TR” program~~required by this supplement ~~must~~ shall register such repairs, alterations, or modifications with the National Board.

b) The repair organization shall maintain a sequential Form “~~T~~R” Log that shall identify the following:

1) Form number assigned for Form ~~T~~R-1;

2) Identify if the activity was a repair, alteration, or modification;

~~2)~~3) When the repair, alteration, or modification was completed, and ~~and~~

~~3)~~4) Date sent to the National Board.

## S6.1~~7~~6 ADDITIONAL REQUIREMENTS FOR REPAIRS, ALTERATIONS, OR MODIFICATIONS

### S6.17~~6~~.1 SCOPE

This section provides additional requirements for repairs, alterations, or modifications to DOT Transport Tank pressure-retaining items and shall be used in conjunction with NBIC Part 3.

### S6.17~~6~~.2 REPAIRS OF DEFECTS

Before a repair is made to a defect in a welded joint or base metal, care should be taken to investigate its cause and to determine its extent and likelihood of recurrence. This information shall be made available to the Inspector.

### S6.17~~6~~.3 MODIFICATIONS

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All modifications to the pressure-retaining item shall meet the requirements of NBIC Part 3~~, Section 6~~ for alterations.

### S6.17~~6~~.4 DRAWINGS

Drawings or instructions shall be prepared to describe the repair, alterations, or modification. Drawings shall include sufficient information to satisfactorily perform the activity.

### S6.17~~6~~.5 AUTHORIZATION

Repairs, alterations, or modifications to a pressure-retaining item shall not be initiated without the authorization of the Inspector, who shall determine that the ~~repair~~ methods are acceptable.~~, and subject to acceptance of the Competent Authority.~~

### S6.18~~7~~ EXAMINATION AND TEST

The following requirements shall apply to all repairs, alterations, or modifications to DOT Transport Tank pressure-retaining items:

a) The integrity of repairs and replacement parts used in repairs, alterations, or modifications shall be verified by examination and test;

b) The "~~T~~R" Certificate Holder is responsible for all activities relating to examination and test of repair, alterations, or modifications;

c) Examination and tests to be used shall be subject to acceptance of the Inspector and the Competent Authority when required.

### S6.18~~7~~.1 METHODS

a) One, or a combination of the following examination methods, shall be applied to DOT Transport Tank pressure-retaining items with the concurrence of the Inspector and the Competent Authority when required.

b) Liquid Pressure Test

   1) Pressure testing of repairs shall meet the following requirements:

   2) Pressure tests shall be conducted using water or other suitable liquid. The test pressure shall be the minimum required to verify the leak tightness integrity of the repair, but not more than 150% of the maximum allowable working pressure (MAWP) stamped on the pressure-retaining item, as adjusted for temperature. When original test pressure included consideration of corrosion allowance, the test pressure may be further adjusted based on the remaining corrosion allowance;

   3) During a pressure test where the test pressure will exceed 90% of the set pressure of the pressure relief device, the device shall be removed whenever possible. If not possible, a test gag should be used using the valve manufacturer's instructions and recommendations; and

   4) Hold time for the pressure test shall be a minimum of 10 minutes prior to examination by the Inspector. Where the test pressure exceeds the MAWP of the item, the test pressure shall be reduced to the MAWP for close examination by the Inspector. Hold time for close examination shall be as necessary for the Inspector to conduct the examination.

c) Pneumatic Test

1) A pneumatic test may be conducted. Concurrence of the owner shall be obtained in addition to that of the Inspector and the Competent Authority where required. The test pressure shall be the minimum required to verify leak tightness integrity of the repair, but shall not exceed the maximum pneumatic test pressure of the original code of construction. Precautionary requirements of the original code of construction shall be followed.

d) Nondestructive Examination

1) Nondestructive examination (NDE) may be conducted. NDE methods shall be suitable for providing meaningful results to verify the integrity of the repair.

**S6.19~~8~~ REPAIRS, ALTERATIONS, OR MODIFICATION REPORTS**

a) ~~If~~ When repairs, alterations, or modifications are performed on a t~~T~~ransport t~~T~~ank, i.e., cargo tank, portable tank, or ton tank, the owner or User shall have the activity performed by a Repair Organization that has a valid "~~T~~R" *Certificate of Authorization* issued by the National Board. "R" forms shall be completed and certified by the "R" Certificate Holder and received and ~~C~~ certified by the Inspector.

~~a)~~b) For the purposes of documentation and stamping, modification shall be considered an alteration.

~~b) The repair, alteration, or modification shall be recorded on the Form TR-1. If additional space is needed to properly record the repair, alteration, or modification, Form TR-2 shall be used.~~

~~c) It is the responsibility of the "TR" Symbol Stamp Holder to prepare, distribute, and maintain the Form TR-1 and, if required, Form TR-2. The Form(s) shall be distributed as follows:~~

~~1) Owner or User;~~

~~2) Registered Inspector;~~

~~3) Competent Authority (DOT); and~~

~~4) National Board.~~

~~d) The Form TR-1 shall be signed by a Registered Inspector as defined in NBIC Part 3, S6.7.1.~~

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# FORM R-1 REPORT OF REPAIR

in accordance with provisions of the *National Board Inspection Code*

(Authorized Rep. Initials)

(Inspectors initials)

(Form "R" Registration no.)

(P.O. no., Job no., etc.)

1. WORK PERFORMED BY: ______________________
(name of repair organization)
______________________
(address)

2. OWNER: ______________________
(name)
______________________
(address)

3. LOCATION OF INSTALLATION: ______________________
(name)
______________________
(address)

4. ITEM IDENTIFICATION: ____________ NAME OF ORIGINAL MANUFACTURER: ____________
(boiler, pressure vessel, or piping)

5. IDENTIFYING NOS: ____________ ____________ ____________ ________ ________
(mfg. serial no.) (National Board no.) (jurisdiction no.) (other) (year built)

6. NBIC EDITION/ADDENDA: ____________ ____________
(edition) (addenda)

Original Code of Construction for Item: ____________ ____________
(name / section / division) (edition / addenda)

Construction Code Used for Repair Performed: ____________ ____________
(name / section / division) (edition / addenda)

7. REPAIR TYPE: ☐ welded ☐ graphite pressure equipment ☐ FRP pressure equipment

8. DESCRIPTION OF WORK: ☐ Form R-4, Report Supplementary Sheet is attached ☐ FFSA Form (NB-403) is attached
(use Form R-4, of neccessary))

Fix Of to IF and para ))

Liquid, Pneumatic, Vacuum, Initial

____________ Pressure Test, if applied ____________ psi MAWP ____________ psi

9. REPLACEMENT PARTS: (Attached are Manufacturer's Partial Data Reports or Form R-3's properly completed for the following items of this report):
(name of part, item number, data report type or certificate of Compliance, mfg's. name and identifying stamp)

10. REMARKS:

Attachment Page 185

_______________
(Form "R" Registration no.)

_______________
(P.O. no., job no., etc.)

## CERTIFICATE OF COMPLIANCE

I, _______________, certify that to the best of my knowledge and belief the statements made in this report are correct and that all material, construction, and workmanship on this Repair conforms to the *National Board Inspection Code.* National Board "**R**" *Certificate of Authorization* No. _______________ expires on _______________, _______________

Date _______________, _______________ (name of repair organization) Signed _______________ (authorized representative)

## CERTIFICATE OF INSPECTION

I, _______________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of _______________ and employed by _______________ of _______________ have inspected the work described in this report on _______________, _______________ and state that to the best of my knowledge and belief, this work complies with the applicable requirements of the National Board Inspection Code. By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Date _______________ Signed _______________ (inspector) _______________ (National Board and Jurisdiction no.)

Including Endorsement

# FORM R-2 REPORT OF ALTERATION

in accordance with provisions of the *National Board Inspection Code*

_______________ (Authorized Rep. initials)

_______________ (Inspectors initials)

_______________ (Form "R" Registration no.)

_______________ (P.O. no., job no., etc.)

1a. DESIGN PERFORMED BY: _______________ (name of "R" organization responsible for design)

_______________ (address)

1b. CONSTRUCTION PERFORMED BY: _______________ (name of "R" organization responsible for construction)

_______________ (address)

2. OWNER OF PRESSURE RETAINING ITEM: _______________ (name)

_______________ (address)

3. LOCATION OF INSTALLATION: _______________ (name)

_______________ (address)

4. ITEM IDENTIFICATION: _______________ (boiler, pressure vessel, or piping) NAME OF ORIGINAL MANUFACTURER: _______________

5. IDENTIFYING NOS: _______________ (mfg. serial no.) _______________ (National Board no.) _______________ (jurisdiction no.) _______________ (other) _______________ (year built)

6. NBIC EDITION/ADDENDA: _______________ (edition) _______________ (addenda)

Original Code of Construction for Item: _______________ (name / section / division) _______________ (edition / addenda)

Construction Code Used for Alteration Performed: _______________ (name / section / division) _______________ (edition / addenda)

7a. DESCRIPTION OF DESIGN SCOPE: ☐ Form R-4, Report Supplementary Sheet is attached

7b. DESCRIPTION OF CONSTRUCTION SCOPE: ☐ Form R-4, Report Supplementary Sheet is attached

_______________ Pressure Test, if applied _______________ psi MAWP _______________ psi

(Form "R" Registration no.)

(P.O. no., job no., etc.)

8. REPLACEMENT PARTS: (Attached are Manufacturer's Partial Data Reports or Form R-3's properly completed for the following items of this report):
(name of part, item number, data report type or Certificate of Compliance, mfg's. name and identifying stamp)

9. REMARKS:

### DESIGN CERTIFICATION

I, ______________, certify that to the best of my knowledge and belief the statements in this report are correct and that the Design Change described in this report conforms to the *National Board Inspection Code*. National Board "**R**" Certificate of Authorization No. ______________ expires on ______________

Date ________, ______________ (name of design organization) Signed ______________ (authorized representative)

### CERTIFICATE OF DESIGN CHANGE REVIEW

I, ______________, holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspector and certificate of competency, where required, issued by the jurisdiction of ______________ and employed by ______________ of ______________ have reviewed the design change as described in this report and state that to the best of my knowledge and belief such change complies with the applicable requirements of the *National Board Inspection Code*.
By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.

Date ______________ Signed ______________ (inspector) Commissions ______________ (National Board and jurisdiction no.)

Including Endorsement

### CONSTRUCTION CERTIFICATION

I, ______________, certify that to the best of my knowledge and belief the statements in this report are correct and that all material, construction, and workmanship on this Alteration conforms to the National Board Inspection Code. National Board "**R**" Certificate of Authorization No. ______________ expires on ______________

Date ________, ______________ (name of alteration organization) Signed ______________ (authorized representative)

### CERTIFICATE OF INSPECTION

I, ______________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of ______________ and employed by ______________ of ______________ have inspected the work described in this report on ______________, ______________ and state that to the best of my knowledge and belief, this work complies with the applicable requirements of the National Board Inspection Code. By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Date ______________ Signed ______________ (inspector) ______________ (National Board and jurisdiction no.)

Including Endorsement

# FORM R-3 REPORT OF PARTS FABRICATED BY WELDING

in accordance with provisions of the *National Board Inspection Code*

(Authorized Rep. initials)

(Inspectors initials)

(Form "R-3" Registration no.)

(P.O. no., job no., etc.)

1. MANUFACTURED BY: ______________________
(name of "NR" certificate holder)

______________________
(address)

2. MANUFACTURED FOR: ______________________
(name)

______________________
(address)

3. DESIGN CONDITION SPECIFIED BY: ______________ CODE DESIGN BY: ______________

4. DESIGN CODE: ________ ________ ________ ________

5. REPAIR/ALTERATION/MODIFICATION ACTIVITIES

| Name of Part | Qty. | Line No. | Manufacturer's Identifying No. | Manufacturer's Drawing No. | MAWP | Shop Hydro PSI | Year Built |
|---|---|---|---|---|---|---|---|
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6. DESCRIPTION OF PARTS

| | (a) Connections other than tubes | | | Heads or Ends | | | (b) Tubes | | |
|---|---|---|---|---|---|---|---|---|---|
| Line No. | Size and Shape | Material Spec. No. | Thickness (in.) | Shape | Thickness (in.) | Material Spec. No. | Diameter (in.) | Thickness (in.) | Material Spec. No. |
| | | | | | | | | | |
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7. REMARKS:

Attachment Page 189

(Form "R-3" Registration no.)

(P.O. no., job no., etc.)

## CERTIFICATE OF COMPLIANCE

I, ______________________________, certify that to the best of my knowledge and belief the statements made in this report are correct and that all material, fabrication, construction, and workmanship of the described parts conforms to the *National Board Inspection Code* and the standards of construction cited.

National Board "**R**" *Certificate of Authorization* No. ____________________ expires on: __________, ____________

Date ________, ______________ ______________________________Signed ______________________________
(name of "R" Certificate holder) (Authorized Representative)

## CERTIFICATE OF INSPECTION

I, ______________________________, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and certificate of competency, where required, issued by the Jurisdiction of ____________________ and employed by ______________________________ of ______________________________ have inspected the part described in this report on ________, ________ and state that to the best of my knowledge and belief the parts comply with the applicable requirements of the *National Board Inspection Code*.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or loss of any kind arising from or connected with this inspection.

Date ________, ________ Signed ______________________________ Commissions ______________________________
(inspector) (National Board and jurisdiction No.)

Including Endorsement

# FORM R-4 REPORT SUPPLEMENT SHEET

in accordance with provisions of the *National Board Inspection Code*

(form "R" referenced)

(P.O. no., job no., etc.)

1. WORK PERFORMED BY: ____________________
(name)

____________________
(address)

2. OWNER: ____________________
(name)

____________________
(address)

3. LOCATION OF INSTALLATION: ____________________
(name)

____________________
(address)

| REFERENCE LINE NO. | CONTINUED FROM FORM R-______ |
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Date ________ , ________ Signed ____________________ (authorized representative) Name ____________________ (Name of "**R**" certificate holder)

Date ________ , ________ Signed ____________________ (inspector) Commissions ____________________ (National Board and jurisdiction no.)

Including Endorsement

NB15-2106

NBIC Changes
"R" Endorsement

Part 1
None

Part 2
None

Part 3

1)

### 1.3 INSPECTOR

a) Inspection and certification shall be made by an Inspector holding ~~the appropriate commission~~ a valid commission with the appropriate endorsement, issued by the National Board and employed by an Authorized Inspection Agency (see NBIC Part 3, Section 9, *Glossary of Terms*, for definition of Authorized Inspection Agency).

2)

**Table 1.8.2.1**

| | |
|---|---|
| ASME | American Society of Mechanical Engineers |
| Applicant | An Organization applying for "NR" *Certificate of Authorization* (new or renewal) |
| CFR | Code of Federal Regulations |
| Code | ASME Code of Construction, Section III, Division I, (NCA, NB, NC, ND, NE, NF, NG, and NH) or ASME Section XI Rules for Inservice Inspection of Nuclear Power Plant Components as applicable. |
| Jurisdiction | Enforcement Authority |
| NB | National Board of Boiler and Pressure Vessel Inspectors |
| NBIC | National Board Inspection Code |
| NB-263 | Rules for National Board Inservice and New Construction Commissioned Inspectors |

Replace last line show to read

~~RCI-1/~~NB-263, RCI-1 Rules for Commissioned Inspectors

3)

1.8.6.2 s)

s) Authorized Nuclear Inspector

Measures shall be taken to reference the commissioned rules for National Board Authorized Nuclear Inspector, in accordance with NB-263, RCI-1 *Rules for ~~National Board Inservice and New Construction~~ Commissioned Inspectors*. The "NR" Certificate Holder shall ensure that the latest documents including the

Quality Assurance Manual, procedures and instructions are made available to the Authorized Nuclear
Inspector. The Authorized Nuclear Inspector shall be consulted prior to the issuance of a repair/replacement
plan by the "NR" Certificate Holder in order that the Authorized Nuclear Inspector may select any

**4)**
**1.8.7.2 s)**
s) Authorized Nuclear Inspector
Measures shall be taken to reference the commissioned rules for National Board Authorized Nuclear
Inspector, in accordance with NB-263, RCI-1 *Rules for ~~National Board Inservice and New Construction~~ Commissioned Inspectors*. The "NR" Certificate Holder shall ensure that the latest documents including the
Quality Assurance Manual, procedures and instructions are made available to the Authorized Nuclear
Inspector. The Authorized Nuclear Inspector shall be consulted prior to the issuance of a repair/replacement
plan by the "NR" Certificate Holder in order that the Authorized Nuclear Inspector may select any
in process inspection or hold points when performing repair/replacement activities. The "NR" Certificate
Holder shall keep the Authorized Nuclear Inspector informed of progress of the repair/replacement activity
so that inspections may be performed. The Authorized Nuclear Inspector shall not sign Form NR-1 or
Form NVR-1, as applicable, unless satisfied that all work carried out is in accordance with this section.
The Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor shall have access to
areas where work is being performed including subcontractors facilities in order to perform their required
duties. The ANI shall be involved in dispositions and verification for nonconformances and corrective
actions involving quality or code requirements.

**These edits are proposed to Part 3 due to action item from Inspection Sub-Committee associated with NB15-0501 and NB15-0502.**

**SUPPLEMENT 10**

**REPAIR AND ALTERATIONS OF PRESSURE VESSELS IN LIQUEFIED**

**PETROLEUM GAS SERVICE**

**S10.1 SCOPE**

This supplement provides general and specific requirements that apply to the repairs or alterations to pressure vessels designed for storing Liquid Petroleum Gas (LPG) and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquid and Gases. When the standard governing the original construction is not the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquid and Gases, the requirements of NBIC Part 3, 1.2 b, shall apply. In addition to this supplement, the applicable paragraphs of Part 3 of the NBIC shall be met. Vessels used for anhydrous ammonia service shall not be considered for repair or alteration in accordance with this supplement.

**S10.2 GENERAL AND ADMINISTRATIVE REQUIREMENTS**

a) Refer to NBIC Part 3, Section 1 for all applicable post construction activities pertaining to general and administrative requirements.

b) Repairs or alterations shall conform to the edition of the ASME Code or standard most applicable to the work.

**S10.3 WELDING**

Refer to NBIC Part 3, Section 2 for all applicable post construction activities pertaining to welding requirements.

**S10.4 REQUIREMENTS FOR REPAIRS AND ALTERATIONS**

a) Refer to NBIC Part 3, Section 3 for all applicable post construction activities pertaining to requirements for repairs and alterations.

Excluded is NBIC Part 3, 3.3.4.8 *Repair of Pressure-Retaining Items Without Complete Removal of Defects*.

b) Radiographic or ultrasonic examinations are considered to be suitable alternative nondestructive examination methods to ensure complete removal of the defect, as described in NBIC Part 3, 3.3.4.1.

**S10.5 REQUIREMENTS FOR CHANGE OF SERVICE FROM ABOVE GROUND TO UNDERGROUND SERVICE**

ASME LPG storage vessels may be altered from above ground (AG) service to underground (UG) service subject to the conditions of NBIC Part 2, S7.10.

**S10.6~~5~~ EXAMINATION AND TESTING**

Refer to NBIC Part 3, Section 4 for all applicable post construction activities pertaining to examination and testing.

**S10.7~~6~~ CERTIFICATION/DOCUMENTATION AND STAMPING**

a) Section 5 of this part is applicable for all post construction activities pertaining to certification/documentation and stamping.

b) The "R" Certificate Holder shall assure all repairs or alterations involving a change to the following are recorded on the proper NBIC form and marked on the NBIC nameplate or stamping without changing the required format of the NBIC markings.

1) Service for which the container is designed (for example, underground, aboveground, or both).

2) Dip tube length.

3) Maximum filling limit with liquid temperature reference.

**S10.8~~7~~ INSPECTION**

Refer to NBIC Part 2, Supplement 7 for all applicable post construction activities pertaining to inspection.

**S10.9~~8~~ COATINGS**

When coatings are reapplied, the user should verify the coating is compatible with any coating that remains intact and is suited for the intended service application.

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# NBIC Subcommittee R&A Action Block

**Subject** Revision to Alternative Welding Methods

**File Number** NB15-3401 **Prop. on Pg.**

**Proposed Revision** Page 2

**Statement of Need** Update NBIC to reflect current welding technology.

**Project Manager:** Galanes

**SubGroup Negatives** 0 **SG Meeting Date**

Concept

***Revise RD-1040(i), Repair Method 2, to read: "i. For the SMAW and FCAW welding process in RD-1040(c), use only electrodes and filler metals which are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower. …".***

***Similar revision to RD-1060, Method 4.***

# NBIC Subcommittee R&A Action Block

## Existing text in 2015 NBIC

### 2.5.3.2 WELDING METHOD 2

i) For the welding process in NBIC Part 3, 2.5.3.2(c), use of austenitic or ferritic filler metals is permitted. For ferritic filler metals, use only electrodes and filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower. When shielding gases are used with a process, the gas shall exhibit a dew point that is below -60°F (-50°C). Surfaces on which welding will be done shall be maintained in a dry condition during welding and be free of rust, mill scale, and hydrogen producing contaminants such as oil, grease, and other organic materials;

Proposed Revision (double underlined only).

i) For the welding process in NBIC Part 3, 2.5.3.2(c), use of austenitic or ferritic filler metals is permitted. For ferritic filler metals, use only electrodes and filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower for the FCAW and SMAW processes.

### 2.5.3.3 WELDING METHOD 3

2) For the welding processes in NBIC Part 3, 2.5.3.3 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower may be used.

Proposed Revision (double underlined only)

2) For the welding processes in NBIC Part 3, 2.5.3.3 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower for the FCAW and SMAW processes.

### 2.5.3.4 WELDING METHOD 4

2) For the welding processes in NBIC Part 3, 2.5.3.4 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower.

Proposed Revision (double underlined only)

2) For the welding processes in NBIC Part 3, 2.5.3.4 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower for the FCAW and SMAW processes.

## SUPPLEMENT 9

## PROCEDURES ~~TO EXTEND THE "VR" CERTIFICATE OF AUTHORIZATION AND STAMP TO~~FOR REPAIRS OF ASME "NV" STAMPED PRESSURE RELIEF DEVICES

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### S9.1 INTRODUCTION

~~Approval to extend the scope of the National Board "VR" *Certificate of Authorization* to the Certificate Holder to use the "VR" Stamp on~~ ASME Code "NV" Class 1, 2, or 3 stamped pressure relief devices, which have been capacity-_certified by the National Board~~, may be given subject to the provisions that follow.~~ may be repaired provided the following requirements are met.

### S9.2 ADMINISTRATIVE PROCEDURES

a) The repair organization shall hold a valid "VR" *Certificate of Authorization*.

b) The repair organization shall obtain a National Board "NR" *Certificate of Authorization* and stamp. The requirements for said certificate and stamp include, but are not limited to, the following. The repair organization shall:

1) Maintain a documented quality assurance program that meets the applicable requirements of NBIC Part 3, 1.8. This program shall also include all the applicable requirements for the use of the "VR" stamp;

2) Have a contract or agreement with an Inspection Agency to provide inspection of repaired "NV" - stamped pressure relief devices by Inspectors who have been qualified in accordance with the requirements of ASME QAI-1, *Qualifications for Authorized Inspection*;

3) Successfully complete a survey of the quality assurance program and its implementation. This survey shall be conducted by representatives of the National Board, the Jurisdiction wherein the applicant's repair facilities are located, and the applicant's Authorized Inspection Agency. Further verification of such implementation by the survey team may not be necessary if the applicant holds a valid ASME "NV" certificate and can verify by documentation the capability of implementing the quality assurance program for repair of "NV"-stamped pressure relief devices, covered by the applicant's ASME "NV" certificate.

c) The application of the "NR" *Certificate of Authorization* and stamp shall clearly define the scope of intended activities with respect to the repair of Section III, "NV"-stamped pressure relief devices.

d) Revisions to the quality assurance program shall be acceptable to the Authorized Nuclear Inspector Supervisor and the National Board before being implemented.

e) The scope of the "VR" *Certificate of Authorization* shall include repair of "NV"-stamped pressure relief devices.

f) Verification testing of valves repaired by the applicant shall not be required provided such testing has been successfully completed under the applicant's "VR" certification program for the applicable test fluids.

g) A survey of the applicant for the "VR" *Certificate of Authorization* and endorsement of the repair of "NV" - stamped pressure relief devices may be made concurrently.

### S9.3 GENERAL RULES

a) ASME Code Section III, "NV"-stamped pressure relief devices, which have been repaired in accordance with these rules, shall be stamped with both the "VR" and "NR" stamps.

b) The "VR" and "NR" stamps shall be applied only to "NV" stamped (Class 1, 2, or 3) National Board capacity certified pressure relief devices that have been disassembled, inspected, and repaired as necessary, such that the valves' condition and performance are equivalent to the standards for new valves.

c) All measuring and test equipment used in the repair of pressure relief devices shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

d) Documentation of the repair of "NV"-stamped pressure relief devices shall be recorded on the National Board Form NVR-1, *Report of Repair/ Replacement Activities for Nuclear Pressure Relief Devices*, in accordance with the requirements of NBIC Part 3, 1.8.

e) When an ASME "NV"-stamped pressure relief device requires a duplicate nameplate because the original nameplate is illegible or missing, it may be applied using the procedures of NBIC Part 3, 5.12.5 provided concurrence is obtained from the Authorized Nuclear Inspector and Jurisdiction. In this case the nameplate shall be marked "SEC. III" to indicate original ASME Code stamping.

f) Repair activities for pressure relief devices shall not include rerating of the device. Set pressure changes within the range of the valve manufacturer's capacity certification and the design pressure of the valve (see Part 3, 5.12.3) are permitted, provided the new set pressure and capacity rating are reconciled with the design of the system where the device will be used. Set pressure changes are not considered to be rerating.

g) Conversions of pressure relief devices as described in NBIC Part 3, S7.2 b~~a~~) are permitted as part of repair activities.

h) Set pressure changes or conversions of pressure relief devices shall be described in the "Remarks" section of Form NVR-1.

NB15-1204

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### 1.8.2 GENERAL

a) An organization applying for an "NR" *Certificate of Authorization* shall have a written Quality Assurance Program (QAP) that details the specific requirements to be met based on the intended category of activities selected by that organization as described below and shown in Table 1.8.2. Controls used, including electronic capabilities, in the Quality Assurance Program shall be documented in a Quality Assurance Manual (QAM). Controls required to be included within the QAM shall include who, what, when, where, why and how with an understanding that the how can be a reference to an implementation procedure or instruction. Quality activities to be described in the Quality Assurance Program are~~is~~ identified in Section 1.8.5 of this part. Applicants shall address all requirements in their Quality Assurance Program based on the category of activity and scope of work to be performed (organization's capabilities) to which certification is requested.

~~b~~1) Category 1

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Any ASME Code certified item or system requiring repair/replacement activities irrespective of physical location and installation status prior to fuel loading.

~~c~~2) Category 2

After fuel loading, any item or system under the scope of ASME Section XI requiring repair/replacement activities irrespective of physical location.

~~d~~3) Category 3

Items constructed to codes or standards other than ASME, requiring repair/replacement activities irrespective of physical location, installation status and fuel loading.

~~e~~b) Repair organizations performing repairs of pressure relief devices in nuclear service shall meet the additional requirements of NBIC Part 3, Supplement 7 and Supplement 9.

# Request for NBIC Part 3, Supplement 2 Revision

Robert V. Underwood
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**NB16-0501**

| | |
|---|---|
| **Purpose** | To clarify when telltale holes are required to be installed in staybolts 8 inches or less in length. |
| **Scope:** | To eliminate the requirement of telltale holes in staybolts when replacing staybolts 8 inches or less in length when the original Code of construction did not require them. |
| **Background** | In the performance of repairs to historical boilers by replacing/installing threaded and welded staybolts, paragraphs S2.13.2(b) and S2.13.4(c) of the NBIC Part 3, Supplement 2 require telltale holes in staybolts 8 inches or less in length.<br><br>There is no reason to install telltale holes in these shorter staybolts if they weren't required by the original code of construction.<br><br>Recommend revising S2.13.2(b) and S2.13.4(c) to eliminate telltale holes if the original construction code or standard did not require them. This will require telltale holes if required by the original code of construction or when replacing existing staybolts with telltale holes, but not all staybolt replacements. |
| **Proposed Revision** | **Paragraphs S2.13.2(b) shall be revised to read as follows:**<br><br>**S2.13.2 INSTALLATION OF THREADED STAYBOLTS**<br><br>a) Threaded staybolts shall have either 11 or 12 thread pitch. Staybolt threads shall have a close fit in sheets. Changing the staybolt thread pitch from 11 to 12 or the reverse shall be considered a repair.<br><br>b) ~~When staybolts 8 in. (200 mm) or less in length are replaced, they shall be replaced with staybolts that have a telltale hole 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter their entire length or with ones that have a 3/16 in. (5 mm) to 7/32 in. (5.5 mm) diameter hole in each end, drilled a minimum of 1-1/4 in. (31 mm) deep. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. (See NBIC Part 3, Figure S2.13.2).~~<br><br>b) Replacement of staybolts 8 inches and less in length shall have telltale holes when required by the original Code of construction or when replacing staybolts with telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred. (See Figure S2.13.2) |

**Paragraph S2.13.4(c) shall be revised to read as follows:**

### S2.13.4 INSTALLATION OF WELDED STAYBOLTS

a) The installation of unthreaded staybolts using full penetration welds is permissible. (See NBIC Part 3, Figure S2.13.4).

b) Threaded stays may be replaced by welded-in stays provided that, in the judgement of the Inspector, the material adjacent to the staybolt has not been materially weakened by deterioration or wasting away. If staybolt hole is threaded, the threads shall be removed prior to welding.

~~c) Staybolts shorter than 8 in. (200 mm) in length shall have telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred.~~

c) Replacement of staybolts 8 inches and less in length shall have telltale holes when required by the original Code of construction or when replacing staybolts with telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred. (See Figure S2.13.4)

**TABLE 1.8.2** (15)

"NR" QUALITY ASSURANCE PROGRAM (QAP) REQUIREMENTS

| Category of Activity | Owner | Organizations other than Owner |
|---|---|---|
| Category 1 | 10 CFR Part 50 Appendix B1, 2 and ASME Section III NCA-4000 | 10 CFR Part 50 Appendix B1, 2 and ASME Section III NCA-4000 |
| Category 2 | 10 CFR Part 50, Appendix B1, 2 or NQA-1, Part 1 and ASME Section XI, IWA-4142 | 10 CFR Part 50, Appendix B1, 2 supplemented as needed with Owner's QA program; or ASME NQA-1, Part 1; or ASME Section III, NCA-4000 |
| Category 3 | ASME NQA-1, or Specify the Standard to which certification is desired | ASME NQA-1,or Specify the Standard to which certification is desired |
| **Note 1:** Code of Federal Regulations (CFR) – rules and regulations published by the executive departments and agencies of the federal government of the United States. | | |
| **Note 2:** 10 CFR 50 Appendix B – Title 10 of the Code of Federal Regulations Part 50 Appendix B describes the quality assurance criteria for nuclear plants and fuel reprocessing plants. | | |

### 1.8.2.1 DEFINITIONS (15)

NBIC

The terms and definitions ~~used within this section shall be as specified below:~~

~~a) For Category 1 terms and definitions shall be as specified in ASME Section III~~

~~b) For Category 2 terms and definitions shall be as specified in ASME Section XI~~

~~c) For Category 3 terms and definitions shall be as specified in ASME NQA-1 and~~ ~~fied by the Regulatory Authority~~

shall be supplemented, as applicable, by the terms and definitions of ASME Section III, Section XI, NQA-1, or other standards specified by the Regulatory Authority,

The following terms are as defined in the NBIC Glossary of Terms Section 9:

a) Authorized Inspection Agency

b) Authorized Nuclear Inspection Agency

[*An Authorized Inspection Agency intending to perform nuclear inspection activities and employing nuclear Inspectors / Supervisors*] – NBIC Glossary

c) Jurisdiction

d) "NR" Certificate Holder

## Interpretation IN15-1401

## Proposed Interpretation

| | |
|---|---|
| **Inquiry:** | IN15-1401 |
| **Source:** | Mark Driver |
| **Subject:** | Valve Repair Nameplate Field Labels |
| **Edition:** | 2015 |
| **Question 1:** | When a pressure relief valve is repaired and capacity and capacity units (para 5.12.2b6) are not changed from the original manufacturers stamping or nameplate, are blank headings for capacity and capacity units required on the valve repair nameplate?<br><br>When a pressure relief valve is repaired and the type/model number (para 5.12.2b7) are not changed from the original manufacturer's stamping or nameplate, are blank headings for type/model number required on the valve repair nameplate? |
| **Reply 1:** | No |
| **Committee's Question:** | When a pressure relief valve is repaired, are field labels for type/model number, capacity, CDTP, and/or BP required on the repair nameplate if the values are not changed from the original manufacturer's nameplate or stamping? |
| **Committee's Reply:** | No |
| **Rationale:** | |
| **SC Vote** | (8) In favor (unanimous) |
| **NBIC Vote** | |

**SC-PRD ITEM NB11-0401, Draft 1-15-13**

Open Issues:

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

Organizational Comments:

1. Part 3 supplement 7 has been changed to main body text, and rearranged for flow

Editorial/ other comments

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

Key:

Underlined indicates new material written for this draft

~~Strikethrough~~ indicates deleted material

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

# NBIC PART 4

# PRESSURE RELIEF DEVICES

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# PART 4, SECTION 1

## Installation of Pressure Relief Devices (previously in Part 1)

### 1.1 INSTALLATION OF PRESSURE RELIEF DEVICES

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

### 1.2 PRESSURE RELIEF DEVICES — DEFINITIONS

a) Pressure Relief Device: A device designed to prevent pressure or vacuum from exceeding a predetermined value in a pressure vessel by the transfer of fluid during emergency or abnormal conditions.

b) Pressure Relief Valve (PRV): A pressure relief device designed to actuate on inlet static pressure and reclose after normal conditions have been restored.

c) Safety valve: A pressure relief valve characterized by rapid opening and normally used to relieve compressible fluids.

d) Safety relief valve: A pressure relief valve characterized by rapid opening or by gradual opening that is generally proportional to the increase in pressure. It can be used for compressible or incompressible fluids.

e) Relief valve; A pressure relief valve characterized by gradual opening that is generally proportional to the increase in pressure. It is normally used for incompressible fluids.

f) Pilot operated pressure relief valve: A pressure relief valve in which the disk is held closed by system pressure, and the holding pressure is controlled by a pilot valve actuated by system pressure.

### 1.2.1 ~~Part 3, 1.4~~ ADDITIONAL DEFINITIONS RELATING TO PRESSURE RELIEF DEVICES

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

### 1.3 ~~2.9~~ PRESSURE RELIEF VALVES FOR POWER BOILERS

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

### 1.3.1 ~~2.9.1~~ GENERAL REQUIREMENTS

a) ~~Safety valves are designed to relieve steam.~~ Only direct spring loaded safety valves, direct spring loaded safety relief valves, or pilot operated pressure relief valves designed to relieve steam shall be used for steam service.

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

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

d) Deadweight or weighted-lever pressure relief~~ving~~ valves shall not be used.

e) For high temperature water boilers, pressure ~~safety~~ relief valves shall have a closed bonnet, and ~~safety relief~~ valve bodies shall not be constructed of cast iron.

f) ~~Safety and safety relief~~ Pressure relief valves with an inlet connection greater than NPS 3 (DN 80) and used for pressure greater than 15 psig (100~~3~~ kPa), shall have a flanged inlet connection or a welding-end inlet connection. The dimensions of flanges subjected to boiler pressure shall conform to the applicable standards.

g) When a ~~safety or safety~~ pressure relief valve is exposed to outdoor elements that may affect operation of the valve, ~~it is permissible to shield the valve~~the valve may be shielded with a cover. The cover shall be properly vented and arranged to permit servicing and normal operation of the valve.

**1.3.2 ~~2.9.1.1~~ NUMBER**

At least one National Board capacity certified pressure ~~safety or safety~~ relief valve shall be installed on the boiler. If the boiler has more than 500 sq. ft. (46 sq. m.) of heating surface, or if an electric boiler has a power input of more than 3.76 million BTU/hr (1100 kW), two or more National Board capacity certified pressure ~~safety or safety~~ relief valves shall be installed.

**1.3.3 ~~2.9.1.2~~ LOCATION**

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

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

c) Pressure ~~Safety or safety~~ relief valves shall be connected to the boiler independent of any other connection without any unnecessary intervening pipe or fittings. Such intervening pipe or fittings shall not be longer than the face-to-face dimension of the corresponding tee fitting of the same diameter and pressure rating as listed in the applicable standards.

**1.3.4 ~~2.9.1.3~~ CAPACITY**

a) The pressure-relieving valve capacity for each boiler shall be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6% above the highest pressure at which any valve is set and in no case to more than 6% above the maximum allowable working pressure of the boiler.

b) The minimum relieving capacity for other than electric boilers and forced-flow steam generators with no fixed steam line and waterline shall be estimated for the boiler and waterwall heating surfaces as given in Table 1.3.4.1 ~~2.9.1.3~~, but in no case ~~should~~shall the minimum relieving capacity be less than the maximum designed steaming capacity as determined by the manufacturer.

c) The required relieving capacity in lbs/hr of the pressure ~~safety or safety~~ relief valves on a high temperature water boiler shall be determined by dividing the maximum output in Btu at the boiler nozzle obtained by the firing of any fuel for which the unit is designed by one thousand.

d) The minimum pressure ~~safety or safety~~ relief valve relieving capacity for electric boilers ~~is~~ shall not be less than 3.5 lbs/hr/kW (1.6 kg/hr/kW) input.

e) If the pressure ~~safety or safety~~ relief valve capacity cannot be computed, or if it is desirable to prove the computations, it should be checked by any one of the following methods; and if found insufficient, additional relieving capacity shall be provided:

1) By performing an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. This method should not be used on a boiler with a superheater or reheater or on a high-temperature water boiler.

2) By measuring the maximum amount of fuel that can be burned and computing the corresponding evaporative capacity upon the basis of the heating value of the fuel.

3) By determining the maximum evaporative capacity by measuring the feedwater. The sum of the safety valve capacities marked on the valves shall be equal to or greater than the maximum evaporative capacity of the boiler. This method should not be used on high-temperature water boilers.

**Table 1.3.4.1 ~~2.9.1.3~~ - Minimum Pounds of steam per hour per square foot of Heating Surface lbs steam/hr/ft$^2$ (kg/hr/m$^2$)**

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

NOTES:

• When a boiler is fired only by a gas having a heat value not in excess of 200 Btu/ft$^3$(7.5MJ/m$^3$), the minimum relieving capacity should be based on the values given for hand-fired boilers above.

• The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes,shells, tubesheets, and the projected area of headers need to be considered, except that for vertical firetube steam boilers, only that portion of the tube surface up to the middle gage cock is to be computed.

• For firetube boiler units exceeding 8000 Btu/ft$^2$ (9085 J/cm$^2$) (total fuel Btu (J) Input divided by total heating surface), the factor from the table will be increased by 1 (4.88) for every 1000 Btu/ft.$^2$ (1136 J/cm$^2$) above 8000 Btu/ft.$^2$ (9085 J/cm$^2$) For units less than 7000 Btu/ft$^2$ (7950 J/cm$^2$), the factor from the table will be decreased by 1 (4.88).

• For watertube boiler units exceeding 16000 Btu/ft$^2$ (18170 J/cm$^2$)(total fuel BTU input divided by the total heating surface) the factor from the table will be increased by 1 (4.88) for every 1000 Btu/ft.$^2$ (1136 J/cm$^2$) above 16000 Btu/ft.$^2$ (18170 J/cm$^2$). For units with less than 15000 Btu/ft.$^2$ (17034 J/cm$^2$), the factor in the table will be decreased by 1 (4.88) for every 1000 Btu/ft.2 (1136 J/cm$^2$) below 15000 Btu/ft.$^2$ (17034 J/cm$^2$).

### 1.3.5 ~~2.9.1.4~~ SET PRESSURE

One or more pressure ~~safety or safety~~ relief valves on the boiler proper shall be set at or below the maximum allowable working pressure. If additional valves are used, the highest pressure setting shall not exceed the maximum allowable working pressure by more than 3%. The complete range of pressure settings of all the pressure ~~safety~~ relief valves on a boiler shall not exceed 10% of the highest pressure to which any valve is set. Pressure setting of pressure ~~safety~~ relief valves on high temperature water boilers may exceed this 10% range.

### 1.3.6 ~~2.9.2~~ FORCED-FLOW STEAM GENERATORS

For a forced-flow steam generator with no fixed steamline and waterline, equipped with automatic controls and protective interlocks responsive to steam pressure, pressure relief ~~safety~~ valves may be provided in accordance with the above paragraphs identified in 1.3.5 ~~2.9.1~~ or the following protection against overpressure shall be provided:

a) One or more power-actuated pressure relief~~ving~~ valves shall be provided in direct communication with the boiler when the boiler is under pressure and shall receive a control impulse to open when the maximum allowable working pressure at the superheater outlet is exceeded. The total combined relieving capacity of the power actuated pressure relief~~ving~~ valves shall be not less than 10% of the maximum design steaming capacity of the boiler under any operating condition as determined by the manufacturer. The valves shall be located in the pressure part system where they will relieve the overpressure. An isolating stop valve of the outside-screw-and-yoke type should be installed between the power actuated pressure-relieving valve and the boiler to permit repairs provided an alternate power-actuated pressure relief~~ving~~ valve of the same capacity is so installed as to be in direct communication with the boiler.

b) Pressure relief valves shall be provided having a total combined relieving capacity, including that of the power-actuated pressure relief~~ving~~ valve, of not less than 100% of the maximum designed steaming capacity of the boiler, as determined by the manufacturer. In this total, credit in excess of 30% of the total relieving capacity shall not be allowed for the power-actuated pressure relief~~ving~~ valves actually installed. Any or all of the pressure relief valves may be set above the maximum allowable working pressure of the parts to which they are connected, but the set pressures shall be such that when all these valves (together with the power-actuated pressure relief~~ving~~ valves) are in operation the pressure will not rise more than 20% above the maximum allowable working pressure of any part of the boiler, except for the steam piping between the boiler and the prime mover.

c) When stop valves are installed in the water steam flow path between any two sections of a forced-flow steam generator with no fixed steamline and waterline:

1) The power-actuated pressure-relieving valve shall also receive a control impulse to open when the maximum allowable working pressure of the component, having the lowest pressure level upstream to the stop valve, is exceeded.

2) The pressure relief valve shall be located to provide overpressure protection for the component having the lowest working pressure.

3) A reliable pressure-recording device shall always be in service and records kept to provide evidence of conformity to the above requirements.

**1.3.7 ~~2.9.3~~ SUPERHEATERS**

a) Every attached superheater shall have one or more ~~safety~~ pressure relief valves. The location shall be suitable for the service intended and shall provide the overpressure protection required. The pressure drop upstream of each ~~safety~~ pressure relief valve shall be considered in determining the set pressure and relieving capacity of that valve. If the superheater outlet header has a full, free steam passage from end to end and is so constructed that steam is supplied to it at practically equal intervals throughout its length so that there is a uniform flow of steam through the superheater tubes and the header, the ~~safety~~ pressure relief valve or valves may be located anywhere in the length of header.

b) The pressure-relieving capacity of the ~~safety~~ pressure relief valve or valves on an attached superheater shall be included in determining the number and size of the safety valves for the boiler provided there are no intervening valves between the superheater ~~safety~~ pressure relief valve and the boiler and the discharge capacity of the pressure ~~safety~~ relief valve or valves, on the boiler, as distinct from the superheater, is at least 75% of the aggregate capacity required.

c) Every independently fired superheater that may be shut off from the boiler and permit the superheater to become a fired pressure vessel shall have one or more ~~safety~~ pressure relief valves having a discharge capacity equal to 6 lbs steam/hr/ft$^2$ (29 kg steam/hr/m$^2$) of superheater surface measured on the side exposed to the hot gases.

d) Every ~~safety~~ pressure relief valve used on a superheater discharging superheated steam at a temperature over 450°F (230°C) shall have a casing, including the base, body, bonnet, and spindle constructed of steel, steel alloy, or equivalent heat-resistant material. The valve shall have a flanged inlet connection or a welding-end inlet connection. The seat and disk shall be constructed of suitable heat-erosive and corrosive-resistant material, and the spring fully exposed outside of the valve casing so that it is protected from contact with the escaping steam.

**1.3.8 ~~2.9.4~~ ECONOMIZERS**

An economizer that may not be isolated from a boiler does not require a pressure ~~safety~~ relief valve. Economizers that may be isolated from a boiler or other heat transfer device, allowing the economizer to become a fired pressure vessel, shall have a minimum of one pressure relief valve. Discharge capacity, rated in lbs/hr (kg/hr), of the pressure ~~safety~~ relief valve or valves shall be calculated from the maximum expected heat absorption rate in Btu/hr (kJ~~oules~~/hr) of the economizer, and will be determined from manufacturer data, divided by 1000 BTU/lb (2326 kj/kg). The pressure ~~safety~~ relief valve shall be located as close as possible to the economizer outlet.

### 1.3.9 ~~2.9.5~~ PRESSURE-REDUCING VALVES

a) Where pressure-reducing valves are used, one or more pressure ~~safety or safety~~ relief valves shall be installed on the low pressure side of the reducing valve in those installations where the piping or equipment on the low pressure side does not meet the requirements for the steam supply piping.

b) The pressure ~~safety or safety~~ relief valves shall be located as close as possible to the pressure reducing valve.

c) Capacity of the pressure ~~safety or safety~~ relief valves shall not be less than the total amount of steam that can pass from the high pressure side to the low pressure side and be such that the pressure rating of the lower pressure piping or equipment shall not be exceeded.

d) The use of hand-controlled bypasses around reducing valves is permissible. The bypass around a reducing valve may not be greater in capacity than the reducing valve unless the piping or equipment is adequately protected by pressure ~~safety or safety~~ relief valves or meets the requirements of the high pressure system.

e) See NBIC Part 4, Supplement 1 for additional information on the calculation of the required capacity of pressure relief valves installed after pressure-reducing valves.

### 1.3.10 ~~2.9.6~~ INSTALLATION ~~MOUNTING~~ AND DISCHARGE REQUIREMENTS

a) Every boiler shall have outlet connections for the pressure ~~safety or safety~~ relief valve, or valves, independent of any other outside steam connection, the area of opening shall be at least equal to the aggregate areas of inlet connections of all of the attached pressure ~~safety or safety~~ relief valves. An internal collecting pipe, splash plate, or pan should be used, provided the total area for inlet of steam thereto is not less than twice the aggregate areas of the inlet connections of the attached pressure ~~safety or safety~~ relief valves. The holes in such collecting pipes shall be at least 1/4 in. (6 mm) in diameter, and the least dimension in any other form of opening for inlet of steam shall be 1/4 in. (6 mm). If pressure ~~safety or safety~~ relief valves are attached to a separate steam drum or dome, the opening between the boiler proper and the steam drum or dome shall be not less than 10 times the total area of the safety valve inlet.

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

c) The opening or connection between the boiler and the pressure ~~safety or safety~~ relief valve shall have at least the area of the valve inlet and the inlet pipe to the pressure relief valve shall be no longer than the face to face dimension of the corresponding tee fitting of the same diameter and pressure class. When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet or of the total of the areas of the valve outlets, discharging there into and shall be as short and straight as possible and arranged to avoid undue stresses on the valve or valves.

d) No valve of any description except a changeover valve as defined below, shall be placed between the pressure ~~safety or safety~~ relief valves and the boiler, nor on the discharge pipe between the pressure ~~safety or safety~~ relief valves and the atmosphere.

A changeover valve, which allows two redundant pressure relief valves to be installed for the purpose of changing from one pressure relief valve to the other while the boiler is operating, may be used provided the changeover valve is in accordance with the original code of construction. It is recommended that the Jurisdiction be contacted to determine the acceptability of the changeover valves on boiler applications. The changeover valve shall be designed such that there is no intermediate position where both pressure relief valves are isolated form the boiler.

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

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

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

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

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

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

**1.3.11 ~~2.3.1~~ SUPPORTS, FOUNDATIONS, AND SETTINGS**

Each boiler pressure relief valve and its associated piping must be safely supported. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal movement), and loadings (including reaction forces ~~the weight of water during a hydrostatic test~~) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.

**1.4 ~~PART 2, 2.2.12.7 f)~~ PRESSURE RELIEF VALVES FOR THERMAL FLUID HEATERS**

a) Pressure Relief Valves — Pressure relief valves shall be a closed bonnet design with no manual lift lever. A valve body drain is not required. The pressure relief discharge should be connected to a closed, vented storage tank or blowdown tank with solid piping (no drip pan elbow, or other air gap). When outdoor discharge is used, the following should be considered for discharge piping at the point of discharge:

1) Both thermal and chemical reactions (personnel hazard)

2) Combustible materials (fire hazard)

3) Surface drains (pollution and fire hazard)

4) Loop seal or rain cap on the discharge (keep both air and water out of the system)

5) Drip leg near device (prevent liquid collection)

6) Heat tracing for systems using high freeze point fluids (prevent blockage)

***(The following was developed based upon ASME Code Section I, Part PVG)***
7) A suitable condenser that will condense all the vapors discharged from the pressure relief valve may be used in lieu of piping the vapors to the atmosphere.

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

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

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

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

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

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

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

Where
A = discharge area of pressure relief valve
C = constant for vapor that is a function of the ratio of Specific Heats $k = cp/cv$ .

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

K = coefficient of discharge for the valve design
M = molecular weight
P = (set pressure × 1.03) + Atmosphere Pressure
T = absolute temperature at inlet, °F + 460 (°C + 273)
W = flow of vapor

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

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

where
C = maximum total weight or volume of fuel burned per hour, lb (kg) or $ft^3$ ($m^3$)
H = heat of combustion of fuel, Btu/lb (J/kg) or Btu/$ft^3$ (J/$m^3$)
h = latent heat of heat transfer fluid at relieving pressure, Btu/lb (J/kg)
W = weight of organic fluid vapor generated per hour

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

**1.5 ~~3.9~~ PRESSURE RELIEF VALVES FOR HEATING BOILERS**

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

**1.5.1 ~~3.9.1~~ PRESSURE RELIEF ~~SAFETY~~ VALVE REQUIREMENTS — GENERAL**

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

**1.5.1.1 ~~3.9.1.1~~ INSTALLATION OF ~~MOUNTING~~ PRESSURE RELIEF ~~SAFETY AND SAFETY RELIEF~~ VALVES FOR HEATING BOILERS**

**1.5.1.1.1 ~~3.9.1.1.1~~ PERMISSIBLE INSTALLATION ~~MOUNTING~~**

Pressure ~~Safety valves and safety~~ relief valves shall be located at the top side of the boiler. The top side of the boiler shall mean the highest practicable part of the boiler proper but in no case shall the safety valves be located below the normal operating level and in no case shall the safety relief valve be located below the lowest permissible water level. They shall be connected directly to a tapped or flanged opening in the boiler, to a fitting connected to the boiler by a short nipple, to a Y-base, or to a valveless header connecting steam or water outlets on the same boiler. Coil or header type boilers shall have the ~~safety valve or safety~~ pressure relief valve located on the steam or hot water outlet end. ~~Safety valves and safety~~ Pressure relief valves shall be installed with their spindles vertical. The opening or connection between the boiler and any safety valve or safety relief valve shall have at least the area of the valve inlet.

**1.5.1.1.2 ~~3.9.1.1.2~~ REQUIREMENTS FOR COMMON CONNECTIONS FOR TWO OR MORE VALVES**

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

b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas. When the size of the boiler requires a ~~safety valve or safety~~ pressure relief valve larger than NPS ~~-~~4 (DN 100), two or more valves having the required combined capacity shall be used. When two or more valves are used on a boiler, they may be single, directly attached, or installed ~~mounted~~ on a Y-base.

**1.5.1.2 ~~3.9.1.2~~ THREADED CONNECTIONS**

A threaded connection may be used for attaching a valve.

**1.5.1.3 ~~3.9.1.3~~ PROHIBITED INSTALLATIONS ~~MOUNTINGS~~**

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

**1.5.1.4 ~~3.9.1.4~~ USE OF SHUTOFF VALVES PROHIBITED**

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

**1.5.1.5 ~~3.9.1.5~~ PRESSURE RELIEF ~~SAFETY AND SAFETY RELIEF~~ VALVE DISCHARGE PIPING**

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

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

**1.5.1.6 ~~3.9.1.6~~ TEMPERATURE AND PRESSURE ~~SAFETY~~ RELIEF VALVES**

Hot-water heating or supply boilers limited to a water temperature of 210°F (99°C) may have one or more National Board capacity certified temperature and pressure ~~safety~~ relief valves installed. The requirements of 1.5.1.1 ~~3.9.1.1~~ through 1.5.1.5 ~~3.9.1.~~5 shall be met, except as follows:

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

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

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

**1.5.2 ~~3.9.2~~ ~~SAFETY~~ PRESSURE RELIEF VALVE REQUIREMENTS FOR STEAM HEATING BOILERS**

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

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

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

d) The minimum valve capacity in lbs/hr (kg/hr) shall be the greater of that determined by dividing the maximum Btu/hr (W~~atts)~~ output at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1000 Btu/hr/lb (645 W/kg), or shall be determined on the basis of the lbs steam/hr/ft$^2$ (kg steam/hr/m$^2$) of boiler heating surface as given in Table 1.3.4.1 ~~3.9.2~~. For cast-iron boilers, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirement of 1.5.2 e) ~~3.9.2e)~~shall be met.

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

f) When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with 1.5.2 e) ~~3.9.2e)~~.The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

**1.5.3 ~~3.9.3~~ ~~SAFETY~~ PRESSURE RELIEF VALVE REQUIREMENTS FOR HOT WATER HEATING OR HOT WATER SUPPLY BOILERS**

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

b) Each hot-water heating or hot-water supply boiler shall have at least one National Board capacity certified ~~safety~~ pressure relief valve, of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.

c) Hot-water heating or hot-water supply boilers limited to a water temperature not in excess of 210°F (99°C) may have, in lieu of the valve(s) specified in (b) above, one or more National Board capacity certified temperature and pressure ~~safety~~ relief valves of the automatic reseating type set to relieve at or below the maximum allowable working pressure of the boiler.

d) When more than one ~~safety~~ pressure relief valve is used on either hot-water heating or hot water supply boilers, the additional valves shall be National Board capacity certified and may have a set pressure within a range not to exceed 6 psig (40 kPa) above the maximum allowable working pressure of the boiler up to and including 60 psig (414kPa), and 5% for those having a maximum allowable working pressure exceeding 60 psig (413 kPa).

e) No ~~safety~~ pressure relief valve shall be smaller than NPS 3/4 (DN 20) nor larger than NPS 4 (DN 100), except that boilers having a heat input not greater than 15,000 Btu/hr (4.4kW) should be equipped with a rated pressure relief valve of NPS 1/2 (DN 15).

f) The required relieving capacity, in lbs/hr (kg/hr), of the pressure relie~~ving~~f valve or valves on a boiler shall be the greater of that determined by dividing the maximum output in Btu/hr (W) at the boiler nozzle obtained by the firing of any fuel for which the unit is installed by 1000 Btu//hr/lb (645 W/kg), or shall be determined on the basis of ~~pounds~~ lbs steam/hr/ft$^2$ (~~kilograms~~kg steam/hr/m$^2$) ~~of steam generated per hour per square foot (square meter) of boiler heating surface~~ as given in Table 1.3.4.1. For cast-iron boilers, the minimum valve capacity shall be determined by the maximum output method. In many cases a greater relieving capacity of valves will have to be provided than the minimum specified by these rules. In every case, the requirements of 1.5.3 h) ~~3.9.3h)~~shall be met.

g) When operating conditions are changed, or additional boiler heating surface is installed, the valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with 1.5.3 h) ~~3.9.3h)~~. The additional valves required, on account of changed conditions, may be installed on the outlet piping provided there is no intervening valve.

h) ~~Safety~~ Pressure relief valve capacity for each boiler with a single ~~safety~~ pressure relief valve shall be such that, with the fuel burning equipment installed and operated at maximum capacity, the pressure cannot rise more than 10% above the maximum allowable working pressure. When more than one ~~safety~~ pressure relief valve is used, the over pressure shall be limited to 10% above the set pressure of the highest set valve allowed by 1.11.3 b) ~~3.9.3b)~~.

**1.5.4 ~~3.9.4~~ ~~SAFETY~~ PRESSURE RELIEF VALVE REQUIREMENTS FOR POTABLE WATER HEATERS**

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

b) The pressure setting shall be less than or equal to the maximum allowable working pressure of the water heater. However, if any of the other components in the hot-water supply system (such as valves, pumps, expansion or storage tanks, or piping) have a lesser working pressure rating than the water heater, the pressure setting for the ~~safety~~ pressure relief valve(s) shall be based upon the component with the lowest maximum allowable working pressure rating. If more than one ~~safety~~ pressure relief valve is used, the additional valve(s) may be set within a range not to exceed 10% above the set pressure of the first valve.

c) The required relieving capacity in Btu/hr (W) of the ~~safety~~ pressure relief valve shall not be less than the maximum allowable input unless the water heater is marked with the rated burner input capacity of the water heater on the casing in a readily visible location, in which case the rated burner input capacity may be used as a basis for sizing the ~~safety~~ pressure relief valves. The relieving capacity for electric water heaters shall be 3500 Btu/hr (1.0 kW) per kW of input. In every case, the following requirements shall be met. ~~Safety~~ Pressure relief valve capacity for each water heater shall be such that with the fuel burning equipment installed and operating at maximum capacity, the pressure cannot rise more than 10% above the maximum allowable working pressure.

d) If operating conditions are changed or additional heating surface is installed, the ~~safety~~ pressure relief valve capacity shall be increased, if necessary, to meet the new conditions and shall be in accordance with the above provisions. In no case shall the increased input capacity exceed the maximum allowable input capacity. The additional valves required, on account of changed conditions, may be installed on the outlet piping providing there is no intervening valve.

**1.5.4.1 ~~3.9.4.1~~ INSTALLATION**

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

**1.5.4.2 ~~3.9.4.2~~ PERMISSIBLE INSTALLATIONS ~~MOUNTINGS~~**

~~Safety~~ Pressure relief valves shall be connected directly to a tapped or flanged opening in the top of the water heater, to a fitting connected to the water heater by a short nipple, to a Y-base, or to a valveless header connecting water outlets on the same heater. ~~Safety~~ Pressure relief valves shall be installed with their spindles upright and vertical with no horizontal connecting pipe, except that, when the ~~safety~~ pressure relief valve is installed ~~mounted~~ directly on the water heater vessel with no more than 4 in. (100 mm) maximum interconnecting piping, the valve may be installed in the horizontal position with the outlet pointed down. The center line of the ~~safety~~ pressure relief valve connection shall be no lower than 4 in. (100 mm) from the top of the shell. No piping or fitting used to install ~~mount~~ the ~~safety~~ pressure relief valve shall be of nominal pipe size less than that of the valve inlet.

**1.5.4.3 ~~3.9.4.3~~ REQUIREMENTS FOR COMMON CONNECTION FOR TWO OR MORE VALVES**

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

b) When a Y-base is used, the inlet area shall be not less than the combined outlet areas.

c) When the size of the water heater requires a ~~safety~~ pressure relief valve larger than NPS 4 (DN 100) two or more valves having the required combined capacity shall be used. When two or more valves are used on a water heater, they may be single, directly attached, or installed ~~mounted~~ on a Y-base.

**1.5.4.4 ~~3.9.4.4~~ THREADED CONNECTIONS**

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

**1.5.4.5 ~~3.9.4.5~~ PROHIBITED INSTALLATIONS ~~MOUNTINGS~~**

Pressure ~~Safety~~ relief valves shall not be connected to an internal pipe in the water heater or a cold water feed line connected to the water heater.

**1.5.4.6 ~~3.9.4.6~~ USE OF SHUTOFF VALVES PROHIBITED**

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

**1.5.4.7 ~~3.9.4.7~~ ~~SAFETY~~ PRESSURE RELIEF VALVE DISCHARGE PIPING**

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

b) The discharge from ~~safety~~ pressure relief valves shall be so arranged that there will be no danger of scalding attendants. When the ~~safety~~ pressure relief valve discharge is piped away from the water heater to the point of discharge, there shall be provisions for properly draining the piping and valve body. The size and arrangement of discharge piping shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the relieving devices below that required to protect the water heater.

**1.5.5 ~~3.9.5~~ PRESSURE RELIEF ~~SAFETY AND SAFETY RELIEF~~ VALVES FOR TANKS AND HEAT EXCHANGERS**

**1.5.5.1 ~~3.9.5.1~~ STEAM TO HOT-WATER SUPPLY**

When a hot-water supply is heated indirectly by steam in a coil or pipe within the service limitations set forth in Part 1, ~~paragraph~~ 3.2*, Definitions*, the pressure of the steam used shall not exceed the safe working pressure of the hot water tank, and a ~~safety~~ pressure relief valve at least NPS 1 (DN 25), set to relieve at or below the maximum allowable working pressure of the tank, shall be applied on the tank.

**1.5.5.2 ~~3.9.5.2~~ HIGH TEMPERATURE WATER TO WATER HEAT EXCHANGER**

When high temperature water is circulated through the coils or tubes of a heat exchanger to warm water for space heating or hot-water supply, within the service limitations set forth in Part 1, ~~paragraph~~ 3.2, *Definitions*, the heat exchanger shall be equipped with one or more National Board capacity certified pressure ~~safety~~ relief valves set to relieve at or below the maximum allowable working pressure of the heat exchanger, and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than 10% above the maximum allowable working pressure of the vessel.

**1.5.5.3 ~~3.9.5.3~~ HIGH TEMPERATURE WATER TO STEAM HEAT EXCHANGER**

When high temperature water is circulated through the coils or tubes of a heat exchanger to generate low pressure steam, within the service limitations set forth in Part 1, 3.2, *Definitions*, the heat exchanger shall be equipped with one or more National Board capacity certified pressure relief ~~safety~~ valves set to relieve at a pressure not to exceed 15 psig (100 kPa), and of sufficient rated capacity to prevent the heat exchanger pressure from rising more than 5 psig (34 kPa) above the maximum allowable working pressure of the vessel. For heat exchangers requiring steam pressures greater than 15 psig (100 kPa), refer to NBIC Part 1, Section 2 or Section 4 ~~of this Part~~.

**1.6 PRESSURE VESSEL PRESSURE RELIEF DEVICES**

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

Pressure vessels protected by pressure relief devices shall meet the following requirements:

**1.6.1 ~~4.5.1~~ DEVICE REQUIREMENTS**

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

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

c) An unfired steam boiler shall be equipped with pressure relief valves as required in NBIC Part 4, 1.3.

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

**1.6.2 ~~4.5.2~~ NUMBER OF DEVICES**

At least one device shall be provided for protection of a pressure vessel. Pressure vessels with multiple chambers with different maximum allowable working pressures shall have a pressure relief device to protect each chamber under the most severe coincident conditions.

**1.6.3 ~~4.5.3~~ LOCATION**

a) The pressure relief device shall be installed directly on the pressure vessel, unless the source of pressure is external to the vessel and is under such positive control that the pressure cannot exceed the maximum overpressure permitted by the original code of construction and the pressure relief device cannot be isolated from the vessel, except as permitted by 1.6.6(e)(2).

b) Pressure relief devices intended for use in compressible fluid service shall be connected to the vessel in the vapor space above any contained liquid or in the piping system connected to the vapor space.

c) Pressure relief devices intended for use in liquid service shall be connected below the normal liquid line. The liquid level during upset conditions shall be considered.

**1.6.4 ~~4.5.4~~ CAPACITY**

a) The pressure relief device(s) shall have sufficient capacity to ensure that the pressure vessel is not exposed to pressure greater than that specified in the original code of construction.

b) Pressure vessels that can be exposed to fire or other sources of unexpected external heat may require supplemental pressure relief devices to provide additional relieving capacity.

1) The combined capacity of all installed pressure relief devices shall be adequate to prevent the pressure from rising more than 21% above maximum allowable working pressure.

2) The set point of any supplemental pressure relief device(s) shall not exceed 110% of the maximum allowable working pressure. If a single pressure relief device is utilized to protect the vessel during both operational and fire or other unexpected external heating conditions, the set point shall not exceed maximum allowable working pressure.

c) Vessels connected together by a system of piping not containing valves that can isolate any pressure vessel may ~~should~~ be considered as one unit when determining capacity requirements.

d) Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid overpressure in case of internal failure.

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

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

**1.6.5 ~~4.5.5~~ SET PRESSURE**

a) When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure.

b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure needs to be at the maximum allowable working pressure. The set pressures of the additional pressure relief devices shall be such that the pressure cannot exceed the overpressure permitted by the code of construction.

**1.6.6 ~~4.5.6~~ INSTALLATION AND DISCHARGE PIPING REQUIREMENTS**

a) The opening through all pipe and fittings between a pressure vessel and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. When a discharge pipe is used, the size shall be such that any pressure that may exist or develop will not reduce the relieving capacity below that required or adversely affect the proper operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

b) A non-reclosing device installed between a pressure vessel and a pressure relief valve shall meet the requirements of 1.6.6 a). ~~4.5.6a)~~

c) The opening in the pressure vessel wall shall be designed to provide unobstructed flow between the vessel and its pressure relief device.

d) When two or more required pressure relief devices are placed on one connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of 1.6.6 a). ~~4.5.6a)~~

e) There shall be no intervening stop valves between the vessel and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge, except under the following conditions:

1) When these stop valves are so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity; or,

2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a pressure vessel and its pressure relief device should be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station.

3) A full area stop valve should also be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked and sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed.

4) A pressure vessel in a system where the pressure originates from an outside source should have a stop valve between the vessel and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of the pressure.

5) Pressure vessels designed for human occupancy (such as decompression or hyperbaric chambers) shall be provided with a quick opening stop valve between the pressure vessel and its pressure relief valve. The stop valve shall be normally sealed open with a frangible seal and be readily accessible to the pressure relief attendant.

f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

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

i) Pressure vessel pressure relief devices and discharge piping shall be safely supported. The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping. Design of supports, foundations, and settings shall consider vibration (including seismic where necessary), movement (including thermal movement), and loadings (including reaction forces during device operation ~~the weight of water during a hydrostatic test~~) in accordance with jurisdictional requirements, manufacturer's recommendations, and/or other industry standards, as applicable.

**1.6.7 ~~4.7.3~~ ~~SAFETY~~ PRESSURE RELIEF DEVICES FOR HOT WATER STORAGE TANKS**

a) Each hot water storage tank shall be equipped with an ASME/NB certified temperature and pressure relieving device set at a pressure not to exceed the maximum allowable working pressure and 210°F.

b) The temperature and pressure relieving device shall meet the requirements of ~~NBIC Part 1, 4.5~~ 1.6.1 through 1.6.6 above.

**1.7 ~~5.3~~ PIPING SYSTEM PRESSURE RELIEF DEVICES**

**See NBIC Part 1, Section 5 for the piping systems associated with this section.**

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

**1.7.1 ~~5.3.1~~ DEVICE REQUIREMENTS**

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

1) In certain cases piping codes of construction permit the use of regulators, which may include integral pressure relief valves to limit the pressure in a piping system. In this case, capacity certification of the pressure relief valve is not required.

2) Some piping codes of construction permit the use of pressure relief devices without capacity certification. In this case, capacity certification of the pressure relief device by the National Board is not required.

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

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

**1.7.2 ~~5.3.2~~ NUMBER OF DEVICES**

At least one pressure relief device shall be provided for protection of a piping system. A pressure relief device installed on a pressure vessel or other component connected to the piping system should be used to meet this requirement. Portions of piping systems with different maximum allowable working pressures shall have a pressure relief device to protect each portion separately.

**1.7.3 ~~5.3.3~~ LOCATION**

Pressure relief devices, except those covered by NBIC Part 4, Sections 1.1 through 1.3 ~~2 and 3~~, may be installed at any location in the system provided the pressure in any portion of the system cannot exceed the maximum overpressure permitted by the original code of construction. Pressure drop to the pressure relief device under flowing conditions shall be considered when determining pressure relief device location. The pressure-relief device shall not be isolated from the piping system except as permitted by 1.7.6 e). ~~NBIC Part 1, 5.3.6e)~~

**1.7.4 ~~5.3.4~~ CAPACITY**

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

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

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

**1.7.5 ~~5.3.5~~ SET PRESSURE**

a) When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure, except when allowed by the original code of construction.

b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure need be at or below the maximum allowable working pressure. The set pressures of the additional pressure relief devices shall be such that the pressure cannot exceed the overpressure permitted by the code of construction.

**1.7.6 ~~5.3.6~~ INLET AND DISCHARGE PIPING REQUIREMENTS**

a) The opening through all pipes and fittings between a piping system and its pressure relief device shall have at least the area of the pressure relief device inlet. The characteristics of this upstream system shall be such that the pressure drop will not reduce the relieving capacity below that required or adversely affect the operation of the pressure relief device.

b) A non-reclosing device installed between a piping system and a pressure relief valve shall meet the requirements of 1.7.6 a). ~~NBIC Part 1, 5.3.6a)~~

c) The opening in the pipe shall be designed to provide unobstructed flow between the pipe and its pressure relief device.

d) When two or more required pressure relief devices are placed on the connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of 1.7.6 a). ~~NBIC Part 1, 5.3.6a)~~

e) There shall be no intervening stop valves between the piping system and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge except under the following conditions:

1) These stop valves ~~are~~ shall be so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity;

2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a piping system and its pressure relief device ~~should~~ may be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station;

3) A full area stop valve ~~should~~ may be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed; or

4) A piping system where the pressure originates from an outside source should have a stop valve between the system and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of pressure.

f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

h) The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping.

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

# PART 4, SECTION 2

## IN-SERVICE INSPECTION (previously in Part 2)

### 2.1 ~~2.5~~ IN-SERVICE INSPECTION OF PRESSURE RELIEF DEVICES

The inspection of pressure relief devices is often coordinated with the inspection of the system. See NBIC Part 2 for in-service inspection requirements and procedures for other portions of the equipment not discussed in this section.

### 2.2 ~~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~~ pressure relief valves, rupture disks, and other nonreclosing devices that are called upon to operate and reduce an overpressure condition.

b) These devices are not designed or intended to control the pressure in the system during normal operation. Instead, they are intended to function when normal operating controls fail or abnormal system conditions are encountered.

c) Periodic inspection and maintenance of these important safety devices is critical to ensure their continued functioning and to provide assurance that they will be available when called upon to operate. See 2.2.6 for recommended testing frequency for PRDs.

d) Inspection areas of concern include:

1) correct set pressure; (matching of set pressure to MAWP)
2) safety considerations;
3) device data;
4) condition of the device;
5) condition of the installation; and
6) testing and operational inspection.

### 2.2.1 ~~2.5.2~~ PRESSURE RELIEF DEVICE DATA

a) Nameplate marking or stamping of the device should be compared to stamping on the protected pressure-retaining item. For a single device, the set pressure shall be no higher than the maximum allowable working pressure (MAWP) marked on the protected pressure-retaining item or system.

b) When more than one pressure relief device is provided to obtain the required capacity, only one pressure relief device set pressure need be at or below the maximum allowable working pressure. 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.

### 2.2.2 ~~2.5.3~~ DEVICE CONDITIONS

a) ~~Check for evidence that the valve or device is~~ The valve or device shall be checked for evidence that it is not leaking or not sealing properly. Evidence of leakage through pressure-relief valves may indicate that the system is being operated at a pressure that is too close to the valve's set pressure. (See ~~Part 2,~~ Supplement 2 ~~8~~ for guidance on the pressure differential between the pressure relief valve set pressure and system operating pressure.)

b) Seals for adjustments shall ~~should~~ be intact and show no evidence of tampering.

c) Connecting bolting should be tight and all bolts intact.

d) The valve or device should be examined for deposits or material buildup.

e) ~~Evidence of rust or corrosion should be checked.~~The valve or device should be checked for evidence of rust or corrosion.

f) The valve or device shall be ~~Check~~checked for damaged or misapplied parts.

g) If a drain hole is visible, the valve or device should be checked to ensure it is not clogged with debris or deposits.

h) ~~Check~~ The valve or device shall be checked for test ~~gages~~ gags left in place after pressure testing of the unit.

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

**2.2.3 ~~2.5.4~~ INSTALLATION CONDITION**

a) ~~Inspect inlet~~ Inlet piping shall be inspected to~~and~~ ensure it meets the requirements of the original ~~Code~~ code of ~~Construction~~construction. For pressure relief valves, ~~check that~~ the inlet pipe shall be checked to ensure the inlet pipe size is not smaller than the device inlet size.

b) ~~Inspect discharge piping and~~Discharge piping shall be inspected to ensure it meets the original ~~Code~~ code of ~~Construction~~construction. For pressure relief valves, the discharge pipe shall be checked to ensure the discharge pipe size is not smaller than the device outlet size.~~Check that the discharge pipe size is not smaller than the device outlet size.~~

c) ~~Check that the valve drain piping is open~~. The valve drain piping shall be checked to ensure the piping is open.

d) ~~Check drainage of discharge piping.~~ The discharge piping shall be checked to ensure it drains properly.

e) ~~Check that~~The inlet and discharge piping shall be checked to ensure they 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~~The condition and adequacy of the pipe supports shall be inspected. Discharge piping should be supported independent of the device itself.

g) ~~Check for possible hazards to personnel from the valve discharge or discharge pipe.~~The valve discharge and discharge pipe shall be checked for possible hazards to personnel.

h) The installation shall be checked to ensure ~~Check~~ that there are no intervening isolation valves between the pressure source and the valve inlet or between the valve outlet and its point of discharge. Isolation valves may be permitted in some pressure vessel service. (See ~~Part 1 5.3.6e)~~ 1.6.6 e)), and jurisdictional requirements. Isolation valves ~~are not permitted~~shall not be used 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.

### 2.2.4 ~~2.5.5~~ ADDITIONAL INSPECTION REQUIREMENTS

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

#### 2.2.4.1 ~~2.5.5.1~~ BOILERS

a) If boilers are piped together with maximum allowable working pressures differing by more than 6%, additional protective devices may be required on the lower pressure units to protect them from overpressure from the higher pressure unit.

b) Hot-Water Heating Boilers and Water Heaters

1) These units generally do not use any water treatment and therefore may be more prone to problems with deposits forming that may impair a safety device's operation. Particular attention should be paid to signs of leakage through valves or buildups of deposits.

2) Hot-water boilers tend to have buildups of corrosion products since the system is closed with little makeup. These products can foul or block the valve inlet.

3) Water heaters will have cleaner water due to continuous makeup. However, these valves usually have a thermal element that will cause the valve to open slightly when the water is heated and the heat is not removed from the system. When this hot water evaporates in the discharge piping, scale ~~calcium~~ deposits may tend to form in the valve inlet and outlet.

#### 2.2.4.2 ~~2.5.5.2~~ PRESSURE VESSELS AND PIPING

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

#### 2.2.4.3 ~~2.5.5.3~~ RUPTURE DISKS

a) Rupture disks or other non-reclosing devices may be used as sole relieving devices or in combination with safety relief valves to protect pressure vessels.

b) The selection of the correct rupture disk device for the intended service is critical to obtaining acceptable disk performance. Different disk designs are intended for constant pressure, varying pressure, or pulsating pressure. Some designs include features that make them suitable for back pressure and/or internal vacuum in the pressure vessel.

c) The margin between the operating pressure and the burst pressure is an important factor in obtaining acceptable performance and service life of the disk. Flat and prebulged solid metal disks are typically used with an operating pressure that is no more than 60% to 70% of the burst pressure. Other designs are available that increase the operating pressure to as much as 90% of the burst pressure. Disks that have been exposed to pressures above the normal operating pressure for which they are designed are subject to fatigue or creep and may fail at unexpectedly low pressures. Disks used in cyclic service are also subject to fatigue and may require a greater operating margin or selection of a device suitable for such service.

d) The disk material is also critical to obtaining acceptable service life from the disk. Disks are available in a variety of materials and coatings, and materials that are unaffected by the process fluid should be used. Disks that experience corrosion may fail and open at an unexpectedly low pressure.

e) Disk designs must also be properly selected for the fluid state. Some disk types are not suitable for use in liquid service. Some disks may have a different flow resistance when used in liquid service, which may affect the sizing of the disk.

f) Information from the rupture disk manufacturer, including catalog data and installation instructions, should be consulted when selecting a disk for a particular service.

g) For rupture disks and other non-reclosing devices, the following additional items should be considered during inspections.

1) The rupture disk nameplate information, including stamped burst pressure and coincident temperature, should be checked to ensure it is compatible with the intended service. The coincident temperature on the rupture disk shall be the expected temperature of the disk when the disk is expected to burst and will usually be related to the process temperature, not the temperature on the pressure vessel nameplate.

2) Markings indicating direction of flow should be carefully checked to ensure they are correct. Some rupture disks when installed in the incorrect position may burst well above the stamped pressure.

3) The marked burst pressure for a rupture disk installed at the inlet of a safety relief valve shall be equal to or less than the safety relief valve set pressure. A marked burst pressure of 90% to 100% of the safety relief valve set pressure is recommended. A disk with a non-fragmenting design that cannot affect the safety relief valve shall be used.

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

4) The rupture disk shall be c~~C~~hecked that the space between the~~a~~ rupture disk and a ~~safety~~ pressure 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~~ shall be of a type not influenced by back pressure due to leakage through the valve. Otherwise, for nontoxic and non-hazardous fluids, the space between the valve and the rupture disk shall be vented or drained to prevent the accumulation of pressure.

6) For rupture disks installed on the valve inlet, the installation should be reviewed to ensure that the combination rules of the original code of construction have been applied. A reduction in the valve capacity up to 10% is expected when used in combination with a non-reclosing device.

7) The frequency of inspection for rupture disks and other non-reclosing devices is greatly dependent on the nature of the contents and operation of the system and only general recommendations can be given. Inspection frequency should be based on previous inspection history. If devices have been found to be leaking, defective, or damaged by system contents during inspection, intervals should be shortened until acceptable inspection results are obtained. With this in mind, the inspection frequency guidelines specified in 2.2.6 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 rupture disks are non-reclosing devices, a visual inspection is the only inspection that can be performed. A rupture disk that is removed from its holder shall not be reinstalled unless recommended by the manufacturer. A rupture disk contained in an assembly that can be removed from a system without releasing the force maintaining the contact between the disk and holder, such as pre-torqued, welded, soldered, and some threaded assemblies, may be suitable for reinstallation after visual inspection. The manufacturer should be consulted for specific recommendations.

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

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

### 2.2.5 ~~2.5.7~~ TESTING AND OPERATIONAL INSPECTION OF PRESSURE RELIEF DEVICES

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

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

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

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

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

c) Valves may be tested using lift assist devices when testing at full pressure may cause damage to the valve being tested, or it is impractical to test at full pressure due to system design considerations. Lift assist devices apply an auxiliary load to the valve spindle or stem, and using the measured inlet pressure, applied load and other valve data allow the set pressure to be calculated. If a lift assist device is used to determine valve set pressure, the conditions of NBIC ~~Part 3 4.5.3~~ Part 4, 3.6.3 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~~ pressure relief valves, high temperature hot-water boiler ~~safety~~ pressure relief valves, low pressure steam heating boilers: steam;

2) Hot-water heating boiler ~~safety~~ pressure 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~~ pressure 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~~ pressure 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~~ Part 4, 3.6.2.

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 Section IV valves require that the valve be capable of being lifted without pressure.

f) ~~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.

g)~~j)~~ Upon completion of set pressure testing, all pressure relief valve gags shall be removed.

**2.2.5.1 CORRECTIVE ACTION**

~~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.) The owner shall be notified and corrective action such as repairing or replacing the inoperable valve shall be taken.

**2.2.5.2 VALVE ADJUSTMENTS**

~~g)~~ a) If a set 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~~ a qualified 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. Qualified organizations are considered to be National Board “VR” Certificate Holders, or organizations authorized by the Jurisdiction to make adjustments. See Supplement 3 for more information.

~~h)~~ b) 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.

**2.2.6 ~~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~~ Set pressure test to verify nameplate set pressure every three years or as determined by operating experience as verified by testing history.

3) ~~Pressure~~ Set 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~~ Set 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) Organic Fluid Vaporizers

Pressure relief valves shall be disconnected from the vaporizer at least once yearly, when they shall be inspected, tested, repaired if necessary, and then replaced on the vaporizer.

~~c)~~ d) Low-Pressure Steam Heating Boilers

Manual check quarterly; set pressure test annually prior to steam heating season to verify nameplate set pressure.

~~d)~~ e) 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~~ pressure relief valves actuate, the valves should be inspected for seat leakage and other damage as soon as possible and any deficiencies corrected.

~~e)~~ f) 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)~~ g) 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, external environment, and operation of the system, therefore only general recommendations can be given. Inspection frequency should be based on previous inspection history. If, during inspection, valves are found to be defective or damaged, 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:

| **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 |

### 2.2.6.1 ~~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)~~ a) Jurisdictional requirements;

~~2)~~ b) Records of test data and inspections from similar processes and similar devices in operation at that facility;

~~3)~~ c) Recommendations from the device manufacturer. In particular, when the valve includes non-metallic parts such as a diaphragm or soft seat, periodic replacement of those parts may be specified;

~~4)~~ d) Operating history of the system. Systems with frequent upsets where a valve has actuated require more frequent inspection;

~~5)~~ e) 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)~~ f) 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)~~ g) 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)~~ h) 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)~~ i) 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.

**2.2.6.2 ~~h)~~ ESTABLISHMENT OF SERVICE INTERVALS**

~~1)~~ a) 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 replacement of the device. Many users will maintain spare pressure relief devices so the process or system is not affected by excessive downtime.

~~2)~~ b) 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)~~ c) 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.

# PART 4, SECTION 3

## REPAIR (previously in Part 3)

### 3.1 ~~S7.1~~ REPAIR OF PRESSURE RELIEF DEVICES, SCOPE

This section ~~supplement~~ provides general requirements that apply to repairs to pressure relief valves. Repairs may be required because of defects found during periodic inspections because testing has identified that valve performance does not meet the original code of construction requirements, failure during operation, or for routine preventative maintenance. Since pressure relief devices are provided for safety and the protection of personnel and property, repairs are often regulated by the jurisdiction where the pressure relief device is installed. The jurisdiction should be contacted for their specific requirements.

### 3.2 ~~S7.2~~ GENERAL REQUIREMENTS

a) Repair of a pressure relief valve is considered to include the disassembly, replacement, re-machining, or cleaning of any critical part, lapping of a seat and disc, reassembly, adjustment, testing, or any other operation that may affect the flow passage, capacity, function, or pressure-retaining integrity.

b) Conversions, changes, or adjustments affecting critical parts are also considered repairs. The scope of conversions may include changes in service fluid and changes such as bellows, soft seats, and other changes that may affect Type/Model number provided such changes are recorded on the document as required for a quality system and the repair nameplate. (See ~~NBIC Part 3, 5.12.1~~ 3.7.1).

c) The scope of repair activities shall not include changes in ASME Code status.

### 3.2.1 ~~S7.2 d)~~ VR REPAIR

a) When a repair is being performed under the administrative requirements for National Board Accreditation, a repair shall consist of the following operations as a minimum:

1) Complete disassembly, cleaning, and inspection of parts, repair or replacement of parts found to be defective, reassembly, testing as required by ~~NBIC Part 3 4.5~~ 3.6, sealing and application of a repair nameplate. When completed, the valve's condition and performance shall be equivalent to the standards for new valves.

2) The administrative requirements for National Board Accreditation apply only to valves that are stamped with an ASME "V," "UV," or "NV" Code symbol or marked with an ASME "HV" symbol and have been capacity certified on the applicable fluid by the National Board.

### 3.2.2 ~~1.2 d)~~ CONSTRUCTION STANDARDS FOR PRESSURE RELIEF DEVICES ~~RETAINING ITEMS~~

a) For pressure relief ~~relieving~~ devices, the applicable new construction standard ~~for new valves~~ to be used for reference during repairs is the ASME Code. ASME Code Cases shall be used for repairs when they were used in the original construction of the valve. ASME Code Cases may be used when they have been accepted for use by the NBIC Committee and the Jurisdiction where the pressure-retaining item is installed.

1) For pressure relief ~~relieving~~ devices, the Code Case number shall be noted on the repair document and, when required by the code case, stamped on the repair nameplate.

2) The Jurisdiction where the pressure retaining item is installed shall be consulted for any unique requirements it may have established.

### 3.2.3 INSTALLATION OF PRESSURE RELIEF DEVICES

Installation of a pressure relief device by mechanical methods is not considered to be a repair, as long as no changes or adjustments are made to the device. Seals installed by the device manufacturer or repair organization shall not be removed when the device is installed.

When a pressure relief device is to be installed by welding on an existing pressure retaining item, the requirements of Part 3 of the NBIC for welded repairs shall be followed.

If a pressure relief valve must be disassembled or its adjustments changed as part of the installation process, the reassembly, resetting, retesting or other such activities shall be done by a qualified organization which meets the requirements of NBIC ~~,~~ Part 4. For a new pressure relief valve, the original valve manufacturer shall perform this activity as required by the original code of construction.

The installation of a non-reclosing pressure relief device or the replaceable element of a non-reclosing pressure relief device such as a rupture disk is not considered to be a repair. The manufacturer's procedures and instruction shall be followed for the installation of these devices.

### 3.2.4 ~~S7.6~~ INITIAL ADJUSTMENTS TO PRESSURE RELIEF VALVES

The initial installation testing and adjustments of a new pressure relief valve on a boiler or pressure vessel are not considered a repair if made by the manufacturer or assembler of the valve.

### 3.3 ~~S7.~~4 MATERIALS FOR PRESSURE RELIEF VALVE REPAIR

The materials used in making repairs shall conform to the requirements of the original code of construction. The "VR" Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the materials to be installed.

### 3.3.1 ~~S7.5~~ REPLACEMENT PARTS FOR PRESSURE RELIEF DEVICES

a) Critical parts shall be fabricated by the valve manufacturer or to the manufacturer's specifications. Critical parts are those that may affect the valve flow passage, capacity, function, or pressure-retaining integrity.

b) Critical parts not fabricated by the valve manufacturer shall be supplied with material test certification for the material used to fabricate the part.

c) Replacement critical parts receiving records shall be attached or be traceable to the valve repair document (see ~~NBIC Part 3, 1.7.5.4i)~~ 3.8.5.4 i)).These records shall conform to at least one of the following.

1) Receiving records documenting the shipping origin of the part fabricated by the valve manufacturer (such as packing list) from the valve manufacturer or assembler of the valve type.

2) A document prepared by the "VR" Certificate holder certifying that the replacement part used in the repair has the manufacturer's identification on the part or is otherwise labeled or tagged by the manufacturer and meets the manufacturer's acceptance criteria (e.g., critical dimensions found in maintenance manual).

3) Receiving records for replacement critical parts obtained from a source other than the valve manufacturer or assembler of the valve type shall include a document that provides as a minimum:

a. The part manufacturer and part designation.

b. A certifying statement that either:

1. The part was fabricated by the valve manufacturer and meets the manufacturer's acceptance criteria (e.g., critical dimensions found in maintenance manual), or

2. The part meets the manufacturer's specifications and was fabricated from material as identified by the attached material test report.

c. The signature of an authorized individual of the part source.

d. The name and address of the part source for whom the authorized individual is signing.

d) Material for bolting shall meet the manufacturer's specification, but does not require material test certification if marked as required by the material specification.

### 3.4 ~~S7.12~~ WELDING FOR PRESSURE RELIEF VALVES

When welding is used as a repair technique during a pressure relief valve repair, the following requirements shall apply.

a) Welding shall be performed in accordance with the requirements of the original code of construction used for the pressure relief valve.

b) Cast iron and carbon or alloy steel having a carbon content of more than 0.35% shall not be welded.

c) Defects in pressure relief valve parts such as cracks, pits, or corrosion that will be repaired by welding shall be completely removed before the weld repair of the part is performed. Removal of the defect shall be verified by suitable NDE as required.

d) Consideration shall be given to the condition of the existing material, especially in the weld preparation area.

#### 3.4.1 ~~S7.12.1~~ WELDING PROCEDURE SPECIFICATIONS

Welding shall be performed in accordance with Welding Procedure Specifications (WPS) qualified in accordance with the original code of construction. When this is not possible or practicable, the WPS may be qualified in accordance with Section IX of the ASME Code.

#### 3.4.2 ~~S7.12.2~~ STANDARD WELDING PROCEDURE SPECIFICATIONS

A "VR" Certificate Holder may use one or more applicable Standard Welding Procedure Specifications shown in NBIC Part 3, 2.3.

#### 3.4.3 ~~S7.12.3~~ PERFORMANCE QUALIFICATION

Welders or welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction or Section IX of the ASME Code.

#### 3.4.4 ~~S7.12.4~~ WELDING RECORDS

The "VR" Certificate Holder shall maintain a record of the results obtained in welding procedure qualifications, except for those qualifications for which the provisions of ~~NBIC Part 3, S7.12.2~~ 3.4.2 are used, and of the results obtained in welding performance qualifications. These records shall be certified by the "VR" Certificate Holder and shall be available to the National Board.

#### 3.4.5 ~~S7.12.5~~ WELDERS' IDENTIFICATION

The "VR" Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The "VR" Certificate Holder shall also establish a written procedure whereby welded joints can be identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and shall be described in the quality control system written description. The welder's or welding operator's identification mark may be stamped (low stress stamp) adjacent to welded joints made by the individual, or the "VR" Certificate Holder may keep a documented record of welded joints and the welders or welding operators used in making the joints.

#### 3.4.6 ~~S7.12.6~~ WELDERS' CONTINUITY

The performance qualification of a welder or welding operator shall be affected when one of the following conditions occur:

a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire.

b) When there is specific reason to question their ability to make welds that meet the specification, the qualification that supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.

### 3.4.7 ~~S7.3~~ WELD REPAIRS TO PRESSURE RELIEF VALVE PARTS BY AN “R” STAMP HOLDER

a) The quality system manual may include controls for the “VR” Certificate Holder to have the pressure relief valve part repaired by a National Board “R” Certificate Holder, per this ~~Supplement~~ section provided the following documentation is provided to the “R” Certificate Holder:

1) Code of construction, year built;

2) Part identification;

3) Part material specified; and

4) “VR” Certificate Holder’s unique identifier for traceability as required by the repair inspection program.

b) Prior to performing weld repairs to pressure relief valve (PRV) parts, the “R” Certificate Holder shall receive repair information required by ~~NBIC Part 3, S7.3(a)~~ 3.4.7 a) from the “VR” Certificate Holder responsible for the pressure relief valve repair.

1) PRV part weld repairs shall be performed under the “R” Certificate Holder’s quality system; however, the requirements for in-process involvement of the Inspector (see Part 3, 1.3.2) may be waived. The requirement for stamping is waived.

2) The process of identifying and controlling repairs shall be documented in the “R” Certificate Holder’s quality system.

3) PRV part repairs shall be documented on a Form R-1 with a statement under the “Remarks” section “PRV Part Repair.” The owner’s name and location of installation shall be that of the “VR” Certificate Holder. The information received from the “VR” Certificate Holder as required in ~~NBIC Part 3, S7.3(a)~~ 3.4.7 a) shall be noted under the “Description of Work” section.

4) Upon completion of the repair, the repaired part and completed Form R-1 shall be returned to the “VR” Certificate Holder responsible for completing the PRV repair.

### 3.5 ~~S7.13~~ HEAT TREATMENT

### 3.5.1 ~~S7.13.1~~ PREHEATING

Preheating may be employed during welding to assist in completion of the welded joint in accordance with ~~NBIC~~ Part 3, 2.5.1. The need for and the temperature of preheat are dependent on a number of factors, such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties. The welding procedure specification for the material being welded shall specify the preheat temperature requirements.

### 3.5.2 ~~S7.13.2~~ POSTWELD HEAT TREATMENT

Postweld heat treatment shall be performed as required by the original code of construction in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment. A time and temperature report or temperature record shall be maintained to document the work performed.

### 3.6 ~~4.5~~ PRESSURE RELIEF VALVE PERFORMANCE TESTING AND TESTING EQUIPMENT

Each pressure relief valve to which the “VR” repair symbol stamp is to be applied shall be subjected to the following tests by the repair Certificate Holder.

### 3.6.1 ~~4.5.1~~ TEST MEDIUM AND TESTING EQUIPMENT

Valves marked for steam service, or having special internal parts for steam service, shall be tested on steam. Valves marked for air, gas, or vapor service shall be tested with air or gas. Valves marked for liquid service shall be tested with water or other suitable liquid. ASME Code, Section IV hot-water valves, shall be tested on water, steam, or air.

a) Each valve shall be tested to demonstrate the following:

1) Set pressure (as defined by the valve manufacturer and as listed in NB-18, *Pressure Relief Device Certifications);*

2) Response to blowdown, when required by the original code of construction;

3) Seat tightness; and

4) For valves designed to discharge to a closed system, the tightness of the secondary pressure zone shall be tested as required by the original code of construction.

b) The equipment used for the performance testing prescribed above shall meet the following requirements:

1) The performance testing equipment shall include a pressure vessel of adequate volume and pressure source capacity to ensure compliance with ~~NBIC Part 3, 4.5.1a)1)~~ 3.6.1 a) 1);

2) Prior to use, all performance testing equipment shall be qualified by the Certificate Holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark testing, comparisons to equipment used for verification testing as specified in the quality system, or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation for a period of at least five years after the testing equipment is retired. Documentation of this qualification shall include but not be limited to:

a. Schematic of the performance test equipment;

b. Size and pressure ranges of valves to be tested and the test fluid to be used;

c. Dimensions of test vessels;

d. Accuracy of pressure measuring equipment;

e. Size and design type of valves used to control flow; and

f. Method of qualifying.

3) Prior to the implementation of any addition or modification to the testing equipment that would alter the contents of the document required in ~~NBIC Part 3, 4.5.1(b)(2)~~ 3.6.1 b) 2), the Certificate Holder shall re-qualify the performance test equipment in accordance with ~~NBIC Part 3, 4.5.1(b)(2)~~ 3.6.1 b) 2). If the equipment changed was used to satisfy the requirements of verification testing, the Certificate Holder shall notify the National Board and additional verification testing, in accordance with the quality system, may be required.

### 3.6.2 ~~4.5.2~~ OWNER-USER ASME CODE SECTION VIII STEAM TESTING

When ASME Code Section VIII valves are repaired by the owner for the owner's own use, valves for steam service may be tested on air for set pressure and, if possible, blowdown adjustment, provided the valve manufacturer's corrections for differential in set pressure between steam and air are applied to the set pressure.

### 3.6.3 ~~4.5.3~~ LIFT ASSIST TESTING

a) A device may be used to apply an auxiliary lifting load on the spring of a repaired valve to establish the set pressure in lieu of the tests required in ~~NBIC Part 3, 4.5.1a)1)~~ 3.6.1 a) 1) when such testing at full pressure:

1) may cause damage to the valve being tested; or

2) is impractical when system design considerations preclude testing at full pressure.

b) While actual valve blowdown and valve performance characteristics cannot be verified using this testing technique, valve set pressure may be determined to an acceptable degree of accuracy if, as a minimum:

1) equipment utilized is calibrated as required in the quality system; including, but not limited to:

a. System pressure measurement equipment;

b. Lifting force measurement equipment; and

c. Other measuring elements required by the device manufacturer.

2) the device and test procedures that have proved to give accurate results are used and followed;

3) a static inlet pressure is applied with the test medium specified in ~~NBIC Part 3, 4.5.1~~ 3.6.1; and

4) adjustments are made in accordance with the valve manufacturer's recommendations to ensure proper lift and blowdown.

c) Prior to use, all lift assist devices shall be qualified by the Certificate Holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation for a period of at least five years after the lift assist device is retired. Documentation of this qualification shall include but not be limited to:

1) A description of the lift assist device including model number, serial number and manufacturer;

2) Size and pressure ranges of valves to be tested with the lift assist device and the test fluid to be used;

**Note**: Maximum set pressure is determined by available lift force and system pressure.

3) Accuracy of pressure measuring equipment; and

4) Method of qualifying.

d) After initial qualification of the device the device shall be re-qualified if:

1) Modifications or repairs to the device are made which would affect test results; or

2) The manufacturer issues a mandatory recall or modification to the device which will affect test results.

**3.6.4 ~~4.5.4~~ PRESSURE TEST OF PARTS**

a) Parts used in repaired valves shall be pressure tested and documentation provided according to the following categories:

1) Replacement Parts

The "VR" Certificate Holder is responsible for documentation that the appropriate pressure test has been completed as required by the original code of construction.

2) Parts Repaired by Welding

These parts shall be subjected to a pressure test required by the original code of construction. The “VR” Certificate Holder shall be responsible for documentation of such test.

b) Parts repaired by re-machining within part specifications, lapping, or polishing do not require a pressure test.

### 3.7 ~~5.12~~ STAMPING REQUIREMENTS FOR PRESSURE RELIEF DEVICES

### 3.7.1 ~~5.12.1~~ NAMEPLATES

Proper marking and identification of tested or repaired valves is critical to ensuring acceptance during subsequent inspections, and also provide for traceability and identification of any changes made to the valve. All operations that require the valve’s seals to be replaced shall be identified by a nameplate as described in ~~NBIC Part 3, 5.12.2 or 5.12.4~~ 3.7.2 or 3.7.4.

### 3.7.2 ~~5.12.2~~ REPAIR NAMEPLATE

When a pressure relief valve is repaired, a metal repair nameplate stamped with the information required below shall be securely attached to the valve adjacent to the original manufacturer’s stamping or nameplate. If not installed ~~mounted~~ directly on the valve, the nameplate shall be securely attached so as not to interfere with valve operation and sealed in accordance with the quality system.

a) Prior to attachment of the repair nameplate, the previous repair nameplate, if applicable, shall be removed from the repaired valve.

b) As a minimum, the information on the valve repair nameplate (see ~~NBIC Part 3 Figure 5.7.5-e~~ Figure 3.7.2-a) shall include:

1) The name of the repair organization preceded by the words “repaired by”;

2) The “VR” repair symbol stamp and the “VR” certificate number;

3) Unique identifier (e.g., repair serial number, shop order number, etc.);

4) Date of repair;

5) Set pressure;

6) Capacity and capacity units (if changed from original nameplate due to set pressure or service fluid change);

7) Type/Model number (if changed from original nameplate by a conversion. See ~~NBIC Part 3, 4.5.2~~ 3.2); and

8) When an adjustment is made to correct for service conditions of superimposed back pressure and/or temperature or the differential between popping pressure between steam and air (see ~~NBIC Part 3, S7.2~~ 3.6.2), the information on the valve repair nameplate shall include the:

a. Cold Differential Test Pressure (CDTP); and

b. Superimposed Back Pressure (BP) (only when applicable).

**FIGURE 3.7.2-a ~~Figure 5.7.5-e~~**

Required markings for repair of ASME/National Board "V," "UV," and "HV"-stamped pressure relief valves

REPAIRED BY

VR®

CERTIFICATE HOLDER

(1)
TYPE/MODEL NUMBER

SET PRESSURE
(1)
CAPACITY

(1)
CDTP
(1)
BP

REPAIR IDENTIFICATION

NATIONAL BOARD "VR" CERTIFICATE NUMBER

DATE REPAIRED

Note 1. To be indicated only when changed

**FIGURE 3.7.2-b ~~Figure 5.7.5-g~~**

Required markings for repair or replacement of nuclear pressure relief valves

NR® VR®

CERTIFICATE HOLDER

NATIONAL BOARD CERTIFICATE NOS.

COMPLETED IN ACCORDANCE WITH ASME SECTION XI

NR
VR

EDITION
ADDENDA
CODE CASE(S)

REPAIR ☐

REPLACEMENT ☐

SET PRESSURE

CAPACITY (IF CHANGE IN SET PRESSURE)

DATE OF REPAIR OR REPLACEMENT

**3.7.3 ~~5.12.3~~ CHANGES TO ORIGINAL PRESSURE RELIEF VALVE NAMEPLATE INFORMATION**

a) If the set pressure is changed, the set pressure, capacity, and blowdown, if applicable, on the original nameplate or stamping shall be marked out but left legible. The new capacity shall be based on that for which the valve was originally certified.

b) If the service fluid is changed, the capacity, including units, on the original nameplate or stamping shall be marked out but left legible. The new capacity shall be based on that for which the valve was originally certified, or if a conversion has been made, as described in ~~NBIC Part 3, S7.2~~ 3.2 on the capacity certification for the valve as converted.

c) If the Type/Model number is changed, the Type/Model number on the original nameplate shall be marked out but left legible.

d) If the blowdown is changed, the blowdown, if shown on the original nameplate or stamping, shall be marked out but left legible. The new blowdown may be based on the current ASME Code requirements.

e) Incorrect information on the original manufacturer's nameplate shall be marked out but left legible. Corrected information shall be indicated on the repair nameplate and noted on the document as required by the quality system.

### 3.7.4 ~~5.12.4~~ TEST ONLY NAMEPLATE

a) Where a valve has been tested and adjusted to restore the set pressure shown on the unmodified original nameplate or stamping, or repair nameplate, as permitted by ~~NBIC Part 3, S7.10.1~~ S3.1, but not otherwise repaired, a "Test Only" nameplate shall be applied that contains the following information:

1) Name of responsible organization;

2) Date of test;

3) Set Pressure; and

4) Identification, such as "Test Only."

b) A "Test Only" nameplate is also recommended when periodic testing has been performed, even when no adjustments have been made, for the purpose of identifying the date the valve was tested.

c) The existing repair nameplate~~s~~, if applicable, shall not be removed during such testing.

### 3.7.5 ~~5.12.5~~ REPLACEMENT OF ILLEGIBLE OR MISSING NAMEPLATES

a) Illegible Nameplates

When the information on the original manufacturer's or assembler's nameplate or stamping is illegible, but traceability can be confirmed, the nameplate or stamping ~~will~~ shall be augmented by a nameplate furnished by the "VR" stamp holder stamped "Duplicate." It shall contain all information that originally appeared on the nameplate or valve, as required by the applicable section of the ASME Code, except the "V," "HV," or "UV" symbol and the National Board mark. The repair organization's nameplate, with the "VR" stamp and other required data specified in ~~NBIC Part 3, 5.12.2~~ 3.7.2, will make the repairer responsible to the owner and the Jurisdiction that the information on the duplicate nameplate is correct.

b) Missing Nameplates

When the original valve nameplate is missing, the repair organization is not authorized to perform repairs to the valve under the "VR" program, unless positive identification can be made to that specific valve and verification that the valve was originally stamped with an ASME "V" or UV" symbol or marked with an ASME "HV" symbol. Valves that can be positively identified ~~will~~ shall be equipped with a duplicate nameplate, as described in this section, in addition to the repairer's "VR"-stamped nameplate. The repairer's responsibilities for accurate data, as defined in ~~NBIC Part 3, 5.12.5~~ 3.7.5(a) (Illegible Nameplates), shall apply.

c) Marking of Original Code Stamp

When a duplicate nameplate is affixed to a valve, as required by this section, it shall be marked “Sec. I,” “Sec. IV,” or “Sec. VIII,” as applicable, to indicate the original ASME Code stamping.

### 3.8 ~~1.7~~ ACCREDITATION OF “VR” REPAIR ORGANIZATIONS

### 3.8.1 ~~1.7.1~~ SCOPE

These administrative rules and procedures are provided by the National Board for those who wish to obtain National Board *Certificate of Authorization* for use of the “VR” (Repair of Pressure Relief Valves) symbol stamp. It should be noted that the issuance of the “VR” stamp is not restricted to companies whose primary business is the repair of pressure relief valves, nor to manufacturers or assemblers that hold an ASME “V,” “HV,” “UV,” or “NV” Code Symbol Stamp. Owners and users of boilers and pressure vessels and other organizations that qualify in accordance with the National Board rules and regulations may also obtain the “VR” Certificate and stamp.

### 3.8.2 ~~1.7.2~~ JURISDICTIONAL PARTICIPATION

The National Board member jurisdiction in which the “VR” organization is located is encouraged to participate in the review and demonstration of the applicant’s quality system. The Jurisdiction may require participation in the review of the repair organization and the demonstration and acceptance of the repair organization’s quality system manual.

### 3.8.3 ~~1.7.3~~ ISSUANCE AND RENEWAL OF THE “VR” *CERTIFICATE OF AUTHORIZATION*

#### 3.8.3.1 ~~1.7.3.1~~ GENERAL

Authorization to use the stamp bearing the official National Board “VR” symbol as shown in ~~NBIC Part 3 Section 5~~ Figure 3.7.2-a, will be granted by the National Board pursuant to the provisions of the following administrative rules and procedures.

#### 3.8.3.2 ~~1.7.3.2~~ ISSUANCE OF CERTIFICATE

Repair organizations, manufacturers, assemblers, or users that make repairs to the ASME Code symbol stamped or marked pressure relief valves and National Board capacity certified pressure relief valves may apply to the National Board for a *Certificate of Authorization* to use the “VR” symbol.

### 3.8.4 ~~1.7.4~~ USE OF THE “VR” AUTHORIZATION

#### 3.8.4.1 ~~1.7.4.1~~ TECHNICAL REQUIREMENTS

The administrative requirements of ~~NBIC Part 3, 1.7~~ 3.8 for use of the “VR” stamp shall be used in conjunction with the technical requirements for valve repair as described in sections 3.1 through 3.7 ~~NBIC Part 3, Supplement 7~~. Those requirements shall be mandatory when a “VR” repair is performed.

#### 3.8.4.2 ~~1.7.4.2~~ STAMP USE

Each “VR” symbol stamp shall be used only by the repair firm within the scope, limitations, and restrictions under which it was issued.

### 3.8.5 ~~1.7.5~~ QUALITY SYSTEM

#### 3.8.5.1 ~~1.7.5.1~~ GENERAL

Each applicant for a new or renewed “VR” *Certificate of Authorization* shall have and maintain a quality system which shall establish that all of these rules and administrative procedures and applicable ASME Code requirements, including material control, fabrication, machining, welding, examination, setting, testing, inspection, sealing, and stamping will be met.

### 3.8.5.2 ~~1.7.5.2~~ WRITTEN DESCRIPTION

A written description, in the English language, of the system the applicant will use shall be available for review and shall contain, as a minimum, the features set forth in ~~NBIC Part 3, 1.7.5.4~~ 3.8.5.4. This description may be brief or voluminous, depending upon the projected scope of work, and shall be treated confidentially. In general, the quality system shall describe and explain what documents and procedures the repair firm will use to validate a valve repair.

### 3.8.5.3 ~~1.7.5.3~~ MAINTENANCE OF CONTROLLED COPY

Each applicant to whom a "VR" *Certificate of Authorization* is issued shall maintain thereafter a controlled copy of the accepted quality system manual with the National Board. Except for changes that do not affect the quality system, revisions to the quality system manual shall not be implemented until such revisions are accepted by the National Board.

### 3.8.5.4 ~~1.7.5.4~~ OUTLINE OF REQUIREMENTS FOR A QUALITY SYSTEM

The following establishes the minimum requirements of the written description of the quality system. It is required that each valve repair organization develop its own quality system that meets the requirements of its organization. For this reason it is not possible to develop one quality system that could apply to more than one organization. The written description shall include, as a minimum, the following features:

a) **Title Page**

The title page shall include the name and address of the company to which the National Board *Certificate of Authorization* is to be issued.

b) **Revision Log**

A revision log ~~is required to~~ shall be included to ensure revision control of the quality system manual. The log should contain sufficient space for date, description and section of revision, company approval, and National Board acceptance.

c) **Contents Page**

The contents page ~~should~~ shall list and reference, by paragraph and page number, the subjects and exhibits contained therein.

d) **Statement of Authority and Responsibility**

A statement of authority and responsibility shall be dated and signed by an officer of the company. It shall include:

1) A statement that the "VR" stamp shall be applied only to pressure relief valves that meet both of the following conditions:

a. Are stamped with an ASME "V", "UV", or "NV" Code symbol or marked with an ASME "HV" symbol and have been capacity certified by the National Board; and

b. Have been disassembled, inspected, and repaired by the Certificate Holder such that the valves' condition and performance are equivalent to the standards for new valves.

2) The title of the individual responsible to ensure that the quality system is followed and who has authority and freedom to effect the responsibility;

3) A statement that if there is a disagreement in the implementation of the written quality system, the matter is to be referred to a higher authority in the company for resolution; and

4) The title of the individual authorized to approve revisions to the written quality system and the method by which such revisions are to be submitted to the National Board for acceptance before implementation.

e) **Organization Chart**

A chart showing the relationship between management, purchasing, repairing, inspection, and quality control personnel ~~is required~~shall be included and shall reflect the actual organization in place.

f) **Scope of Work**

1) The scope of work section shall indicate the scope and type of valve repairs, including conversions the organization is capable of and intends to perform. The location of repairs (shop, shop and field, or field only), ASME Code Section(s) to which the repairs apply, the test medium (air, gas, liquid, or steam, or combinations thereof), and special processes (machining, welding, postweld heat treatment, or nondestructive examination, or combinations thereof) shall be specifically addressed.

2) The types and sizes of valves to be repaired, pressure ranges and other limitations, such as engineering and test facilities, should also be addressed.

g) **Drawings and Specification Control**

The drawings and specification control system shall provide procedures assuring that the latest applicable drawings, specifications, and instructions required are used for valve repair, including conversions, inspection, and testing.

h) **Material and Part Control**

The material and part control section shall describe purchasing, receiving, storage, and issuing of parts.

1) ~~State the title~~The title of the individual responsible for the purchasing of all material shall be stated.

2) ~~State the title~~The title of the individual responsible for certification and other records as required shall be stated.

3) All incoming material and parts shall be checked for conformance with the purchase order and, where applicable, the material specifications or drawings. Indicate how material or part is identified and how identity is maintained by the quality system.

i) **Repair and Inspection Program**

The repair and inspection program section shall include reference to a document (such as a report, traveler, or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure relief valves. Repair procedures shall require verification that the critical parts meet the valve manufacturer's specification. Supplement ~~S-7.14~~ S4 outlines recommended procedures covering some specific items. Provisions shall be made to retain this document for a period of at least five years.

1) Each valve or group of valves shall be accompanied by the document referred to above for processing through the plant. Each valve shall have a unique identifier (i.e., repair serial number, shop order number, etc.) appearing on the repair documentation and repair nameplate such that traceability is established.

2) The document referred to above shall describe the original nameplate information, including the ASME Code symbol stamping and the repair nameplate information, if applicable. In addition, it shall include material checks, replacement parts, conversion parts (or both), reference to items such as the welding procedure specifications (WPS), fitup, NDE technique, heat treatment, and pressure test methods to be used. Application of the "VR" stamp to the repair nameplate shall be recorded in this document. Specific conversions performed with the new Type/Model number shall be recorded on the document. There shall be a space for "signoffs" at each operation to verify that each step has been properly performed.

3) The system shall include a method of controlling the repair or replacement of critical valve parts. The method of

identifying each spring shall be indicated.

4) The system shall also describe the controls used to ensure that any personnel engaged in the repair of pressure relief valves are trained and qualified in accordance with ~~NBIC Part 3 Supplement 7~~, this section.

j) **Welding, NDE, and Heat Treatment (when applicable)**

The quality system manual shall indicate the title of the person(s) responsible for and describe the system used in the selection, development, approval, and qualification of welding procedure specifications, and the qualification of welders and welding operators in accordance with the provisions of ~~NBIC Part 3, S7.12 & S7.13~~ 3.4.

1) The quality system manual may include controls for the “VR” Certificate Holder to have the pressure relief valve part repaired by a National Board “R” Certificate Holder, per ~~NBIC Part 3, S7.3~~ 3.4.7.

2) The completed Form R-1 shall be noted on and attached to the “VR” Certificate Holder’s document required in ~~NBIC Part 3, 1.7.7.5i)~~ 3.8.5.4 i). Similarly, NDE and heat treatment techniques must be covered in the quality system manual. When outside services are used for NDE and heat treatment, the quality system manual shall describe the system whereby the use of such services meet the requirements of the applicable section of the ASME Code.

k) **Valve Testing, Setting, and Sealing**

The system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code Section and the National Board. The seal shall identify the “VR” Certificate Holder making the repair. Abbreviations or initials shall be permitted, provided such identification is acceptable to the National Board.

l) **Valve Repair Nameplates**

An effective valve stamping system shall be established to ensure proper stamping of each valve as required by ~~NBIC Part 3, 5.12.2~~ 3.7.2. The manual shall include a description of the nameplate or a drawing.

m) **Calibration**

1) The manual shall describe a system for the calibration of examination, measuring, and test equipment used in the performance of repairs. Documentation of these calibrations shall include the standard used and the results.

2) All calibration standards shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

n) **Manual Control**

The quality system shall include:

1) Measures to control the issuance of and revisions to the quality system manual;

2) Provisions for a review of the system in order to maintain the manual current with these rules and the applicable sections of the ASME Code;

3) The title(s) of the individual(s) responsible for control, revisions, and review of the manual;

4) Provision of a controlled copy of the written quality system manual to be submitted to the National Board; and

5) Revisions shall be submitted for acceptance by the National Board prior to being implemented.

o) **Nonconformities**

The system shall establish measures for the identification, documentation, evaluation, segregation, and disposition of nonconformities. A nonconformity is a condition of any material, item, product, or process in which one or more characteristics do not conform to the established requirements. These may include, but are not limited to, data discrepancies, procedural and/or documentation deficiencies, or material defects. Also, the title(s) of the individual(s) involved in this process shall be included.

p) **Exhibits**

Forms used in the quality system shall be included in the manual with a written description. Forms exhibited should be marked SAMPLE and completed in a manner typical of actual valve repair procedures.

q) **Testing Equipment**

The system shall include a means to control the development, addition, or modification of testing equipment to ensure the requirements of ~~NBIC Part 3, 4.5.1(b)~~ 3.6.1 b) and 3.6.3 c) are met.

(See ~~NBIC Part 3, Supplement 8~~ Supplement 5 for a guide on the sizing of pressure vessels used as part of pressure relief valve test equipment)r) **Field Repairs**

If field repairs are included in the scope of work, the system shall address any differences or additions to the quality system required to properly control this activity, including the following:

1) Provisions for annual audits of field activities shall be included;

2) Provisions for receipt and inspection of replacement parts, including parts received from the owner-user, shall be addressed;

3) If owner-user personnel will assist with repairs, provisions for the use of owner user personnel shall be included; and

4) Provisions for use of owner-user measurement and test equipment, if applicable, shall be addressed.

### 3.8.6 ~~*S7.7*~~ FIELD REPAIR

Repair organizations may obtain a “VR” *Certificate of Authorization* for field repair, either as an extension to their in-shop/plant scope, or as a field-only scope, provided that:

a) Qualified technicians in the employ of the Certificate Holder perform such repairs;

b) An acceptable quality system covering field repairs, including field audits, is maintained;

c) Functions affecting the quality of the repaired valves are supervised from the address of record where the “VR” certification is issued.

### 3.8.6.1 ~~*S7.8*~~ AUDIT REQUIREMENTS

Upon issuance of a *Certificate of Authorization*, provided field repairs are performed, annual audits of the work carried out in the field shall be performed to ensure that the requirements of the Certificate Holder’s quality system are met. The audit shall include, but not be limited to, performance testing, in accordance with ~~NBIC Part 3, 4.5~~ 3.6, of valve(s) that were repaired in the field. The audits shall be documented.

### 3.8.6.2 ~~*S7.9*~~ USE OF OWNER-USER PERSONNEL

For the repair of pressure relief valves at an owner-user’s facility for the owner-user’s own use, the “VR” Certificate Holder may utilize owner-user personnel to assist Certificate Holder technician(s) in the performance of repairs provided:

a) The use of such personnel is addressed in the “VR” Certificate Holder’s quality system;

b) The owner-user personnel are trained and qualified in accordance with ~~NBIC Part 3, S7.10~~ Supplement 3

c) Owner-user personnel work under direct supervision and control of the “VR” Certificate Holder’s technician(s) during any stage of the repair when they are utilized;

d) The “VR” Certificate Holder shall have the authority to assign and remove owner-user personnel at its own discretion; and

e) The names of the owner-user personnel utilized are recorded on the document as required for a quality system.

**3.9 ~~S7.11~~ TRAINING AND QUALIFICATION OF PERSONNEL**

**~~S7.11.1 GENERAL~~**

**3.9.1 ~~S7.11.2~~ CONTENTS OF TRAINING PROGRAM**

The repair organization shall establish a documented in-house training program. This program shall establish training objectives and provide a method of evaluating training effectiveness. As a minimum, training objectives for knowledge level shall include:

a) Applicable ASME Code and NBIC requirements;

b) Responsibilities within the organization’s quality system; and

c) Knowledge of the technical aspects and mechanical skills for the applicable position held.

**3.9.2 ~~S7.11.3~~ QUALIFICATION OF PERSONNEL**

Each repair organization shall establish minimum qualification requirements for those positions within the organization as they directly relate to pressure relief valve repair. Each repair organization shall document the evaluation and acceptance of an individual’s qualification for the applicable position.

**3.9.3 ~~S7.11.4~~ ANNUAL REVIEW OF QUALIFICATION**

The repair organization shall annually review the qualifications of repair personnel to verify proficiency as well as compliance with the Certificate Holder’s quality system. This review shall include training records, documented evidence of work performed, and when necessary, monitoring job performance. The review shall be documented.

# SUPPLEMENTS

## SUPPLEMENT 1

## PRESSURE RELIEF ~~SAFETY~~ VALVES ON THE LOW PRESSURE SIDE OF STEAM PRESSURE-REDUCING VALVES (was Part 1 Supplement 2)

### S1.1 ~~S2.1~~ SCOPE

a) The subject of protection of vessels in steam service connected to the low-pressure side of a steam-pressure-reducing valve is of considerable importance to proper operation of auxiliary equipment such as pressure cookers, hot-water heating systems, etc., operating at pressures below that which the primary boiler generating unit is operating.

b) To automatically reduce the primary boiler pressure for such processing equipment, pressure-reducing valves are used. The manufacturers of such equipment have data available listing the volume of flow through reducing valves manufactured by them, but such data are not compiled in a form that the results can be deduced readily. To protect the equipment operating on the low pressure side of a pressure-reducing valve, ~~safety~~ pressure relief valves of a relieving capacity sufficient to prevent an unsafe pressure rise in case of failure of the pressure-reducing valve, should be installed.

c) The pressure-reducing valve is a throttling device, the design of which is based on certain diaphragm pressures opposed by spring pressure which, in turn, controls the opening through the valve. If the spring, the diaphragm, or any part of the pressure- reducing valve fails, steam will flow directly through the valve and the low pressure equipment will be subjected to the boiler pressure. To protect the equipment operating on the low pressure side of the pressure-reducing valve, ~~safety~~ pressure relief valve(s) should be installed on the low pressure side of the pressure-reducing valve, which will provide a relieving capacity sufficient to prevent the pressure from rising above the system design pressure.

d) In most cases pressure-reducing valves used for the reduction of steam pressures have the same pipe size on the inlet and outlet. In case of failure of a pressure-reducing valve, the ~~safety~~ pressure relief valve on the low-pressure side must have a capacity to take care of the volume of steam determined by the high pressure side and the area of the pipe.

### S1.2 ~~S2.2 SAFETY~~ PRESSURE RELIEF VALVE CAPACITY

a) The capacity of the ~~safety~~ pressure relief valve(s) on the low-pressure side of the pressure-reducing valve should be based on the capacity of the pressure-reducing valve when wide open or under maximum flow conditions or the flow capacity through the bypass valve.

b) By using the formula in ~~NBIC Part1, S2.3~~ S1.3 below, Inspectors may calculate the required relieving capacities of the ~~safety~~ pressure relief valve(s) installed on the low-pressure side of the pressure reducing valve.

c) Usually a pressure-reducing valve has a bypass arrangement so that in case of failure of the pressure-reducing valve the boiler pressure may be short circuited into the low-pressure line without passing through the pressure-reducing valve. When determining the required relieving capacity of ~~safety~~ pressure relief valves for the low-pressure side of the pressure-reducing valve, the steam flow through the bypass must be taken into consideration.

### S1.3 ~~S2.3~~ CALCULATION OF SAFETY VALVE RELIEVING CAPACITY

a) When a pressure-reducing valve is installed, there are two possibilities of introducing boiler pressure into the low-pressure system:

1) the failure of the pressure-reducing valve so that it remains wide open; and

2) the possibility of the bypass valve being open.

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

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

W = AKC
*where,*

A = internal area in in.$^2$ (mm$^2$) of the inlet pipe size of the pressure reducing valve (see ~~NBIC Part 1, S2.5~~ S1.5)
K = flow coefficient for the pressure reducing valve (see ~~NBIC Part 1, S2.4~~ S1.4)
C = flow capacity of saturated steam through a ~~1 in.$^2$ (1 mm$^2$)~~ pipe in lbs/hr/in$^2$ (kg/hr/mm$^2$)at various pressure differentials from
~~NBIC Part 1 Tables S2.3-a, S2.3-b, or S2.3-c~~ Tables S1.3-a, S1.3-b, or S1.3-c. (for U.S. Customary units) or
~~NBIC Part 1 Tables S2.3M-a, S2.3M-b, or S2.3M-c~~ Tables S1.3M-a, S1.3M-b, or S1.3M-c ( for metric units).

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

$W = A_1K_1C_1$
*where,*

$A_1$ = internal area in in.$^2$ (mm$^2$) of the pipe size of the bypass around the pressure-reducing valve
$K_1$ = flow coefficient for the bypass valves (see ~~NBIC Part 1, S2.4~~ S1.4)
$C_1$ = flow capacity of saturated steam through a ~~1 in.$^2$ (1 mm$^2$)~~ pipe in lbs/hr/in$^2$ (kg/hr/mm$^2$) at various pressure differentials from
~~NBIC Part 1 Tables S2.3-a, S2.3-b, or S2.3-c~~ Tables S1.3-a, S1.3-b, or S1.3-c. (for U.S. Customary units) or
~~NBIC Part 1 Tables S2.3M-a, S2.3M-b, or S2.3M-c~~ Tables S1.3M-a, S1.3M-b, or S1.3M-c ( for metric units).

**Table S1.3-a ~~S2.3-a~~**
**Capacity of saturated steam, in lbs/hr, per in.$^2$ of Pipe Area**

| outlet pres., | Pressure-reducing valve inlet pressure, psi | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| psi | 1500 | 1450 | 1400 | 1350 | 1300 | 1250 | 1200 | 1150 | 1100 | 1050 | 1000 | 950 | 900 |
| 1000 | 76560 | 72970 | 69170 | 64950 | 60540 | 55570 | 49930 | 43930 | 35230 | 25500 | ..... | ..... | ..... |
| 950 | 77430 | 74180 | 70760 | 67000 | 63100 | 58770 | 53920 | 48610 | 42380 | 34890 | 24910 | ..... | ..... |
| 900 | 77750 | 74810 | 71720 | 68340 | 64870 | 61040 | 56820 | 52260 | 47050 | 41050 | 33490 | 23960 | ..... |
| 850 | 77830 | 74950 | 72160 | 69130 | 66020 | 62610 | 58900 | 54930 | 50480 | 45470 | 39660 | 29080 | 23190 |
| 800 | ..... | 75070 | 72330 | 69490 | 66700 | 63680 | 60390 | 56910 | 53060 | 48800 | 43980 | 38340 | 31610 |
| 750 | ..... | ..... | ..... | 69610 | 66880 | 64270 | 61260 | 58200 | 54840 | 51170 | 47080 | 42420 | 37110 |
| 700 | ..... | ..... | ..... | ..... | 66900 | 64270 | 61520 | 58820 | 55870 | 52670 | 49170 | 45230 | 40860 |
| 650 | ..... | ..... | ..... | ..... | ..... | ..... | 61550 | 58860 | 56260 | 53480 | 50440 | 47070 | 43400 |
| 600 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 58980 | 56270 | 53660 | 51020 | 48470 | 45010 |
| 550 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 53810 | 51040 | 48470 | 45800 |
| 500 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 45850 |
| 450 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 45870 |
| 400 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 350 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 300 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 250 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 200 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 175 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 150 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 125 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 110 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 60 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 40 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 30 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

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

## Table S1.3M-a ~~S2.3M-a~~
## Capacity of Saturated Steam, in kg/hr, per mm$^2$ of Pipe Area

| outlet pres., mPa | 10.25 | 10.00 | 9.75 | 9.50 | 9.25 | 9.00 | 8.75 | 8.50 | 8.25 | 8.00 | 7.75 | 7.50 | 7.25 | 7.00 | 6.75 | 6.50 | 6.25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pressure-reducing valve inlet pressure, mPa | | | | | | | | | | | | | | | | |
| 6.75 | 53.44 | 51.68 | 49.82 | 47.85 | 45.77 | 43.63 | 41.28 | 38.73 | 36.01 | 33.09 | 29.47 | 25.37 | 20.89 | ..... | ..... | ..... | ..... |
| 6.50 | 53.87 | 52.23 | 50.52 | 48.69 | 46.79 | 44.83 | 42.69 | 40.40 | 37.95 | 35.30 | 32.33 | 29.02 | 25.31 | 20.46 | ..... | ..... | ..... |
| 6.25 | 54.07 | 52.55 | 50.96 | 49.27 | 47.51 | 45.71 | 43.75 | 41.67 | 39.46 | 37.08 | 34.46 | 31.59 | 28.43 | 24.45 | 19.36 | ..... | ..... |
| 6.00 | 54.15 | 52.67 | 51.19 | 49.62 | 47.99 | 46.33 | 44.53 | 42.63 | 40.62 | 38.74 | 36.12 | 33.59 | 30.83 | 27.53 | 23.13 | 17.64 | ..... |
| 5.75 | 54.19 | 52.74 | 51.32 | 49.85 | 48.33 | 45.80 | 45.14 | 43.40 | 41.56 | 39.62 | 37.51 | 35.25 | 32.82 | 30.04 | 26.20 | 21.90 | 18.76 |
| 5.50 | 54.20 | 52.78 | 51.40 | 49.97 | 48.53 | 47.11 | 45.60 | 44.00 | 42.32 | 40.55 | 38.56 | 36.63 | 34.48 | 32.05 | 29.37 | 26.41 | 23.01 |
| 5.25 | ..... | ..... | ..... | 50.00 | 48.60 | 47.20 | 45.82 | 44.35 | 42.78 | 41.17 | 39.44 | 37.62 | 35.68 | 33.52 | 31.16 | 28.59 | 25.72 |
| 5.00 | ..... | ..... | ..... | 50.01 | 48.62 | 47.23 | 45.89 | 44.49 | 43.02 | 41.55 | 39.98 | 38.33 | 36.57 | 34.64 | 32.56 | 30.01 | 27.84 |
| 4.75 | ..... | ..... | ..... | ..... | ..... | 47.24 | ..... | 44.52 | 43.13 | 41.75 | 40.31 | 38.81 | 37.22 | 35.50 | 33.64 | 31.66 | 29.51 |
| 4.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 44.53 | 43.14 | 41.77 | 40.43 | 39.08 | 37.63 | 36.07 | 34.41 | 32.65 | 30.76 |
| 4.25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 43.15 | 41.82 | 40.46 | 39.10 | 37.74 | 36.33 | 34.90 | 33.39 | 31.60 |
| 4.00 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 41.84 | 40.48 | 39.12 | 37.82 | 36.45 | 35.12 | 33.76 | 32.15 |
| 3.75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 39.14 | 37.88 | 36.48 | 35.13 | 33.81 | 32.45 |
| 3.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 32.47 |
| 3.25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 32.48 |
| 3.00 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

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

## Table S1.3-b ~~S2.3-b~~
## Capacity of Saturated Steam, in lbs/hr, per in.$^2$ of Pipe Area

| Outlet pres., psi | 850 | 800 | 750 | 700 | 650 | 600 | 550 | 500 | 450 | 400 | 350 | 300 | 250 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pressure-reducing valve inlet pressure, psi | | | | | | | | | | | | |
| 1000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 950 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 900 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 850 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 800 | 22550 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 750 | 30600 | 21800 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 700 | 35730 | 29420 | 21020 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 650 | 39200 | 34250 | 28260 | 20190 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 600 | 41500 | 37470 | 32800 | 27090 | 19480 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 550 | 42840 | 39850 | 35730 | 31310 | 25940 | 18620 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 500 | 43330 | 40530 | 37610 | 33880 | 29760 | 24630 | 17720 | ..... | ..... | ..... | ..... | ..... | ..... |
| 450 | 43330 | 40730 | 38150 | 35260 | 31980 | 28080 | 23290 | 16680 | ..... | ..... | ..... | ..... | ..... |
| 400 | ..... | 40760 | 38220 | 35680 | 33050 | 29980 | 26380 | 21870 | 15760 | ..... | ..... | ..... | ..... |
| 350 | ..... | ..... | ..... | ..... | 33120 | 30690 | 27910 | 24570 | 20460 | 14790 | ..... | ..... | ..... |
| 300 | ..... | ..... | ..... | ..... | 33240 | ..... | 28140 | 25610 | 22620 | 18860 | 13630 | ..... | ..... |
| 250 | ..... | ..... | ..... | ..... | ..... | ..... | 28150 | 25650 | 23200 | 21000 | 17100 | 10800 | ..... |
| 200 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 21350 | 18250 | 15350 | 10900 |
| 175 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 18250 | 16000 | 12600 |
| 150 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 18250 | 16200 | 13400 |
| 125 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 18780 | ..... | 13600 |
| 110 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 13600 |
| 100 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 13600 |
| 85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 13600 |
| 75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 13600 |
| 60 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 13630 |
| 50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 40 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 30 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

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

## Table S1.3M-b ~~S2.3M-b~~
## Capacity of saturated steam, in kg/hr, per mm$^2$ of Pipe Area

| outlet pres., mPa | Pressure-reducing valve inlet pressure, mPa 6.00 | 5.75 | 5.50 | 5.25 | 5.00 | 4.75 | 4.50 | 4.25 | 4.00 | 3.75 | 3.50 | 3.25 | 3.00 | 2.75 | 2.50 | 2.25 | 2.00 | 1.75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5.50 | 18.66 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5.25 | 22.24 | 17.52 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 5.00 | 24.96 | 21.60 | 17.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 4.75 | 27.06 | 24.31 | 21.18 | 17.17 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 4.50 | 28.64 | 26.30 | 23.70 | 20.58 | 16.54 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 4.25 | 29.71 | 27.67 | 25.44 | 22.83 | 19.75 | 15.63 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 4.00 | 30.49 | 28.74 | 26.86 | 24.59 | 22.06 | 19.18 | 15.75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3.75 | 30.99 | 29.49 | 27.95 | 25.92 | 23.77 | 21.42 | 18.76 | 15.23 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3.50 | 31.15 | 29.77 | 28.32 | 26.74 | 24.90 | 22.87 | 20.68 | 17.93 | 14.24 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3.25 | 31.18 | 29.86 | 28.49 | 27.10 | 25.53 | 23.81 | 21.95 | 19.73 | 17.12 | 13.72 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3.00 | 31.19 | 29.88 | 28.56 | 27.25 | 25.86 | 24.40 | 22.82 | 20.98 | 18.90 | 16.51 | 13.46 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 2.75 | ..... | ..... | 28.58 | 27.28 | 25.98 | 24.68 | 23.34 | 21.79 | 20.09 | 18.19 | 15.90 | 12.98 | ..... | ..... | ..... | ..... | ..... | ..... |
| 2.50 | ..... | ..... | ..... | ..... | ..... | ..... | 23.37 | 22.05 | 20.62 | 19.04 | 17.19 | 14.94 | 11.83 | ..... | ..... | ..... | ..... | ..... |
| 2.25 | ..... | ..... | ..... | ..... | ..... | ..... | 23.42 | 22.15 | 20.83 | 19.45 | 17.94 | 16.18 | 14.11 | 11.59 | ..... | ..... | ..... | ..... |
| 2.00 | ..... | ..... | ..... | ..... | ..... | ..... | 23.46 | 22.17 | 20.87 | 19.57 | 18.28 | 16.85 | 15.26 | 13.48 | 10.95 | ..... | ..... | ..... |
| 1.75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 19.58 | 18.30 | 17.03 | 15.79 | 14.59 | 12.54 | 9.55 | ..... | ..... |
| 1.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 17.05 | 15.90 | 14.84 | 12.12 | 10.46 | 8.75 | ..... |
| 1.25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 15.92 | 14.95 | 12.98 | 11.75 | 10.62 | 8.75 |
| 1.00 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 14.96 | 13.44 | 12.19 | 11.00 | 9.60 |
| 0.90 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 14.97 | 13.60 | 12.30 | 11.02 | 9.67 |
| 0.80 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 13.66 | 12.35 | 11.03 | 9.70 |
| 0.70 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9.70 |
| 0.60 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9.70 |
| 0.50 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9.70 |
| 0.40 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9.72 |
| 0.30 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

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

## Table S1.3-c ~~S2.3-c~~
## Capacity of Saturated Steam, in lbs/hr, per in.$^2$ of Pipe Area

| Outlet pres., Psi | Pressure-reducing valve inlet pressure, psi 200 | 175 | 150 | 125 | 100 | 85 | 75 | 60 | 50 | 40 | 30 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1000 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 950 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 900 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 850 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 800 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 750 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 700 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 650 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 600 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 550 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 500 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 450 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 400 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 350 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 300 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 250 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 200 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 175 | 7250 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 150 | 9540 | 6750 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 125 | 10800 | 8780 | 6220 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 110 | 11000 | 9460 | 7420 | 4550 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 100 | 11000 | 9760 | 7970 | 5630 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 85 | 11000 | ..... | 8480 | 6640 | 4070 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 75 | 11000 | ..... | ..... | 7050 | 4980 | 3150 | ..... | ..... | ..... | ..... | ..... | ..... |
| 60 | 11000 | ..... | ..... | 7200 | 5750 | 4540 | 3520 | ..... | ..... | ..... | ..... | ..... |
| 50 | 11000 | ..... | ..... | ..... | 5920 | 5000 | 4230 | 2680 | ..... | ..... | ..... | ..... |
| 40 | 11000 | ..... | ..... | ..... | ..... | 5140 | 4630 | 3480 | 2470 | ..... | ..... | ..... |
| 30 | 11050 | ..... | ..... | ..... | ..... | ..... | ..... | 3860 | 3140 | 2210 | ..... | ..... |
| 25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3340 | 2580 | 1485 | ..... |
| 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2830 | 2320 | 1800 |
| 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2060 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

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

**TABLE S1.3M-c ~~S2.3M-c~~**
**Capacity of Saturated Steam, in kg/hr, per mm$^2$ of Pipe Area**

| outlet pres., kPa | Pressure-reducing valve inlet pressure, kPA 1500.00 | 1250.00 | 1000.00 | 900.00 | 800.00 | 700.00 | 600.00 | 500.00 | 400.00 | 300.00 | 200.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1250.00 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| 1000.00 | 7.78 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| 900.00 | 8.15 | 6.25 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| 800.00 | 8.34 | 6.77 | 4.29 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| 700.00 | 8.38 | 7.06 | 5.21 | 4.22 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| 600.00 | 8.38 | 7.08 | 5.65 | 4.87 | 3.82 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| 500.00 | 8.38 | . . . . . | 5.77 | 5.19 | 4.48 | 3.68 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . |
| 400.00 | 8.38 | . . . . . | 5.78 | 5.26 | 4.71 | 4.13 | 3.37 | . . . . . | . . . . . | . . . . . | . . . . . |
| 300.00 | 8.38 | . . . . . | . . . . . | . . . . . | 4.74 | 4.22 | 3.66 | 3.01 | . . . . . | . . . . . | . . . . . |
| 200.00 | 8.41 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | 3.69 | 3.71 | 2.62 | 1.83 | . . . . . |
| 100.00 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | 2.64 | 2.12 | 1.56 |
| 80.00 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | 1.58 |
| 60.00 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | 1.60 |
| 40.00 | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |

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

### S1.4 ~~S2.4~~ STEAM FLOW WHEN FLOW COEFFICIENTS ARE NOT KNOWN

a) It is possible that the flow coefficients K and $K_1$ may not be known and in such instances for approximating the flow, a factor of 1/3 may be substituted for K and 1/2 for $K_1$.

The formulas in ~~S2.3~~ S1.3 then become:

W = 1/3*A*C for the capacity through the pressure-reducing valve; and
W = 1/2*$A_1$*$C_1$ for the capacity through the bypass valve.

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

### S1.5 ~~S2.5~~ TWO-STAGE PRESSURE-REDUCING VALVE STATIONS

The ~~safety~~ pressure relief valve for two-stage pressure-reducing valve stations shall be sized on the basis of the highside pressure and the inlet size of the first pressure-reducing valve in the line. If an intermediate pressure line is taken off between the pressure-reducing valves, then this line and the final low side shall be protected by safety relief valves sized on the basis of the high-side pressure and the inlet size of the first pressure-reducing valve. See ~~NBIC Part 1, Table S2.5~~ Table S1.5.

**TABLE S1.5 ~~S2.5~~**
**Pipe Data**

| nominal Pipe size, unit less (ansI b36.10) | nominal Pipe size, unit less (Iso 3607) | average outside diam- eter, in. | average outside diam- eter, mm | nominal wall thick- ness of standard weight Pipe, in. | nominal wall thick- ness of standard weight Pipe, mm | ap- prox. Inter- nal area, sq. in. | ap- prox. Inter- nal area, sq. mm |
|---|---|---|---|---|---|---|---|
| NPS 3/8 | DN 10 | 0.675 | 9.53 | 0.091 | 2.311 | 0.191 | 124 |
| NPS 1/2 | DN 15 | 0.840 | 12.7 | 0.109 | 2.769 | 0.304 | 198 |
| NPS 3/4 | DN 20 | 1.050 | 19.1 | 0.113 | 2.870 | 0.533 | 347 |
| NPS 1 | DN 25 | 1.315 | 25.4 | 0.133 | 3.378 | 0.864 | 562 |
| NPS 1-1/4 | DN 32 | 1.660 | 38.1 | 0.140 | 3.556 | 1.50 | 973 |
| NPS 1-1/2 | DN 40 | 1.900 | 50.8 | 0.145 | 3.683 | 2.04 | 1324 |
| NPS 2 | DN 50 | 2.375 | 63.5 | 0.154 | 3.912 | 3.36 | 2182 |
| NPS 2-1/2 | DN 65 | 2.875 | 76.2 | 0.203 | 5.516 | 4.79 | 3113 |
| NPS 3 | DN 80 | 3.500 | 88.9 | 0.216 | 5.486 | 7.40 | 4807 |
| NPS 3-1/2 | DN 90 | 4.000 | 114.3 | 0.226 | 5.740 | 9.89 | 6429 |
| NPS 4 | DN 100 | 4.500 | 136.5 | 0.237 | 6.020 | 12.73 | 8278 |
| NPS 5 | DN 125 | 5.563 | 141.3 | 0.258 | 6.553 | 20.01 | 13009 |
| NPS 6 | DN 150 | 6.625 | 168.3 | 0.280 | 7.112 | 28.89 | 18786 |
| NPS 8 | DN 200 | 8.625 | 1219.1 | 0.322 | 8.179 | 50.27 | 32530 |
| NPS 10 | DN 250 | 10.750 | 273.1 | 0.365 | 9.271 | 78.85 | 51275 |
| NPS 12 | DN 300 | 12.750 | 323.8 | 0.375 | 9.525 | 113.1 | 73541 |

Note: In applying these rules, the area of the pipe is always based upon standard weight pipe and the inlet size of the pressure-reducing valve.

# SUPPLEMENT 2

## PRESSURE DIFFERENTIAL BETWEEN SAFETY OR SAFETY RELIEF VALVE SETTING AND BOILER OR PRESSURE VESSEL OPERATING PRESSURE (Was Part 2, Supplement 8)

### S2.1 ~~S8.1~~ SCOPE

If a ~~safety valve or safety~~ pressure 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.

### S2.2 ~~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~~ pressure 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~~ pressure relief valve of a hot water heating boiler is set to open at 100 psi (700 kPa), the boiler operating pressure should not exceed 75 psi (520 kPa). Section IV of the ASME Code does not require that pressure 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.

### S2.3 ~~S8.3~~ STEAM HEATING BOILERS

For steam heating boilers, the recommended pressure differential between the ~~safety~~ pressure relief 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.

### S2.4 ~~S8.4~~ POWER BOILERS

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

(MINIMUM PRESSURE DIFFERENTIAL AS PERCENTAGE OF BOILER DESIGN PRESSURE)

| Boiler Design Pressure | Minimum Pressure Differential |
|---|---|
| over 15 psi to 300 psi (100 KPa to 2.10 MPa): | 10% but not less than 7 psi (50 KPa) |
| over 300 psi to 1000 psi (2.14 MPa to 6.89 MPa): | 7% but not less than 30 psi (200 KPa) |
| over 1000 psi to 2000 psi (6.89 MPa to 13.8 MPa): | 5% but not less than 70 psi (480 KPa) |
| over 2000 psi (13.8 MPa): | per designer's judgment |

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 judgment , taking into consideration such factors as satisfactory operating experience and the intended service conditions.

2. ~~Safety~~ Pressure relief valves in hot water service are more susceptible to damage and subsequent leakage, than ~~safety~~ pressure relief valves relieving steam. It is recommended that the maximum allowable working pressure of the boiler and ~~safety~~ pressure 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~~ pressure relief valve must lift.

*3.* For organic fluid vaporizers a pressure differential of 40 psi (280 kPa) is recommended.

**S2.5 ~~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 quick-closing valves, etc. When such conditions are not considered, the pressure relief devices may become, in effect, a pressure controller, a duty for which they were 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.

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:

**(Sub-paragraphs a, b, and c were organized into tabular format)**

| Set Pressure | Recommended pressure differential |
|---|---|
| up to 70 psi (480 kPa) | 5 psi (35 kPa) |
| 70 – 1000 psi (480 kPa – 6.89 MPa) | 10% of set pressure |
| Above 1000 psi (6.89 MPa) | 7% of set pressure |

# SUPPLEMENT 3

## GUIDE TO JURISDICTIONS FOR AUTHORIZATION OF OWNERS-USERS TO MAKE ADJUSTMENTS TO PRESSURE RELIEF VALVES (WAS PART 3 S7.10)

### S3.1 ~~S7.10.1~~ GENERAL

The Jurisdiction may authorize properly trained and qualified employees of boiler and pressure vessel owners or users or their designees to confirm or restore set pressure shown on the unmodified original nameplate or stamping, or repair nameplate and/or performance of pressure relief valves. All external adjustments shall be resealed with a seal identifying the responsible organization and a metal tag that identifies the organization and the date the adjustment shall be installed.

### S3.2 ~~S7.10.2~~ TRAINING

a) The user shall establish a documented in house training program. This program shall establish training objectives and provide a method of evaluating the training effectiveness. As a minimum, training objectives for knowledge level shall include:

1) Applicable ASME Code and NBIC requirements;

2) Responsibilities within the organization's quality system;

3) Knowledge of the technical aspects and mechanical skills for making set pressure and/or blowdown adjustments to pressure relief valves;

4) Knowledge of the technical aspects and mechanical skills for marking of pressure relief valve adjustments.

b) If the user established a designee, the designee shall establish a training program and make their documentation available to the user and the jurisdictional authority.

### S3.3 ~~S7.10.3~~ DOCUMENTATION

Each user shall document the evaluation and acceptance of an employee's or designee's qualifications.

### S3.4 ~~S7.10.4~~ QUALITY SYSTEM

a) A written quality system shall be established by either the user or the designee with a written description available to the jurisdictional authority.

b) The written description shall include at a minimum:

1) Calibration of Test Equipment: This shall describe a system for the calibration of measuring and test equipment. Documentation of these calibrations shall include the standard used and the results. Calibration standards shall be calibrated against the equipment having valid relationships to nationally recognized standards.

2) Valve Testing, Setting, and Sealing: This system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code section and ~~NBIC Part 3, S7.10.1 a)~~ S3.1.

3) Valve Marking: An effective marking system shall be established to ensure proper marking of the metal tag required by ~~NBIC Part 3, S7.10.1 a)~~ S3.1. The written quality system shall include a description or drawing of the metal tag.

### S3.5 ~~S7.10.5~~ EXTERNAL ADJUSTMENTS

Only external adjustments to restore the set pressure shown on the unmodified original nameplate or stamping, or repair nameplate and/or performance of a pressure relief valve shall be made under the provisions of ~~NBIC Part 3, S7.10.1 and NBIC Part 2, 2.5.7~~ S3.1 and 2.2.5.

**S3.6 ~~S7.10.6~~ REPAIRS**

If disassembly, change of set pressure, or additional repairs are necessary, the valve shall be repaired by an organization that meets the requirements of the NBIC.

# SUPPLEMENT 4

## RECOMMENDED PROCEDURES FOR REPAIRING PRESSURE RELIEF VALVES (Was Supplement S7.14)

### S4.1 ~~S7.14.1~~ INTRODUCTION

a) It is essential that the repair organization establish basic, specific procedures for the repair of pressure relief valves. The purpose of these recommended procedures is to provide the repair organization with guidelines for this important aspect of valve repair. It is realized that there are many types of valves and conditions under which they are repaired and, for this reason, the specific items in these recommended procedures may not apply, or they may be inadequate for each of those types or to the detailed repairs that may be required for each valve.

b) ~~NBIC Part 3, S7.14.2~~ S4.2 contains recommended procedures for the repair of spring-loaded pressure relief valves, and ~~NBIC Part 3, S7.14.3~~ S4.3 contains recommended procedures for the repair of pilot operated types of safety relief valves. Information on Packaging, Shipping and Transportation is included as S4.5.

### S4.2 ~~S7.14.2~~ SPRING-LOADED PRESSURE RELIEF VALVES

Prior to removal of a valve from a system for a repair or any disassembly, ensure that all sources of pressure have been removed from the valve.

a) Visual Inspection as Received

1) This information is to be recorded:

a. Record user (customer) identification number;

b. Complete original PRV nameplate data, previous repair nameplate data, plus any important information received from customer;

c. Check external adjustment seals for warranty repair;

d. Check bonnet for venting on bellows type valves; and

e. Check appearance for any unusual damage, missing, or misapplied parts.

2) If sufficient damage or other unusual conditions are detected that may pose a safety risk during preliminary testing, then proceed directly to ~~NBIC Part 3, S7.14.2~~ S4.2 c)

3) Valves that are to be repaired in place proceed to ~~NBIC Part 3, S7.14.2~~ S4.2 c) unless preliminary testing has been authorized by the owner.

b) Preliminary Test as Received

1) Information from the recommended preliminary performance test and subsequent disassembly and inspections will provide a basis for any repair interval change that should be necessary to ensure that the valve will function as intended.

2) Determine set pressure or Cold Differential Test Pressure (CDTP) in accordance with manufacturer's recommendations and appropriate ASME Code Section. Do not allow test pressure to exceed 116% of set pressure unless otherwise specified by the owner. A minimum of three tests is usually required to obtain consistent results.

3) If results do not correlate with field performance, then steps to duplicate field conditions (fluid and temperature) may be necessary.

4) Record preliminary test results and test bench identification data.

c) Disassembly

1) Remove cap and lever assembly, if applicable.

2) Remove release nut assembly, if applicable.

3) Loosen jam nut on adjusting (compression) screw.

4) Record measurement and remove adjusting (compression) screw.

5) Remove bonnet or yoke.

6) Remove spring and washers, and tag (identify) including upper and lower washers, as appropriate.

7) Remove spindle and disk assembly.

8) Remove ring pins.

9) Record measurement and remove adjusting rings, nozzle, and guide, as applicable.

d) Cleaning

1) Wire all small parts together and clean. (Caution: do not use a cleaning method that will damage the parts.)

2) Do not clean in a chemical solution except under acceptable circumstances.

3) Protect seating surfaces and nameplates prior to cleaning.

e) Inspection

1) Check spring for correct range, damage such as erosion, corrosion, cracking, or compression below free height.

2) Check nozzle for cracks (NDE as applicable) or unusual wear.

3) Check disk assembly for cracks (NDE as applicable) or unusual wear.

4) Check spindle for trueness, bearing areas, and thread condition.

5) Check guide for wear and galling.

6) Check adjusting ring(s) for worn threads and wear.

7) Check ring pins for bent or broken pin and thread condition.

8) Check bellows, if provided, for pinholes and corrosion.

9) Check flange gasket facings for wear and cuts.

f) Machining

Machine nozzle and disk as necessary to the manufacturer’s critical dimension charts.

g) Lapping

1) Machine or hand lap disk and nozzle to be sure of flatness.

2) Lap bevel seats to a grey finish; then re-machine disk or plug to the manufacturer's critical dimension.

h) Bearing Points

Grind all bearing areas with grinding compound to make sure they are round and true.

i) Assembly

1. Install Nozzle
2. Install lower ring and guide ring to the measurement from c) 9) above or to manufacturer's specifications.
3. Install guide
4. Install disc and holder
5. Install spindle
6. Install spring washers
7. Install bonnet
8. Install bonnet bolting
9. Install adjusting screw and lock nut to the measurement from c) 4) above,
10. Install release nut and lock nut, and cap and lever assembly, and
11. Document installation of replacement parts.

j) Testing

Test data shall be recorded. Testing will be done in accordance with manufacturer's recommendations and appropriate ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.

k) Sealing

After final adjusting and acceptance by quality control inspection, all external adjustments ~~will~~ shall be sealed with a safety seal providing a means of identification of the organization performing the repair.

l) Nameplate

The repairer will place a repair nameplate on each repaired valve. The nameplate shall, as a minimum, meet the requirements of ~~NBIC Part 3, 5.12.1~~ 3.7.1.

~~m) Packaging, Shipping and Transportation (~~moved to the end of this section and combined with Part 2 info)

~~1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces.~~

~~2) Threaded and socket-weld valves up to 2 in. (50 mm) may be securely packaged and cushioned during transport.~~

~~3) 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 plugsare removed prior to installation.~~

~~4) Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored.~~

~~5) Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.~~

**S4.3 ~~S7.14.3~~ PILOT OPERATED SAFETY RELIEF VALVES**

a) Visual Inspection as Received

1) This information is to be recorded:

a. Complete nameplate data, plus any other important information received from the customer;

b. User identification number, if applicable;

c. Seals on external adjustments (~~yes/no~~, ensure seals are intact);

d. Identification on seal; and

e. Obvious damage and external condition including missing or misapplied parts.

b) Disassembly

1) Remove pilot and disassemble per manufacturer's maintenance instruction.

2) Disassemble main valve. Where lift adjustments are provided, do not remove the locking device or change the lift unless it is required as part of conversion.

3) Remove the nozzle if recommended by the manufacturer's maintenance instructions and/or when required as part of conversion.

c) Cleaning

1) Pilot — Components of pilot are small and must be handled carefully to prevent damage or loss. Clean parts and nameplates with solvents that will not affect the parent metal and/or polish with 500 grit paper.

2) Main Valve — Clean by appropriate means such as abrasive blast. Finishes of machined surfaces must not be affected. (Caution: Do not use a cleaning method that will damage the parts or nameplates.)

d) Inspection

1) Pilot

a. Check spring for damage such as corrosion, cracks, out of square ends, etc.

b. Inspect all parts for damage. Small burrs or scratches may be removed by polishing. Severely damaged parts should be replaced. (Internal components or pilots should not be repaired by machining as the functions of the pilot could easily be impaired.)

c. Check strainers and filters on inlet and outlet lines.

d. Replace all soft goods per manufacturer's recommendation.

2) Main Valve

a. Check nozzle seating surface for nicks. These can be removed by machining or lapping as required.

b. Check the piston and liner (or other moving member) for galling or excessive wear. The piston should move freely in the liner.

c. Replace soft goods or re-lap disk as required.

d. Where lift adjustments are provided, measure the lift per the manufacturer's specifications.

e) Testing

Test data shall be recorded. Testing will be done in accordance with the manufacturer's recommendation and in accordance with the applicable ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.

f) Sealing

After final adjustment and acceptance by quality control, all external adjustments ~~will~~ shall be sealed by means assuring positive identification of the organization performing the repair.

g) Nameplate

The repairer will place a repair nameplate on each repaired valve. The nameplate, as a minimum, shall meet the requirements of ~~NBIC Part 3, 5.12.1~~ 3.7.1.

**S4.4 ~~2.5.6~~ PACKAGING, SHIPPING AND TRANSPORTATION OF PRESSURE RELIEF DEVICES**

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 NPS 2 (DN 50 ~~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.

~~h) Packaging, Shipping and Transportation~~

~~1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces.~~

~~2) Threaded and socket-weld valves up to 2 in. (50 mm) may be securely packaged and cushioned during transport.~~

~~3) Valve inlet and outlet connection and drain connections 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.~~

~~4) Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored.~~

~~5) Tubing should be protected during shipment and storage to avoid damage and/or breakage.~~

~~6)~~ 5)Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.

# SUPPLEMENT 5

## RECOMMENDED GUIDE FOR THE DESIGN OF A TEST SYSTEM FOR PRESSURE RELIEF DEVICES IN COMPRESSIBLE FLUID SERVICE (Was Part 3, Supplement 8)

### S5.1 ~~S8.1~~ INTRODUCTION

This supplement provides guidance for the design of a test system using compressible fluids (e.g., steam or air/gas) and permits the determination of pressure relief valve set pressure and valve operating characteristics such as blowdown. The size of the test vessel needed depends on the size of the valve, its set pressure, the design of the test system, and whether blowdown must be demonstrated. A repair organization may use the information provided in this supplement to determine the minimum size test vessel needed so that the measured performance is characteristic of the valve and not the test system.

### S5.2 ~~S8.2~~ GENERAL

a) The National Board administrative rules and procedures for the "VR" *Certificate of Authorization* and symbol stamp require that pressure relief valves, after repair, be tested in accordance with the manufacturer's recommendations and the applicable ASME Code. The purpose of this testing is to provide reasonable assurance that valves will perform according to design when they are returned to service.

b) It is recognized that a full evaluation of the performance of some pressure relief valve designs requires testing at maximum allowable overpressure. However, it is beyond the scope of this supplement to define test equipment or facilities for such testing.

c) ~~NBIC Part 3 Section 9~~ Section 6 of this part provides a glossary, ~~NBIC Part 3, S38.3~~ S5.3 describes typical test equipment, and ~~NBIC Part 3, S38.4~~ S5.4 provides data for estimating the size of test vessels required.

### S5.3 ~~S8.3~~ TEST SYSTEM DESCRIPTION

a) An optimum configuration, particularly when the test medium source is of small capacity, is shown in ~~NBIC Part 3, Figure S8.3-a~~ Figure S5.3-a. The test medium flows from the pressure source, usually a compressor or boiler, to an accumulator. It then flows through a pressure-controlling valve into the test vessel, from which it is discharged, through the pressure relief valve installed ~~mounted~~ on the test vessel. The pressure-controlling valve is usually a globe valve, although any throttling valve is acceptable. If the pressure-controlling valve is of adequate size and can open quickly, large transient flows can be generated, increasing the pressure above the pressure relief valve set pressure, causing it to lift, and be sustained in its lifted condition.

b) ~~NBIC Part 3, Figure S8.3-b~~ Figure S5.3-b shows a simpler test system in which the test vessel is pressurized directly from the pressure source without the use of an accumulator. In this configuration, flow-rates through the pressure relief valve and any consequent over-pressure are dependent on the flow generating capacity of the pressure source.

c) In a test facility, the pressure relief valve is usually installed ~~mounted~~ on an isolating valve that should be of sufficient size that it will not choke flow to the pressure relief valve. There should be no intervening piping between the two valves to avoid any significant pressure drop between the test vessel and the pressure relief valve.

d) The isolating valve and any adapter flanges or valve test nozzles must be designed to sustain pressure relief valve discharge forces, and so secured that these forces are not transmitted to the test vessel. This is especially important for larger valves set at pressures greater than 100 psig (700 kPa).

e) The vessel should have a length-to-diameter ratio as low as is practical, and should be suitably anchored.

f) Pressure sensing lines should be connected to the test vessel well away from any inlet or outlet connections where pressure distortions due to transient changes in flow velocity during testing could cause erroneous pressure readings. When testing with steam, any water head that develops in the gage line must be taken into consideration.

g) Any intervening piping between the test vessel and the pressure relief valve should be as short and as straight as possible and be of adequate size to minimize inlet pressure drop.

h) In the case of steam, the equipment should be insulated and steam traps should be installed, as appropriate, to ensure that the test steam is dry, saturated steam with a minimum quality of 98%.

i) Safety valves shall be used to protect the test vessel and the accumulator.

Figure S5.3-a ~~S8.3-a~~

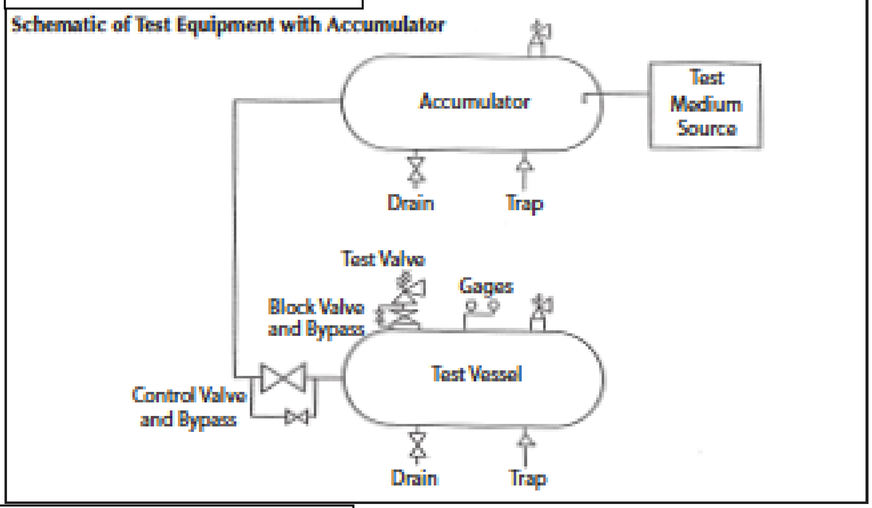
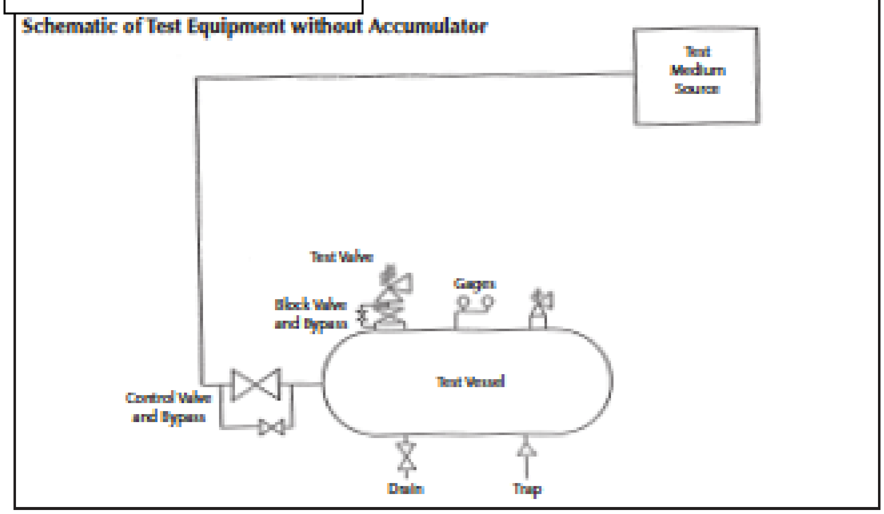



Figure S5.3-b ~~S8.3-b~~




**S5.4 ~~S8.4~~ TEST VESSEL SIZING DATA**

a) Recommended test vessel sizes are given in ~~NBIC Part 3, Figures S8.4-a and S8.4-b~~ Figures S5.4-a and S5.4-b for a configuration using one vessel fed directly from the source of the test medium. Figure ~~S8.4-a~~ S5.3-a gives the test vessel size in cu. ft. vs. the valve orifice area in sq. in. for dry, saturated steam. Curves are shown for set pressures up to 500 psig (3.45MPa) for three different blowdowns: 4%, 7%, and 10%. The source is assumed to be capable of feeding the test vessel at 2500 lbs/hr. (1135 kg/hr). Figure ~~S8.4-b~~ S5.4-b gives similar curves for air with a source capable of feeding the test vessel at 200 ft.$^3$/min (5.66m$^3$/min).

b) For valves, with effective orifices less than 1.28 in.$^2$ (826 mm$^2$), the size of the test vessel needed becomes less dependent on the flow capacity of the source. For these valves, a 15 ft.$^3$ (.425 m$^3$) minimum size test vessel is recommended. This should allow the accurate measurement and setting of blowdown for small valves. This minimum size should also be adequate for determining set pressures of larger valves; however, larger test vessels must be used if blowdown is to be set accurately. It is recognized that there are practical limits on the size and maximum pressure of a test vessel used to demonstrate pressure relief valve operational characteristics. In such cases, determination of valve set pressure remains the only viable production and repair test option. The recommended minimum size test vessel (15 ft.$^3$ [0.425 m$^3$]) is normally adequate for this purpose.

Figure S5.4-a ~~S5.4-a~~

**Recommended Test Vessel Size, Test Medium: Steam**

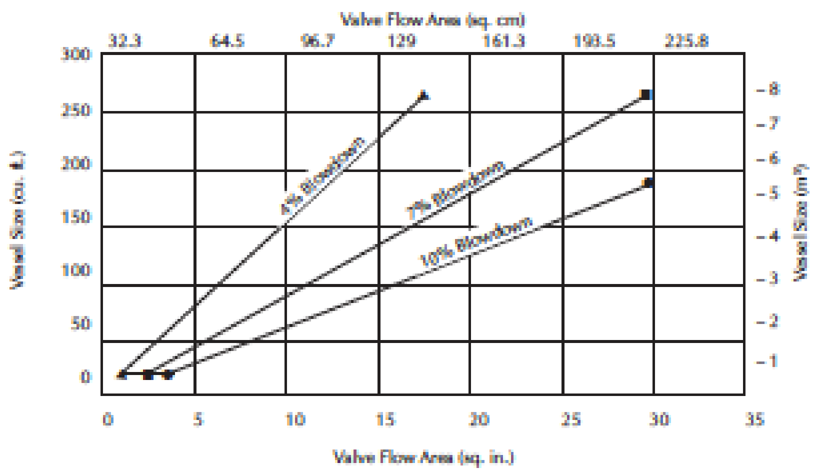
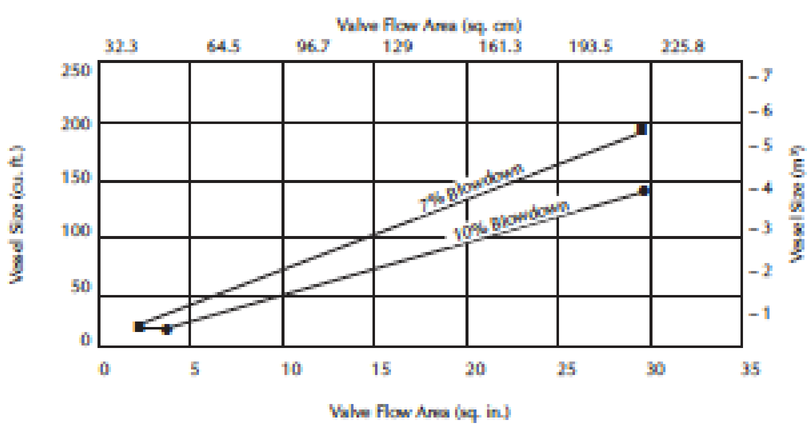



Figure S5.4-b ~~S8.4-b~~

**Recommended Test Vessel Size, Test Medium: Air or Gas**



# SUPPLEMENT 6

## PROCEDURES TO EXTEND THE "VR" CERTIFICATE OF AUTHORIZATION AND STAMP TO ASME "NV" STAMPED PRESSURE RELIEF DEVICES (Was part 3, suppl. 9)

### S6.1 ~~S9.1~~ INTRODUCTION

Approval to extend the scope of the National Board "VR" *Certificate of Authorization* to the Certificate Holder to use the "VR" stamp on ASME Code "NV" Class 1, 2, or 3 stamped pressure relief devices, which have been capacity certified by the National Board, may be given subject to the provisions that follow.

### S6.2 ~~S9.2~~ ADMINISTRATIVE PROCEDURES

a) The repair organization shall hold a valid "VR" *Certificate of Authorization*.

b) The repair organization shall obtain a National Board "NR" *Certificate of Authorization* and stamp. The requirements for said certificate and stamp include, but are not limited to, the following. The repair organization shall:

1) Maintain a documented quality assurance program that meets the applicable requirements of NBIC Part 3, 1.8. This program shall also include all the applicable requirements for the use of the "VR" stamp;

2) Have a contract or agreement with an Inspection Agency to provide inspection of repaired "NV"-stamped pressure relief devices by Inspectors who have been qualified in accordance with the requirements of ASME QAI-1, *Qualifications for Authorized Inspection*;

3) Successfully complete a survey of the quality assurance program and its implementation. This survey shall be conducted by representatives of the National Board, the Jurisdiction wherein the applicant's repair facilities are located, and the applicant's Authorized Inspection Agency. Further verification of such implementation by the survey team may not be necessary if the applicant holds a valid ASME "NV" certificate and can verify by documentation the capability of implementing the quality assurance program for repair of "NV"-stamped pressure relief devices, covered by the applicant's ASME "NV" certificate.

c) The application of the "NR" *Certificate of Authorization* and stamp shall clearly define the scope of intended activities with respect to the repair of Section III, "NV"- stamped pressure relief devices.

d) Revisions to the quality assurance program shall be acceptable to the Authorized Nuclear Inspector Supervisor and the National Board before being implemented.

e) The scope of the "VR" *Certificate of Authorization* shall include repair of "NV"-stamped pressure relief devices.

f) Verification testing of valves repaired by the applicant shall not be required provided such testing has been successfully completed under the applicant's "VR" certification program.

g) A survey of the applicant for the "VR" *Certificate of Authorization* and endorsement of the repair of "NV"-stamped pressure relief devices may be made concurrently.

### S6.3 ~~S9.3~~ GENERAL RULES

a) ASME Code Section III, "NV"-stamped pressure relief devices, which have been repaired in accordance with these rules, shall be stamped with both the "VR" and "NR" stamps.

b) The "VR" and "NR" stamps shall be applied only to "NV" stamped (Class 1, 2, or 3) National Board capacity certified pressure relief devices that have been disassembled, inspected, and repaired as necessary, such that the valves' condition and performance are equivalent to the standards for new valves.

c) All measuring and test equipment used in the repair of pressure relief devices shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.

d) Documentation of the repair of “NV” stamped pressure relief devices shall be recorded on the National Board Form NVR-1, *Report of Repair/ Replacement Activities for Nuclear Pressure Relief Devices*, in accordance with the requirements of NBIC Part 3, 1.8.

e) When an ASME “NV”-stamped pressure relief device requires a duplicate nameplate because the original nameplate is illegible or missing, it may be applied using the procedures of ~~NBIC Part 3, 5.12.5~~ 3.7.5 provided concurrence is obtained from the Authorized Nuclear Inspector and Jurisdiction. In this case the nameplate shall be marked “SEC. III” to indicate the original ASME Code stamping.

# PART 4, SECTION 4 ~~Parts 1,2, and 3, SECTION 7~~

## PRESSURE RELIEF DEVICES — NBIC POLICY FOR METRICATION

### 4.1 ~~7.1~~ GENERAL

This policy provides guidance for the use of US customary units and metric units. Throughout the NBIC, metric units are identified and placed in parentheses after the US customary units referenced in the text and associated tables. In Parts 2 and 3, Supplement 6, Continued Service and Inspection of DOT Transport Tanks the metric units are shown first with U.S. Customary units shown in parentheses. For each repair or alteration performed, selection of units shall be based on the units used in the original code of construction. For example, items constructed using US customary units shall be repaired or altered using US customary units. The same example applies to items constructed using metric units. Whichever units are selected, those units are to be used consistently throughout each repair or alteration. Consistent use of units includes all aspects of work required for repairs or alterations (i.e. materials, design, procedures, testing, documentation, and stamping, etc.).

### 4.2 ~~7.~~2 EQUIVALENT RATIONALE

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

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

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

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

### 4.3 ~~7.3~~ PROCEDURE FOR CONVERSION

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

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

b) Soft conversion calculations will be reviewed for accuracy;

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

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

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

**Note**: Care shall be taken to minimize percentage difference between units.

### 4.4 ~~7.~~4 REFERENCING TABLES

The following tables are provided for guidance and convenience when converting between US customary units and metric units. See ~~NBIC Part 1, Tables 7.4-1 through 7.4-8~~ Tables 4.4-1 through 4.4-8.

Temperature shall be converted to within 1°C as shown in ~~NBIC Part 1, Table 7.4-2~~ Table 4.4-2.

Fractions of an inch shall be converted according to ~~NBIC Part 1, Table 7.4-3~~ Table 4.4.3. Even increments of inches are in even multiples of 25 mm. For example, 40 inches is equivalent to 1000 mm. Intermediate values may be interpolated rather than converting and rounding to the nearest mm.

For nominal pipe sizes, the following relationships were used as shown in ~~NBIC Parts 1, 2 or 3, Table 7.4-4~~ 4.4-4 Areas in square inches ($in^2$) were converted to square mm (mm2) and areas in square feet ($ft^2$) were converted to square meters ($m^2$). See examples in ~~NBIC Parts 1, 2 or 3~~ ~~Tables 7.4-5a and 7.4-5b~~ Tables 4.4-5a and 4.4-5b

Volumes in cubic inches (in. $^3$) were converted to cubic mm **(**mm3**)** and volumes in cubic feet (ft3) were converted to cubic meters ($m^3$). See examples in ~~NBIC Parts 1, 2 or 3, Tables 7.4-6a and 7.4-6b.~~ Tables 4.4-6a and 4.4-6b.

Although the pressure should always be in MPa for calculations, there are cases where other units are used in the text. For example, kPa is used for small pressures. Also, rounding was to two significant figures. See examples in Table ~~7.4-7~~ 4.4-7 (Note that 14.7 psi converts to 101 kPa, while 15 psi converts to 100 kPa. While this may seem at first glance to be an anomaly, it is consistent with the rounding philosophy.)

Material properties that are expressed in psi or ksi (e.g., allowable stress, yield and tensile strength, elastic modulus) were generally converted to MPa to three significant figures. See example in ~~NBIC Parts 1, 2 or 3, Table 7.4-8~~ 4.4-8.

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

**TABLE 4.4-1 ~~7.4.1~~**
**US Fractions/Metric Equivalents**

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

**TABLE 4.4-2 ~~7.4.2~~**
**Soft Conversion Factors**
**(US x Factor = Metric)**

| **US Customary** | **Metric Factor** |
|---|---|
| in. | mm 25.4 |
| ft. | m 0.3048 |
| in. $^2$ | $mm^2$ 645.16 |

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

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

**TABLE 4.4-3 ~~7.4.3~~**
**Temperature Equivalents**

| Temperature °F | Temperature °C |
|---|---|
| 60 | 16 |
| 70 | 21 |
| 100 | 38 |
| 120 | 49 |
| 350 | 177 |
| 400 | 204 |
| 450 | 232 |
| 800 | 427 |
| 1150 | 621 |

**TABLE 4.4-4 ~~7.4.4~~**
**Pipe Sizes/Equivalents**

| US Customary Practice | Metric Practice |
|---|---|
| NPS 1/8 | DN 6 |
| NPS 1/4 | DN 8 |
| NPS 3/8 | DN 10 |
| NPS 1/2 | DN 15 |
| NPS 3/4 | DN 20 |
| NPS 1 | DN 25 |
| NPS 1-1/4 | DN 32 |
| NPS 1-1/2 | DN 40 |
| NPS 2 | DN 50 |
| NPS 2-1/2 | DN 65 |
| NPS 3 | DN 80 |
| NPS 3-1/2 | DN 90 |
| NPS 4 | DN 100 |
| NPS 5 | DN 125 |
| NPS 6 | DN 150 |
| NPS 8 | DN 200 |
| NPS 10 | DN 250 |

| | |
|---|---|
| NPS 12 | DN 300 |
| NPS 14 | DN 350 |
| NPS 16 | DN 400 |
| NPS 18 | DN 450 |
| NPS 20 | DN 500 |
| NPS 22 | DN 550 |
| NPS 24 | DN 600 |
| NPS 26 | DN 650 |
| NPS 28 | DN 700 |
| NPS 30 | DN 750 |
| NPS 32 | DN 800 |
| NPS 34 | DN 850 |
| NPS 36 | DN 900 |
| NPS 38 | DN 950 |
| NPS 40 | DN 1000 |
| NPS 42 | DN 1050 |
| NPS 44 | DN 1100 |
| NPS 46 | DN 1150 |
| NPS 48 | DN 1200 |
| NPS 50 | DN 1250 |
| NPS 52 | DN 1300 |
| NPS 54 | DN 1350 |
| NPS 56 | DN 1400 |
| NPS 58 | DN 1450 |
| NPS 60 | DN 1500 |

**Table 4.4-5a ~~7.4.5-a~~**

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

**Table 4.4-5b ~~7.4.5-b~~**

| **Area (US Customary)** | **Area (Metric)** |
|---|---|
| 5 $ft^2$ | 0.46 $mm^2$ |

**Table 4.4-6a ~~7.4.6-a~~**

| **Area (US Customary)** | **Area (Metric)** |
|---|---|
| 1 $in^3$ | 16,000 $mm^3$ |
| 6 $in^3$ | 96,000 $mm^3$ |
| 10 $in^3$ | 160,000 $mm^3$ |

**Table 4.4-6b ~~7.4.6b~~**

| **Area (US Customary)** | **Area (Metric)** |
|---|---|
| 5 $ft^3$ | 0.14 $m^3$ |

**TABLE 4.4-7 ~~7.4.7~~**
**Pressure/Equivalents**

| **Pressure (US Customary)** | **Pressure (Metric)** |
|---|---|
| 0.5 psi | 3 kPa |
| 2 psi | 15 kPa |
| 3 psi | 20 kPa |
| 10 psi | 70 kPa |
| 15 psi | 100 kPa |
| 30 psi | 200 kPa |
| 50 psi | 350 kPa |
| 100 psi | 700 kPa |
| 150 psi | 1.03 MPa |

| | |
|---|---|
| 200 psi | 1.38 MPa |
| 250 psi | 1.72 MPa |
| 300 psi | 2.10 MPa |
| 350 psi | 2.40 MPa |
| 400 psi | 2.76 MPa |
| 500 psi | 3.45 MPa |
| 600 psi | 4.14 MPa |
| 1,200 psi | 8.27 MPa |
| 1,500 psi 1 | 0.34 MPa |

**Table 4.4-8 ~~7.4.8~~**

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

# PART 4, SECTION 5 ~~PART 3, SECTION 8~~

## PRESSURE RELIEF DEVICES — PREPARATION OF TECHNICAL INQUIRIES TO THE NATIONAL BOARD INSPECTION CODE COMMITTEE

### 5.1 ~~8.1~~ INTRODUCTION

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

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

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

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

### 5.2 ~~8.~~2 INQUIRY FORMAT

Inquiries submitted to the Committee shall include:

a) Purpose

Specify one of the following:

1) revision of present Code rules;

2) new or additional Code rules; or

3) Code Interpretation.

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

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

### 5.3 ~~8.3~~ CODE REVISIONS OR ADDITIONS

Request for Code revisions or additions shall provide the following:

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

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

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

**5.4 ~~8.~~4 CODE INTERPRETATIONS**

Requests for Code Interpretations shall provide the following:

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

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

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

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

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

3) A request seeking the rationale for Code requirements.

**5.5 ~~8.5~~ SUBMITTALS**

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

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

Secretary, NBIC Committee
The National Board of Boiler and
Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, OH 43229

As an alternative, inquiries may be submitted via fax or email to:

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

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

# PART 4, SECTION 6 (SELECTIONS FROM PART 3, SECTION 9)

## PRESSURE RELIEF DEVICES — GLOSSARY OF TERMS

### 6.1 ~~9.1~~ DEFINITIONS

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

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

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

**Alteration** — A change in the item described on the original Manufacturer's Data Report which affects the pressure containing capability of the pressure-retaining item. (See Part 3, 3.4.3, EXAMPLES OF ALTERATION) Nonphysical changes such as an increase in the maximum allowable working pressure (internal or external), increase in design temperature, or a reduction in minimum temperature of a pressure-retaining item shall be considered an alteration.

**ANSI** — The American National Standards Institute

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

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

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

**Authorized Inspection Agency —**

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

Inservice: An Authorized Inspection Agency is either:

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

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

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

**Boiler** — A boiler is a closed vessel in which water or other liquid is heated, steam or vapor generated, steam or vapor is superheated, or any combination thereof, under pressure for use external to itself, by the direct application of energy from the combustion of fuels or from electricity or solar energy. The term boiler also shall include the apparatus used to generate heat and all controls and safety devices associated with such apparatus or the closed vessel.

1) Power Boiler — a boiler in which steam or other vapor is generated at a pressure in excess of

15 psig (100 kPa) for use external to itself. The term power boiler includes fired units for vaporizing liquids other than water, but does not include fired process heaters and systems. (See also High-Temperature Water Boiler).

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

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

4) Hot-Water Heating Boiler — A hot water boiler installed to operate at pressures not exceeding 160 psig (1100 kPa) and/or temperatures not exceeding 250QF (121 Qq, at or near the boiler outlet.

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

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

**Carbons Recycle** − See Flyash Recycle

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

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

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

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

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

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

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

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

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

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

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

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

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

**Fluidized Bed (Circulating) —** A fluidized bed in which the fluidizing velocities exceed the terminal velocity of the individual bed particles.

**Flyash —** Suspended ash particles carried in the flue gas.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**Metering Device** - A method of controlling the amount of fuel, or air, flowing into the combustion zone.

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

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

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

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

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

**Original Code of Construction** — Documents promulgated by recognized national standards writing bodies that contain technical requirements for construction of pressure-retaining items or equivalent to which the pressure retaining item was certified by the original manufacturer.

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

**Owner or User** — As referenced in lower case letters means any person, firm or corporation legally responsible for the safe operation of any pressure-retaining item.

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

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

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

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

**Potable Water Heaters** — A corrosion resistant appliance that includes the controls and safety devices to supply potable hot water at pressure not exceeding 160 psig (1100 kPa) and temperature not in excess of 210°F (99°C).

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

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

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

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

**Pressure Test** — A test that is conducted using a fluid (liquid or gas) contained inside a pressure-retaining item.

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

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

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

**Re-rating** — See alteration.

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

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

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

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

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

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

**Thermal Fluid Heater** − A thermal fluid heater is a closed vessel in which a fluid other than water is heated by the direct application of heat from a thermal energy source. Depending on the process heating requirements, the fluid may be vaporized with normal circulation but, more often, the fluid is heated and circulated by a pump.

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

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

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

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

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

# Part 4, Section 7

## PRESSURE RELIEF DEVICES – NBIC-APPROVED INTERPRETATIONS

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THE NATIONAL BOARD

# 2015 NBIC
## NATIONAL BOARD INSPECTION CODE

# PART 3 REPAIRS AND ALTERATIONS
## AN AMERICAN NATIONAL STANDARD

THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

Attachment Page 290

# NATIONAL BOARD INSPECTION CODE
# 2015 EDITION
# DATE OF ISSUE — JULY 1, 2015

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

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



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**www.nationalboard.org**

# PART 3 — REPAIRS AND ALTERATIONS
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# INTRODUCTION

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

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

## SCOPE

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

- Installation
- Inspection
- Repairs and Alterations

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

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

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

## ORGANIZATION

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

- Part 1, Installation – This part provides requirements and guidance to ensure all types of pressure-retaining items are installed and function properly. Installation includes meeting specific safety criteria for construction, materials, design, supports, safety devices, operation, testing, and maintenance.
- Part 2, Inspection – This part provides information and guidance needed to perform and document inspections for all types of pressure-retaining items. This part includes information on personnel safety, non-destructive examination, tests, failure mechanisms, types of pressure equipment, fitness for service, risk-based assessments, and performance-based standards.
- Part 3, Repairs and Alterations – This part provides information and guidance to perform, verify, and document acceptable repairs or alterations to pressure-retaining items regardless of code of construction. Alternative methods for examination, testing, heat treatment, etc., are provided when the original code of construction requirements cannot be met. Specific acceptable and proven repair methods are also provided.

Each NBIC part is divided into major sections as outlined in the Table of Contents.

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

## TEXT IDENTIFICATION AND NUMBERING

Each page in the text will be designated in the top header with the publication's name, part number, and part title. The numbering sequence for each section begins with the section number followed by a dot to further designate major sections (e.g., 1.1, 1.2, 1.3). Major sections are further subdivided using dots to designate subsections within that major section (e.g., 1.1.1, 1.2.1, 1.3.1). Subsections can further be divided as necessary. Paragraphs under sections or subsections shall be designated with small letters in parenthesis (e.g., a), b), c)) and further subdivided using numbers in parenthesis (e.g., 1), 2), 3)).

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

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

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

## SUPPLEMENTS

Supplements are contained in each part of the NBIC to provide rules, information, and guidance only pertaining to a specific type of pressure-retaining item (e.g., Locomotive Boilers, Historical Boilers, Graphite Pressure Vessels.) Supplements follow the same numbering system used for the main text only preceded by the Letter "S." Each page of the supplement will be tabbed to identify the supplement number.

## EDITIONS

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

## INTERPRETATIONS

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

## JURISDICTIONAL PRECEDENCE

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

## UNITS OF MEASUREMENT

Both U.S. customary units and metric units are used in the NBIC. The value stated in U.S. customary units or metric units are to be regarded separately as the standard. Within the text, the metric units are shown in parentheses. In Part 2, Supplement 6 and Part 3, Supplement 6 regarding DOT Transport Tanks, the metric units are shown first with the U.S. customary units shown in parentheses.

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

## ACCREDITATION PROGRAMS

The National Board administers and accredits three specific repair programs[1] as shown below:

"**R**"……….Repairs and Alterations to Pressure-Retaining Items
"**VR**"……..Repairs to Pressure Relief Valves
"**NR**"……..Repair and Replacement Activities for Nuclear Items

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

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

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

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

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

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

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

## CERTIFICATES OF AUTHORIZATION FOR ACCREDITATION PROGRAMS

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

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



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

# FOREWORD

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

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

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

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

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

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

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

Organizations or users of pressure-retaining items are cautioned against making use of revisions that are less restrictive than former requirements without having assurance that they have been accepted by the Jurisdiction where the pressure-retaining item is installed.

The general philosophy underlying the NBIC is to parallel those provisions of the original code of construction, as they can be applied to post-construction activities.

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

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

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

It is intended that this edition of the NBIC not be retroactive. Unless the Jurisdiction imposes the use of an earlier edition, the latest effective edition is the governing document.

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# PART 3, SECTION 1
# REPAIRS AND ALTERATIONS — GENERAL AND ADMINISTRATIVE REQUIREMENTS

## 1.1 SCOPE

a) This part provides general requirements that apply when performing repairs and alterations to pressure-retaining items.

b) This part describes the administrative requirements for the accreditation of repair organizations.[2]

c) The National Board administers three specific accreditation programs:

"R" — Repairs and Alterations to Pressure-Retaining Items

"VR" — Repairs to Pressure Relief Valves

"NR" — Repair and Replacement Activities for Nuclear Items

## 1.2 CONSTRUCTION STANDARDS FOR PRESSURE-RETAINING ITEMS

a) When the standard governing the original construction is the ASME Code or ASME RTP-1, repairs and alterations to pressure-retaining items shall conform, insofar as possible, to the section and edition of the ASME Code most applicable to the work planned.

b) If the pressure-retaining item was not constructed to a construction code or standard, or when the standard governing the original construction is not the ASME Code or ASME RTP-1, repairs or alterations shall conform, insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practicable, it is permissible to use other codes, standards, or specifications, including the ASME Code or ASME RTP-1, provided the "R" Certificate Holder has the concurrence of the Inspector and the Jurisdiction where the pressure-retaining item is installed.

c) For historical boilers, the 1971 Edition of Section I of ASME Boiler Code, Part PR and PFT provides the many pressure-related components and features of construction encountered in firetube boilers.

~~d) For pressure relieving devices the applicable standard for new valves to be used for reference during repairs is the ASME Code. ASME Code Cases shall be used for repairs when they were used in the original construction of the valve. ASME Code Cases may be used when they have been accepted for use by the NBIC Committee and the Jurisdiction where the pressure-retaining item is installed.~~

~~1) For pressure relieving devices the code case number shall be noted on the repair document and, when required by the code case, stamped on the repair nameplate.~~

~~2) The Jurisdiction where the pressure-retaining item is installed shall be consulted for any unique requirements it may have established.~~

e) Piping systems are designed for a variety of service conditions such as steam, water, oil, gas, or air. Design requirements for repairs and alterations are to meet the original code of construction or the code most appropriate for the repair or alteration. These systems shall be designed for the most severe conditions of pressure, temperature, loadings, and expected transients considered for normal operation. All pipe materials, fittings, and valves shall be rated for the maximum service conditions for normal operation. Design corrosion of piping systems should also be considered when determining types of materials and thicknesses.



2 Caution: Some jurisdictions may independently administer a program of authorization for organizations to perform repairs and alterations within that Jurisdiction.

f) For Transport Tanks, the Competent Authority (DOT) shall be consulted for any requirements which it has established since they take precedence for repairs. (15)

1) Transport tanks manufactured prior to the adoption of ASME Section XII by the Competent Authority (DOT) were constructed in accordance with ASME Section VIII, Division 1. Certain transport tanks manufactured to this code were required to be stamped in accordance with Section VIII, Division 1, if the design pressure of the transport tank was 241 kPa (35 psi) (depending on material being transported) and greater. If the design pressure was less than 241 kPa (35 psi) (depending on material being transported), the transport tank was manufactured in accordance with Section VIII, Division 1, but not required by the Competent Authority (DOT) to be stamped.

2) ASME stamped transport tanks are subject to the requirements of NBIC Part 3, for continued inservice repairs, alterations, or modifications, unless exempted by the Competent Authority (DOT).

## 1.3 INSPECTOR

a) Inspection and certification shall be made by an Inspector holding the appropriate commission issued by the National Board and employed by an Authorized Inspection Agency (see NBIC Part 3, Section 9, *Glossary of Terms,* for definition of Authorized Inspection Agency).

b) An Inspector employed by an Owner-User Inspection Organization or a Federal Inspection Agency may authorize and accept work only on pressure-retaining items owned or used by the respective organization. Each accredited Owner-User Inspection Organization's quality program shall have specific approval of the Jurisdiction as required.

### 1.3.1 AUTHORIZATION

a) The Inspector's authorization to perform a repair or alteration shall be obtained by the repair organization prior to initiation of a repair or alteration to a pressure-retaining item. The Inspector shall determine that the repair or alteration methods are acceptable.

b) Subject to acceptance of the Jurisdiction, the Inspector may give approval for routine repairs prior to the start of work provided the Inspector ensures that the "R" Certificate Holder has adequately addressed routine repairs in the quality program.

### 1.3.2 ACCEPTANCE INSPECTION

a) The Inspector making the acceptance inspection shall be the same Inspector who authorized the repair or alteration. Where this is not possible or practicable, another Inspector may perform the acceptance inspection; however, in all cases, the Inspector who performs the acceptance inspection shall be an employee of the same organization as the Inspector who authorized the repair or alteration.

b) Before signing the appropriate NBIC Report Form, the Inspector shall review the drawings, ensure the repair or alteration was performed in accordance with the accepted code of construction or standard, witness any pressure test or any acceptable alternative test method applied, ensure that the required nondestructive examinations have been performed satisfactorily, and that the other functions necessary to ensure compliance with the requirements of this code have been satisfactorily performed.

c) The Inspector shall verify the stamping or nameplate is correct and where applicable, the nameplate has been properly attached.

## ~~1.4 DEFINITIONS RELATING TO PRESSURE RELIEF DEVICES~~

~~Unless otherwise specified in these rules and procedures, the definitions relating to pressure relief devices in Section 2 of ANSI/ASME PTC-25 shall apply.~~

## 1.5 ACCREDITATION

a) Organizations performing repairs or alterations to pressure-retaining items shall be accredited as described in this section, as appropriate for the scope of work to be performed.

b) Organizations performing repairs outside the scope of the NBIC may be accredited and shall meet any additional requirements of the Jurisdiction where the work is performed.

### 1.5.1 ACCREDITATION PROCESS

a) The National Board administers accreditation programs for authorization of organizations performing repairs and alterations to pressure-retaining items and/or pressure relief valves.

b) Any organization may apply to the National Board to obtain a *Certificate of Authorization* for the requested scope of activities. A review shall be conducted to evaluate the organization's quality system. The individual assigned to conduct the evaluation shall meet the qualification requirements prescribed by the National Board. Upon completion of the evaluation, any deficiencies within the organization's quality system will be documented and a recommendation will be made to the National Board regarding issuance of a *Certificate of Authorization*.

c) As part of the accreditation process, an applicant's quality system is subject to a review. National Board procedures provide for the confidential review resulting in recommendations to issue or not issue a *Certificate of Authorization*.

d) The accreditation programs provide requirements for organizations performing repairs and alterations to pressure-retaining items. Depending upon the expected scope of activities at the time of review, organizations may be authorized to perform design only, metallic or non-metallic repairs, and/or alterations either in the shop only, field only, or shop and field. Repairs and/or alterations to metallic and non-metallic pressure-retaining items are made by welding, bonding and/or mechanical assembly.

e) Organizations desiring to renew or obtain a National Board *Certificate of Authorization* shall apply to the National Board using forms obtained from the National Board. Application for renewal shall be made prior to the expiration date of the *Certificate of Authorization*.

f) When an organization has plants or shops in more than one location, the organization shall submit separate applications for each plant or shop. The organization may perform repairs or alterations in its plants, shops, or in the field, provided such operations are described in the organization's Quality System.

g) The Jurisdiction[3] may audit the Quality System and activities of an organization upon a valid request from an owner, user, inspection agency, or the National Board.

h) The NBIC Committee may at any time change the rules for the issuance of *Certificates of Authorization* and use of the "R" Symbol Stamp. These rules shall become binding on all certificate holders.

### 1.5.2 NATIONAL BOARD "R" SYMBOL STAMP

a) All "R" Symbol Stamps shall be obtained from The National Board of Boiler and Pressure Vessel Inspectors. Authorization to use the "R" Symbol Stamp may be granted by the National Board at its absolute discretion to the certificate holder.

b) The "R" Symbol Stamp is furnished on loan by the National Board for a nominal fee. Each organization

3 Jurisdiction: The National Board member Jurisdiction where the organization is located. Alternatively, where the Jurisdiction elects not to perform the review or where there is no Jurisdiction or where the Jurisdiction is the organization's Authorized Inspection Agency, The National Board of Boiler and Pressure Vessel Inspectors will represent the Jurisdiction. At the Jurisdiction's discretion, the Jurisdiction may choose to be a member of the review team if the Jurisdiction chooses not to be the team leader.

shall agree if authorization to use the “R” Symbol Stamp is granted, that the “R” Symbol Stamp is at all times the property of the National Board and will be promptly returned upon demand. If the organization discontinues the use of the “R” Symbol Stamp, inspection agreement with an Authorized Inspection Agency, or if the *Certificate of Authorization* has expired and no new certificate has been issued, the “R” Symbol Stamp shall be returned to the National Board.

c) The organization’s Quality System shall provide for adequate control of the “R” Symbol Stamp. Provisions may be made for the issuance of the “R” Symbol Stamp for use at various field locations.

d) The holder of a *Certificate of Authorization* may obtain more than one “R” Symbol Stamp provided the organization’s Quality System describes how the use of such stamps is controlled from the location shown on the certificate.

e) An organization shall not permit others to use the “R” Symbol Stamp loaned to it by the National Board.

## 1.6 QUALITY SYSTEM

A holder of a National Board *Certificate of Authorization* shall have and maintain a written Quality System. The System shall satisfactorily meet the requirements of the NBIC and shall be available for review. The Quality System may be brief or voluminous, depending on the projected scope of work. It shall be treated confidentially by the National Board.

### 1.6.1 OUTLINE OF REQUIREMENTS FOR A QUALITY SYSTEM FOR QUALIFICATION FOR THE NATIONAL BOARD “R” *CERTIFICATE OF AUTHORIZATION*

The following is a guide for required features of a Quality System which shall be included in the organization’s Quality System Manual. As a minimum, each organization shall address the required features relative to the scope of work to be performed. Organizations shall explain their intent, capability and applicability for each required feature outlined in this section. Work may be subcontracted provided controls are clearly defined for maintaining full responsibility for code compliance by the National Board repair organization certifying the work.

a) **Title Page**

The name and complete address of the company to which the National Board *Certificate of Authorization* is issued shall be included on the title page of the Quality System Manual.

b) **Contents Page**

The manual should contain a page listing the contents of the manual by subject, number (if applicable), and revision number of each document.

c) **Scope of Work**

The manual shall clearly indicate the scope and type of repairs or alterations the organization is capable of and intends to carry out.

d) **Statement of Authority and Responsibility**

A dated *Statement of Authority*, signed by an officer of the organization, shall be included in the manual. Further, the *Statement of Authority* shall include:

1) A statement that all repairs or alterations carried out by the organization shall meet the requirements of the NBIC and the Jurisdiction, as applicable;

2) A statement that if there is a disagreement in the implementation of the Quality System, the matter is to be referred for resolution to a higher authority in the company;

3) The title of the individual who will be responsible to ensure that 1) above is followed and has the freedom and authority to carry out the responsibility.

e) **Manual Control**

The manual shall include the necessary provisions for revising and issuing documents to keep the manual current. The title of the individual authorized to approve revisions shall be included in the manual. Revisions must be accepted by the Authorized Inspection Agency prior to issuance of the manual and its implementation.

f) **Organization**

An organizational chart shall be included in the manual. It shall include the title of the heads of all departments or divisions that perform functions that can affect the quality of the repair or alteration, and it shall show the relationship between each department or division.

The manual shall identify the title of those individuals responsible for preparation, implementation, or verification of the Quality System. The responsibilities shall be clearly defined and the individuals shall have the organizational freedom and authority to fulfill those responsibilities.

g) **Drawings, Design and Specifications**

The manual shall contain controls to ensure that all design information, applicable drawings, design calculations, specifications, and instructions are prepared or obtained, controlled, and interpreted in accordance with the original code of construction.

h) **Repair and Alteration Methods**

The manual shall include controls for repairs and alterations, including mechanical assembly procedures, materials, nondestructive examination methods, pre-heat, and postweld heat treatment, as applicable. Special requirements such as nonmetallic repairs and alterations to graphite and fiber-reinforced thermosetting plastic pressure-retaining items including bonding or mechanical assembly procedures shall be addressed, if applicable.

i) **Materials**

The manual shall describe the method used to ensure that only acceptable materials (including welding material) are used for repairs and alterations. The manual shall include a description of how existing material is identified and new material is ordered, verified, and identified. The manual shall identify the title of the individual(s) responsible for each function and a brief description of how the function is to be performed.

j) **Method of Performing Work**

The manual shall describe the methods for performing and documenting repairs and alterations in sufficient detail to permit the Inspector to determine at what stages specific inspections are to be performed. The method of repair or alteration must have prior acceptance of the Inspector.

k) **Welding, NDE and Heat Treatment**

The manual shall describe controls for welding, nondestructive examination, and heat treatment. The manual is to indicate the title of the individual(s) responsible for the welding procedure specification (WPS) and its qualification, and the qualification of welders and welding operators. It is essential that only welding procedure specifications and welders or welding operators qualified, as required by the NBIC, be used in the repair or alteration of pressure-retaining items. It is also essential that welders and welding operators maintain their proficiency as required by the NBIC, while engaged in the repair or alteration of pressure-retaining items. The manual shall also describe controls for ensuring that the required WPS or Standard Welding Procedure Specification (SWPS) is available to the welder or welding operator prior to welding. Similar responsibility for nondestructive examination and heat treatment shall be described in the manual.

l) **Examinations and Tests**

Reference shall be made in the manual for examinations and tests upon completion of the repair or alteration.

m) **Calibration**

The manual shall describe a system for the calibration of examination, measuring, and test equipment used in the performance of repairs and alterations.

n) **Acceptance and Inspection of Repair or Alteration**

The manual shall specifically indicate that before the work is started, acceptance of the repair/alteration shall be obtained from an Inspector who will make the required inspections and confirm NBIC compliance by signing and dating the applicable NBIC Report Form [4] upon completion of the work.

o) **Inspections**

The manual shall make provisions for the Inspector to have access to all drawings, design calculations, specifications, procedures, process sheets, repair or alteration procedures, test results, and other documents as necessary to ensure compliance with the NBIC. A copy of the current manual shall be available to the inspector.

p) **Report of Repair or Alteration Form**

The manual shall indicate the title of the individuals responsible for preparing, signing, and presenting the NBIC Report Forms to the Inspector. The distribution of the NBIC Report Forms[4] shall be described in the manual.

q) **Exhibits**

Any forms referenced in the manual shall be included. The form may be a part of the referencing document or included as an appendix. For clarity, the forms may be completed and identified as examples. The name and accepted abbreviations of the "R" Certificate Holder shall be included in the manual.

r) **Construction Code**

The manual shall include provisions for addressing the requirements that pertain to the specific construction code for the equipment being repaired or altered.

s) **Nonconforming Items**

There shall be a system acceptable to the Inspector for the correction of nonconformities. A nonconformance is any condition that does not comply with the applicable rules of the NBIC, construction code, jurisdictional requirements, or the quality system. Nonconformance must be corrected or eliminated before the repaired or altered component can be considered in compliance with the NBIC.

t) **Records Retention**

The quality manual shall describe a system for filing, maintaining, and easily retrieving records supporting or substantiating the administration of the Quality System within the scope of the "R" *Certificate of Authorization*.



4 NBIC Report Form: National Board Form R-1 for Repair, Form R-2 for Alterations, Form R-3 for Fabricated Parts, or Form R-4 Report Supplementary Sheet.

1) Records may represent any information used to further substantiate the statements used to describe the scope of work completed to a pressure-retaining item (PRI), and documented on a Form "R" report.

2) Records are not limited to those depicting or calculating an acceptable design, material compliance or certifications, NDE-reports, PWHT-charts, a WPS used, a welder, bonder, or cementing technician's process continuity records, drawings, sketches, or photographs.

3) The record retention schedule described in the Quality System Manual is to follow the instructions identified in NBIC Part 3, Table 1.6.1.

**TABLE 1.6.1**

| Form "R" Reports, Records, or Documents | Instructions | Minimum Retention Period |
|---|---|---|
| a) Form "R" Reports and supporting records and documentation | The organization performing repairs and alterations shall retain a copy of the completed "R" Form report on file, and all records substantiating the summary of work described in NBIC Part 3, 5.13.4.1, Item 12, for a minimum of 5 years. When the method of repair described in NBIC Part 3, 3.3.4.8 is used, the record retention period shall be described in b). | 5 years |
| b) Form "R" Report with REPORT OF FITNESS FOR SERVICE ASSESSMENT FORM (NB-403) attached. | When the method of repair described in NBIC Part 3,3.3.4.8 is used, the record retention period shall be for the duration described on the FITNESS FOR SERVICE ASSESSMENT (FFSA) Form required by the repair method and as described in NBIC Part 2, 4.4.<br><br>Notes:<br><br>1. The "R" Certificate Holder should be aware that when used, some of the referenced codes and standards identified in NBIC Part 2,, 1.3 describe requirements for permanent record retention throughout the service life of each equipment item.<br><br>2. When the "R" Certificate Holder is not the owner or user of the equipment, the record retention period is limited to the FFSA-results described on line 8 of the Report of Fitness for Service Assessment Form (NB-403). | 5 years or as described on line 8 as reported on Form NB-403; whichever period is longer. |

| Form “R” Reports, Records, or Documents | Instructions | Minimum Retention Period |
|---|---|---|
| c) Continuity records for a welder, welding operator, bonder, or cementing technician. | Minimally, continuity records for a welder, bonder, or cementing technician within the Certificate Holder’s quality system shall be described and established at the time of the applicant’s initial certificate review and demonstrated at each triennial review required thereafter. | As applicable to the scope of work identified on the *Certificate of Authorization*, the continuity records are subject to review during each National Board triennial certificate review. |
| d) Administrative record review of the “R” Certificate Holder’s administrative processes. | Records supporting completed administrative reviews or audits of procedures or processes required by the “R” Certificate Holder’s Quality System Manual, or in combination with the applicable part of the NBIC Part 3, Supplement 6 as it applies to the identified scope listed on the “R” *Certificate of Authorization*. | Subject to review during the triennial evaluation of the certificate holder’s Quality System. |

## ~~1.7 ACCREDITATION OF “VR” REPAIR ORGANIZATIONS~~

### ~~1.7.1 SCOPE~~

~~These administrative rules and procedures are provided by the National Board for those who wish to obtain National Board *Certificate of Authorization* for use of the “VR” (Repair of Pressure Relief Valves) symbol stamp. It should be noted that the issuance of the “VR” stamp is not restricted to companies whose primary business is the repair of pressure relief valves, nor to manufacturers or assemblers that hold an ASME “V,” “HV,” “UV,” or “NV” Code Symbol Stamp. Owners and users of boilers and pressure vessels and other organizations that qualify in accordance with the National Board Rules and Regulations may also obtain the “VR” Certificate and stamp.~~

### ~~1.7.2 JURISDICTIONAL PARTICIPATION~~

~~The National Board member jurisdiction in which the “VR” organization is located is encouraged to participate in the review and demonstration of the applicant’s quality system. The Jurisdiction may require participation in the review of the repair organization and the demonstration and acceptance of the repair organization’s quality system manual.~~

### ~~1.7.3 ISSUANCE AND RENEWAL OF THE “VR” *CERTIFICATE OF AUTHORIZATION*~~

#### ~~1.7.3.1 GENERAL~~

~~Authorization to use the stamp bearing the official National Board “VR” symbol as shown in NBIC Part 3, Section 5, will be granted by the National Board pursuant to the provisions of the following administrative rules and procedures.~~

#### ~~1.7.3.2 ISSUANCE OF CERTIFICATE~~

~~a) Repair organizations, manufacturers, assemblers, or users that make repairs to the American Society of Mechanical Engineers (ASME) Code symbol, stamped or marked (as applicable), and The National~~

~~Board of Boiler and Pressure Vessel Inspectors (National Board) capacity certified pressure relief valves may apply to the National Board for a *Certificate of Authorization* to use the "VR" symbol.~~

### ~~1.7.4 USE OF THE "VR" AUTHORIZATION~~

#### ~~1.7.4.1 TECHNICAL REQUIREMENTS~~

~~The administrative requirements of NBIC Part 3, 1.7 for use of the "VR" stamp shall be used in conjunction with the technical requirements for valve repair as described in NBIC Part 3, Supplement 7. Those requirements shall be mandatory when a "VR" repair is performed.~~

#### ~~1.7.4.2 STAMP USE~~

~~Each "VR" symbol stamp shall be used only by the repair firm within the scope, limitations, and restrictions under which it was issued.~~

### ~~1.7.5 QUALITY SYSTEM~~

#### ~~1.7.5.1 GENERAL~~

~~Each applicant for a new or renewed "VR" *Certificate of Authorization* shall have and maintain a quality system which shall establish that all of these rules and administrative procedures and applicable ASME Code requirements, including material control, fabrication, machining, welding, examination, setting, testing, inspection, sealing, and stamping will be met.~~

#### ~~1.7.5.2 WRITTEN DESCRIPTION~~

~~A written description, in the English language, of the system the applicant will use shall be available for review and shall contain, as a minimum, the features set forth in NBIC Part 3, 1.7.5.4. This description may be brief or voluminous, depending upon the projected scope of work, and shall be treated confidentially. In general, the quality system shall describe and explain what documents and procedures the repair firm will use to validate a valve repair.~~

#### ~~1.7.5.3 MAINTENANCE OF CONTROLLED COPY~~

~~Each applicant to whom a "VR" *Certificate of Authorization* is issued shall maintain thereafter a controlled copy of the accepted quality system manual with the National Board. Except for changes that do not affect the quality system, revisions to the quality system manual shall not be implemented until such revisions are accepted by the National Board.~~

#### ~~1.7.5.4 OUTLINE OF REQUIREMENTS FOR A QUALITY SYSTEM~~

~~The following establishes the minimum requirements of the written description of the quality system. It is required that each valve repair organization develop its own quality system that meets the requirements of its organization. For this reason it is not possible to develop one quality system that could apply to more than one organization. The written description shall include, as a minimum, the following features:~~

~~a) **Title Page**~~

~~The title page shall include the name and address of the company to which the National Board *Certificate of Authorization* is to be issued.~~

~~b) **Revision Log**~~

~~A revision log is required to ensure revision control of the quality system manual. The log should contain sufficient space for date, description and section of revision, company approval, and National Board acceptance.~~

~~c) **Contents Page**~~

~~The contents page should list and reference, by paragraph and page number, the subjects and exhibits contained therein.~~

~~d) **Statement of Authority and Responsibility**~~

~~A statement of authority and responsibility shall be dated and signed by an officer of the company. It shall include:~~

~~1) A statement that the “VR” stamp shall be applied only to pressure relief valves that meet both of the following conditions:~~

~~a. Are stamped with an ASME “V”, “UV”, or “NV” Code symbol or marked with an ASME “HV” symbol and have been capacity certified by the National Board; and~~

~~b. Have been disassembled, inspected, and repaired by the Certificate Holder such that the valves’ condition and performance are equivalent to the standards for new valves.~~

~~2) The title of the individual responsible for ensuring that the quality system is followed and who has authority and freedom to affect the responsibility;~~

~~3) A statement that if there is a disagreement in the implementation of the written quality system, the matter is to be referred to a higher authority in the company for resolution; and~~

~~4) The title of the individual authorized to approve revisions to the written quality system and the method by which such revisions are to be submitted to the National Board for acceptance before implementation.~~

~~e) **Organization Chart**~~

~~A chart showing the relationship between management, purchasing, repairing, inspection, and quality control personnel is required and shall reflect the actual organization in place.~~

~~f) **Scope of Work**~~

~~1) The scope of work section shall indicate the scope and type of valve repairs, including conversions the organization is capable of and intends to perform. The location of repairs (shop, shop and field, or field only), ASME Code Section(s) to which the repairs apply, the test medium (air, gas, liquid, or steam, or combinations thereof), and special processes (machining, welding, postweld heat treatment, or nondestructive examination, or combinations thereof) shall be specifically addressed.~~

~~2) The types and sizes of valves to be repaired, pressure ranges and other limitations, such as engineering and test facilities, should also be addressed.~~

~~g) **Drawings and Specification Control**~~

~~The drawings and specification control system shall provide procedures assuring that the latest applicable drawings, specifications, and instructions required are used for valve repair, including conversions, inspection, and testing.~~

~~h) **Material and Part Control**~~

~~The material and part control section shall describe purchasing, receiving, storage, and issuing of parts.~~

~~1) State the title of the individual responsible for the purchasing of all material.~~

~~2) State the title of the individual responsible for certification and other records as required.~~

~~3) All incoming materials and parts shall be checked for conformance with the purchase order and, where applicable, the material specifications or drawings. Indicate how material or part is identified and how identity is maintained by the quality system.~~

~~i) **Repair and Inspection Program**~~

~~The repair and inspection program section shall include reference to a document (such as a report, traveler, or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure relief valves. Repair procedures shall require verification that the critical parts meet the valve manufacturer's specification. NBIC Part 3, S7.14 outlines recommended procedures covering some specific items. Provisions shall be made to retain this document for a period of at least five years.~~

~~1) Each valve or group of valves shall be accompanied by the document referred to above for processing through the plant. Each valve shall have a unique identifier (e.g., repair serial number, shop order number, etc.) appearing on the repair documentation and repair nameplate such that traceability is established.~~

~~2) The document referred to above shall describe the original nameplate information, including the ASME Code symbol stamping and the repair nameplate information, if applicable. In addition, it shall include material checks, replacement parts, conversion parts (or both), reference to items such as the welding procedure specifications (WPS), fit-up, NDE technique, heat treatment, and pressure test methods to be used. Application of the "VR" stamp to the repair nameplate shall be recorded in this document. Specific conversions performed with the new Type/Model Number shall be recorded on the document. There shall be a space for "signoffs" at each operation to verify that each step has been properly performed.~~

~~3) The system shall include a method of controlling the repair or replacement of critical valve parts. The method of identifying each spring shall be indicated.~~

~~4) The system shall also describe the controls used to ensure that any personnel engaged in the repair of pressure relief valves are trained and qualified in accordance with NBIC Part 3, Supplement 7.~~

~~j) **Welding, NDE, and Heat Treatment (when applicable)**~~

~~The quality system manual shall indicate the title of the person(s) responsible for and describe the system used in the selection, development, approval, and qualification of welding procedure specifications, and the qualification of welders and welding operators in accordance with the provisions of NBIC Part 3, S7.12 and S7.13.~~

~~1) The quality system manual may include controls for the "VR" Certificate Holder to have the pressure relief valve part repaired by a National Board "R" Certificate Holder, per NBIC Part 3, S7.3.~~

~~2) The completed Form R-1 shall be noted on and attached to the "VR" Certificate Holder's document required in NBIC Part 3, 1.7.5.4. i). Similarly, NDE and heat treatment techniques must be covered in the quality system manual. When outside services are used for NDE and heat treatment, the quality system manual shall describe the system whereby the use of such services meet the requirements of the applicable section of the ASME Code.~~

~~k) **Valve Testing, Setting, and Sealing**~~

~~The system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code Section and the National Board. The~~

~~seal shall identify the "VR" Certificate Holder making the repair. Abbreviations or initials shall be permitted, provided such identification is acceptable to the National Board.~~

~~l) **Valve Repair Nameplates**~~

~~An effective valve stamping system shall be established to ensure proper stamping of each valve as required by NBIC Part 3, 5.12.2. The manual shall include a description of a nameplate or a drawing.~~

~~m) **Calibration**~~

~~1) The manual shall describe a system for the calibration of examination, measuring, and test equipment used in the performance of repairs. Documentation of these calibrations shall include the standard used and the results.~~

~~2) All calibration standards shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.~~

~~n) **Manual Control**~~

~~The quality system shall include:~~

~~1) Measures to control the issuance of and revisions to the quality system manual;~~

~~2) Provisions for a review of the system in order to maintain the manual current with these rules and the applicable sections of the ASME Code;~~

~~3) The title(s) of the individual(s) responsible for control, revisions, and review of the manual;~~

~~4) Provision of a controlled copy of the written quality system manual to be submitted to the National Board; and~~

~~5) Revisions shall be submitted for acceptance by the National Board prior to being implemented.~~

~~o) **Nonconformities**~~

~~The system shall establish measures for the identification, documentation, evaluation, segregation, and disposition of nonconformities. A nonconformity is a condition of any material, item, product, or process in which one or more characteristics do not conform to the established requirements. These may include, but are not limited to, data discrepancies, procedural and/or documentation deficiencies, or material defects. Also, the title(s) of the individual(s) involved in this process shall be included.~~

~~p) **Exhibits**~~

~~Forms used in the quality system shall be included in the manual with a written description. Forms exhibited should be marked "SAMPLE" and completed in a manner typical of actual valve repair procedures.~~

~~q) **Testing Equipment (See NBIC Part 3, Supplement 8)**~~

~~The system shall include a means to control the development, addition, or modification of testing equipment to ensure the requirements of NBIC Part 3, 4.5.1 b) are met.~~

~~r) **Field Repairs (See NBIC Part 3, S7.7)**~~

~~If field repairs are included in the scope of work, the system shall address any differences or additions to the quality system required to properly control this activity, including the following:~~

~~1) Provisions for annual audits of field activities shall be included;~~

~~2) Provisions for receipt and inspection of replacement parts, including parts received from the owner-user, shall be addressed;~~

3) ~~If owner-user personnel will assist with repairs, provisions for the use of owner-user personnel shall be included; and~~

4) ~~Provisions for use of owner-user measurement and test equipment, if applicable, shall be addressed.~~

## (15) 1.8 "NR" PROGRAM REQUIREMENTS

### (15) 1.8.1 SCOPE

a) This section provides requirements that must be met for an organization to obtain a National Board *Certificate of Authorization* to use the "NR" Symbol Stamp for repair/replacement activities to nuclear items constructed in accordance with the requirements of the ASME Code or other internationally recognized codes or standards for construction or inservice inspection of nuclear facilities.

b) For administrative requirements to obtain or renew a National Board "NR" *Certificate of Authorization* and the "NR" Symbol Stamp, refer to National Board Procedure NB-417[5], Accreditation of "NR" Repair Organizations.

### (15) 1.8.2 GENERAL

a) An organization applying for an "NR" *Certificate of Authorization* shall have a written Quality Assurance Program (QAP) that details the specific requirements to be met based on the intended category of activities selected by that organization as described below and shown in Table 1.8.2. Controls used, including electronic capabilities, in the Quality Assurance Program shall be documented in a Quality Assurance Manual (QAM). Controls required to be included within the QAM shall include who, what, when, where, why and how with an understanding that the how can be a reference to an implementation procedure or instruction. Quality activities to be described in the Quality Assurance Program is identified in Section 1.8.5 of this part. Applicants shall address all requirements in their Quality Assurance Program based on the category of activity and scope of work to be performed (organization's capabilities) to which certification is requested.

b) Category 1

Any ASME Code certified item or system requiring repair/replacement activities irrespective of physical location and installation status prior to fuel loading.

c) Category 2

After fuel loading, any item or system under the scope of ASME Section XI requiring repair/replacement activities irrespective of physical location.

d) Category 3

Items constructed to codes or standards other than ASME, requiring repair/replacement activities irrespective of physical location, installation status and fuel loading.



5 Requirements for Accreditation of "NR" Repair Organizations NB-417, may be found on the NB website www.nationalboard.org under tab "Stamps and Marks."

## TABLE 1.8.2 (15)

“NR” QUALITY ASSURANCE PROGRAM (QAP) REQUIREMENTS

| Category of Activity | Owner | Organizations other than Owner |
|---|---|---|
| Category 1 | 10 CFR Part 50 Appendix B1, 2 and ASME Section III NCA-4000 | 10 CFR Part 50 Appendix B1, 2 and ASME Section III NCA-4000 |
| Category 2 | 10 CFR Part 50, Appendix B1, 2 or NQA-1, Part 1 and ASME Section XI, IWA-4142 | 10 CFR Part 50, Appendix B1, 2 supplemented as needed with Owner’s QA program; or ASME NQA-1, Part 1; or ASME Section III, NCA-4000 |
| Category 3 | ASME NQA-1, or Specify the Standard to which certification is desired | ASME NQA-1,or Specify the Standard to which certification is desired |
| **Note 1:** Code of Federal Regulations (CFR) – rules and regulations published by the executive departments and agencies of the federal government of the United States. | | |
| **Note 2:** 10 CFR 50 Appendix B – Title 10 of the Code of Federal Regulations Part 50 Appendix B describes the quality assurance criteria for nuclear plants and fuel reprocessing plants. | | |

### 1.8.2.1 DEFINITIONS (15)

The terms and definitions used within this section shall be as specified below:

a) For Category 1 terms and definitions shall be as specified in ASME Section III

b) For Category 2 terms and definitions shall be as specified in ASME Section XI

c) For Category 3 terms and definitions shall be as specified in ASME NQA-1 and other standards specified by the Regulatory Authority

The following terms are as defined in the NBIC Glossary of Terms Section 9:

a) Authorized Inspection Agency

b) Authorized Nuclear Inspection Agency

[*An Authorized Inspection Agency intending to perform nuclear inspection activities and employing nuclear Inspectors / Supervisors*] – NBIC Glossary

c) Jurisdiction

d) “NR” Certificate Holder

(15) **TABLE 1.8.2.1**

ACRONYMS

| | |
|---|---|
| ASME | American Society of Mechanical Engineers |
| Applicant | An Organization applying for "NR" *Certificate of Authorization* (new or renewal) |
| CFR | Code of Federal Regulations |
| Code | ASME Code of Construction, Section III, Division I, (NCA, NB, NC, ND, NE, NF, NG, and NH) or ASME Section XI Rules for Inservice Inspection of Nuclear Power Plant Components as applicable. |
| Jurisdiction | Enforcement Authority |
| NB | National Board of Boiler and Pressure Vessel Inspectors |
| NBIC | National Board Inspection Code |
| NB-263 | Rules for National Board Inservice and New Construction Commissioned Inspectors |
| NCA | ASME Section III, Subsection NCA, General Requirements for Division 1 and Division 2 |
| NQA–1* | ASME Quality Assurance Requirements for Nuclear Facility Applications |
| NR | Nuclear Repair |
| "NR" CH | "NR" Certificate Holder |
| QA | Quality Assurance |
| QAI–1 | ASME Qualifications for Authorized Inspection |
| QAM | Quality Assurance Manual |
| QAP | Quality Assurance Program |
| QC | Quality Control |
| WA | ASME Section III, Division 3, Subsection WA, General Requirements |

**Note:**

* Latest Edition endorsed by the Regulatory Authority

(15) **1.8.3 PREREQUISITES FOR ISSUING A NATIONAL BOARD "NR" *CERTIFICATE OF AUTHORIZATION***

Before an organization can obtain a National Board "NR" *Certificate of Authorization*, the organization shall:

a) Have and maintain an inspection agreement with an Authorized Nuclear Inspection Agency accepted in accordance with NB-360[6] or accredited in accordance with NB-369[7].

b) Have a written Quality Assurance Program that complies with the requirements of this section and address all controls for the intended category and scope of activities.

c) Have a current edition of the NBIC.



6 NB-360, Criteria for Acceptance of Authorized Inspection Agencies for New Construction.
7 NB-369, Qualifications and Duties for Authorized Inspection Agencies (AIAs) Performing Inservice Inspection Activities and Qualification of Inspectors of Boilers and Pressure Vessels.

d) Have available ASME Section XI, the code of construction and referenced code sections and standards appropriate for the scope of work to be performed. ASME Section XI and codes of construction (Editions/Addenda) shall meet the requirements of the Regulatory Authority[8] and the owner.

## 1.8.4 OBTAINING OR RENEWING A NATIONAL BOARD "NR" *CERTIFICATE OF AUTHORIZATION* (15)

a) Before an "NR" *Certificate of Authorization* will be issued or renewed, the applicant must have the Quality Assurance Program and the implementation of the program reviewed and found acceptable by representatives of the National Board, the Jurisdiction, and the Authorized Nuclear Inspection Agency. The Jurisdiction will be the National Board Member Jurisdiction in which the applicant is located or the location where the Quality Assurance Program is demonstrated/implemented. At the request of the Jurisdiction, or where there is no National Board Member Jurisdiction, the National Board representative shall act on behalf of the Jurisdiction. The implementation of the Quality Assurance Program shall be satisfactorily demonstrated by the organization. Demonstration of implementation shall meet the most stringent (classification) code requirements for the scope and category of work to be specified on the *Certificate of Authorization* or as requested by the applicant.

b) If the applicant is an ASME "N" type *Certificate of Authorization* holder, has satisfactorily demonstrated within the last twelve (12) months the implementation of their Quality Assurance Program and can provide documentation that the organization is capable of implementing its Quality Assurance Program as being in compliance with this section, a further hardware verification implementation may not be necessary.

c) The Regulatory Authority or Jurisdiction, upon request to the National Board, may attend the survey process for an "NR" *Certificate of Authorization* to be issued or renewed.

d) The "NR" *Certificate of Authorization* holder shall be subject to an audit annually by the Authorized Nuclear Inspection Agency to ensure compliance with the Quality Assurance Program.

## 1.8.5 QUALITY ASSURANCE PROGRAM (15)

a) An applicant or a holder of a National Board "NR" *Certificate of Authorization* ("NR" Certificate Holder) shall have and maintain a written Quality Assurance Program. The Quality Assurance Program shall satisfactorily meet the requirements of this section, and Jurisdictional and Regulatory requirements as applicable. The Quality Assurance Program may be brief or voluminous, depending on the circumstances. It shall be treated confidentially by the National Board and available for review by the Survey Team.

b) Each applicant or "NR" Certificate Holder is responsible for establishing and executing a Quality Assurance Program. The applicant or "NR" Certificate Holder may subcontract activities needed to implement the Quality Assurance Program, as limited by ASME Section III and XI, but responsibility for adherence to the Quality Assurance Program remains with the Applicant or "NR" Certificate Holder.

c) These rules set forth the requirements for planning, managing, and implementing the organization's Quality Assurance Program to control and ensure quality is performed and maintained during repair/replacement activities of components, items, parts, and systems for nuclear facilities. These rules are to be the basis for evaluating such programs prior to the issuance or renewal of the National Board "NR" *Certificate of Authorization*. Rules identified in subsections 1.8.6, 1.8.7 and 1.8.8 of this section detail the Quality Assurance Program requirements for each category of activity. These rules are established to meet and follow the requirements specified in NBIC Part 3, Table 1.8.2-1 of this section.

## 1.8.6 QUALITY ASSURANCE PROGRAM REQUIREMENTS FOR CATEGORY 1 ACTIVITIES (15)

8 Regulatory Authority, A government agency, such as the United States Nuclear Regulatory Commission, empowered to issue and enforce regulations concerning the design, construction, and operation of nuclear power plants.

### (15) 1.8.6.1 SCOPE

Owners or organizations other than owners shall have a written Quality Assurance Program meeting the criteria specified in Table 1.8.2 of this section for Category 1 activities. The following quality elements shall be specified and described within the QAM.

### (15) 1.8.6.2 QUALITY PROGRAM ELEMENTS

a) Organization

The provisions identified in ASME NQA-1, Part 1, Requirement 1, shall apply in its entirety. The Authority and responsibility for individuals involved in activities affecting quality shall be clearly established and documented throughout the Quality Assurance Program and identified on a functional organizational chart contained within the QA Manual.

b) Quality Assurance Program (QAP)

The provisions identified in ASME NQA-1, Part 1, Requirement 2, shall apply, except paragraph 301. Additionally, the following criteria shall be used when developing and maintaining the QAP.

1) The Quality Assurance Program as used in this section shall include a written Quality Assurance Manual, with supporting procedures and instructions used to meet all the requirements of this Section.

2) Qualification of non-destructive examination personnel shall be as required by the code of construction or as specified in the owner's Quality Assurance Program.

3) The "NR" Certificate Holder shall be responsible for advising the Authorized Nuclear Inspection Agency of proposed changes to the Quality Assurance Manual to obtain acceptance of the Authorized Nuclear Inspector Supervisor before putting such changes into effect. The "NR" Certificate Holder shall make a current controlled copy of the Quality Assurance Manual available to the Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor. The Certificate Holder shall be responsible for notifying the Authorized Nuclear Inspector of QAM changes, including evidence of acceptance by the Authorized Nuclear Inspector Supervisor.

4) The Quality Assurance Manual need not be in the same format or sequential arrangement as the requirements in these rules as long as all applicable requirements have been covered.

5) The "NR" Certificate Holder shall implement and maintain a program for qualification, indoctrination, training and maintaining proficiency of personnel involved with quality functions, including personnel of subcontracted services.

6) The "NR" Certificate Holder shall address in their QAM the requirements for interfacing with the owner specified in 1.8.9 of this section.

c) Design Control

The provisions identified in ASME NQA-1, Part 1, Requirement 3, shall apply except Paragraph 601. The following additional requirements shall be considered when applicable.

1) The "NR" Certificate Holder shall establish measures to ensure applicable requirements of the owner's design specifications, owner's requirements, and code of construction requirements are correctly translated into drawings, specifications, procedures and instructions.

2) All design documents, including revisions, shall be verified by the"NR" Certificate Holder to be correct and adequate in accordance with the owners requirements.

3) Repair/replacement plans shall be completed prior to performing any work, inspections, examinations or testing; however repair/replacement plans are not required for the design phase of a repair/replacement activity including activities that require design only (except rerating).

4) The repair/replacement plan shall identify any applicable Code Edition/Addenda and Code Cases, owner's requirements and the Construction Code Edition/Addenda utilized to perform the work.

5) The repair/replacement plan shall identify expected life of the item when less than the intended life as specified in the owner's design specification.

6) The "NR" Certificate Holder shall ensure that specifications, drawings, procedures and instructions do not conflict with the owner's design specifications. A system must be described in the Quality Assurance Manual to resolve or eliminate such conflicts. Resolution shall consider the Design Specification Requirements, as well as, the owner requirements, Jurisdictional and Regulatory Authority Requirements as applicable.

d) Procurement Document Control

The provisions identified in ASME NQA-1, Part 1, Requirement 4, shall apply. Procurement documents shall require suppliers to provide a Quality Assurance Program consistent with the applicable requirements of ASME Section III and this section:

e) Instructions, Procedures and Drawings

The provisions identified in ASME NQA-1, Part 1, Requirement 5, shall apply. All activities affecting quality shall be prescribed by documented instructions, procedures or drawings appropriate for the scope of work to be performed. Instructions, procedures or drawings shall describe acceptance criteria to ensure quality activities are accomplished.

f) Document Control

The provisions identified in ASME NQA-1, Part 1, Requirement 6, shall apply. The Quality Assurance Program shall detail measures to control the preparation, review, issuance, use, approval and distribution of all documents related to quality as identified in the applicants Quality Assurance Program. Revisions shall meet the same requirements as the originals unless the applicant specifies other measures within their program. Measures shall ensure the latest approved documents represent the repair/replacement activities performed.

g) Control of Purchased Material, Items, and Services

The provisions identified in ASME NQA-1, Part 1, Requirement 7 shall apply, except:

1) Procurement of Authorized Inspection Agency services is not applicable as specified in paragraph 507.

2) The decision to perform bid evaluation as described in paragraph 300 is the responsibility of the "NR" Certificate Holder.

3) For Certificates of Conformance specified in paragraph 503 changes, waivers, or deviations including resolution of non-conformances must meet the requirements of ASME Section III and this Section.

4) The provisions identified in ASME NQA-1, Part 1, Requirement 7, paragraph 700 are not applicable to this section.

5) Documentary evidence for items shall conform to the requirements of ASME Section III, NCA and this Section. Materials shall meet the material certification requirements as specified in ASME Section III, NCA-3800 or NCA-3970 as applicable. Documented evidence for ASME stamped items is

satisfied by a Manufacturer's Data Report. Utilization of unqualified source material shall meet the requirements of ASME Section III, NCA-3855.5.

6) The "NR" Certificate Holder may obtain items from an owner, provided the owner provides the required documentation and items are identified to meet Code and the Certificate Holders Quality Assurance Program. The "NR" Certificate Holder shall not be required to audit the owner as an approved supplier, provided the items used are exclusively for the owner and the owner procured and controlled the items under the owner's Quality Assurance Program.

7) The Quality Assurance Program shall establish controls to ensure all purchased materials, items, and services conform to the requirements of the owner's design specifications and the code of construction Edition/Addenda used to perform the work. Materials shall meet the requirements specified in ASME Section III, NCA-3800 or NCA-3970 as applicable.

h) Identification and Control of Items

The provisions identified in ASME NQA-1, Part 1, Requirement 8, shall apply and include the following additional requirements.

1) Controls shall assure only correct and acceptable items, parts and components are used or installed when performing repair/replacement activities.

2) Welding, brazing and fusing materials shall be identified and controlled.

3) Required Certified Material Test Reports and Certificates of Conformance shall be received, traceable to the items, reviewed to comply with the material specification and found acceptable.

4) The "NR" Certificate Holder shall utilize checklists to identify required characteristics using accepted procedures, compliance with records received, results of examinations and tests performed, range of valves when required, and spaces for inclusion of document numbers and revision levels, signatures initials / stamps and dates of examinations or tests performed, verified, and/or witnessed by the "NR" Certificate Holder's qualified Representative and Authorized Nuclear Inspector.

i) Control of Processes

The provisions identified in ASME NQA-1, Part 1, Requirement 9, shall apply. Documents used to control processes shall include spaces for signatures, initials, stamps and dates that activities were performed by the Certificate Holder's representative and the Authorized Nuclear Inspector when the processes conforms to the specified acceptance criteria as listed on drawings, procedures, instructions, specifications or other appropriate documents including revisions.

j) Examinations, Tests and Inspections

The provisions identified in ASME NQA-1, Part 1, Requirement 10, shall apply, except paragraph 700 for inspections during operations is not required.

1) A repair/replacement plan shall be described in the Quality Assurance Manual that addresses required information to perform the work needed for repair/replacement activities. Spaces shall be included for mandatory hold points where witnessing is required by the "NR" Certificate Holder's Qualified Representative, the Authorized Nuclear Inspector or the owner's representative, if required. Work shall not proceed beyond designated mandatory hold points without documented consent as appropriate.

2) The following guidance is provided for information to be included within the repair/replacement plan:

a. A detailed description of repair/replacement activities to be performed;

b. Describe any defects and examination methods used to detect the defects;

c. Defect removal method and requirements for identifying reference points;

d. Any procedures including revisions utilized; (e.g. welding, brazing, heat treat, examination, testing) and material requirements;

e. Required documentation and stamping; and

f. Acceptance criteria used to verify acceptability.

3) Repair/Replacement plans and evaluations shall be subject to review by the Jurisdictional and Regulatory Authority when required.

k) Test Control

The provisions identified in ASME NQA-1, Part 1, Requirement 11 shall apply. Testing shall be performed in accordance with written test procedures with acceptance criteria clearly defined. Pre-requisites for performing each test to include calibration, equipment, trained personnel,environmental conditions and provisions for data acquisition shall be described. Test results shall be documented and evaluated by qualified personnel.

l) Control of Measuring and Test Equipment

The provisions identified in ASME NQA-1, Part 1, Requirement 12 shall apply.

1) The "NR" Certificate Holder may perform periodic checks on equipment to determine calibration is maintained. When periodic checks are used the method and frequency shall be included in the "NR" Certificate Holder's Quality Assurance Program and if discrepancies are found, shall be resolved to the prior periodic check.

2) The "NR" Certificate Holder may accept accreditation for calibration activities by National Voluntary Laboratory Accreditation Program (NVLAP), American Association for Laboratory Accreditation (A2LA) or other accrediting body recognized by NVLAP through the International Laboratory Accreditation Cooperation (ILAC) mutual recognition arrangement (MRA) provided the following requirements are met:

a. Accreditation is to ANSI/ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories";

b. Scope of the accreditation for the calibration laboratory covers needed measurement parameters, ranges and uncertainties;

c. "NR" Certificate Holder shall specify that calibration reports shall include, laboratory equipment/standards used and as found and as left data;

d. The "NR" Certificate Holder shall verify conformance to the requirements of this process; and

e. Utilization of this process shall be described and documented in the "NR" Certificate Holders QAM.

m) Handling, Storage and Shipping

The provisions of ASME NQA-1, Part 1, and Requirement 13 shall apply.

n) Quality Assurance Records

The provisions identified in ASME NQA-1, Part 1, Requirement 17, shall apply, except Paragraphs 400, 500, and 600 are not applicable. The following requirements shall be followed:

1) Records shall be identifiable and retrievable;

2) Records shall be retained consistent with the owners requirements for duration, location and assigned responsibility;

3) Forms NR-1 and NVR-1 as applicable shall be completed by the "NR" Certificate Holder upon completion of all repair/replacement activities. Completion of forms, registrations and stamping of the "NR" symbol stamp shall meet the requirements of NBIC Part 3, Section 5; and

4) Lifetime and non-permanent records shall be as specified in ASME Section III, NCA-4134, Tables NCA-4134.17-1, and 4134.17-2.

5) Radiographs (digital images or film) may be reproduced provided that:

   a. The process shall be subject to owner's approval;

   b. The "NR" Certificate Holder is responsible for the process used and shall include a system for controlling and monitoring the accuracy so that the image will provide the same information as the original; and

   c. Procedures shall contain requirements for exposure scanning, focusing, contrast, resolution and distinguishing film artifacts as applicable for reproduced images.

6) Records shall be classified, maintained and indexed and shall be accessible to the owner, owner's designee, and the Authorized Nuclear Inspector.

7) When the "NR" Certificate Holder is the owner, designated records and reports received by the owner, shall be filed and maintained in a manner to allow access by the Authorized Nuclear Inservice Inspector. Suitable protection from deterioration and damage shall be provided by the owner. All records and reports shall be retained as specified in the owners QAP for the lifetime of the component or system.

o) Corrective Action

The provisions identified in ASME NQA-1, Part 1, Requirement 16 shall apply.

1) Measures shall be established to ensure that conditions adverse to quality such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and other non-conformances are promptly identified and corrected.

2) In the case of significant conditions adverse to quality, the measures shall also ensure that the cause of these conditions be determined and corrected to preclude repetition. The identification of significant conditions adverse to quality, the cause, condition, and the corrective action taken shall be documented and reported to the appropriate levels of management.

3) These requirements shall also extend to the performance of subcontractors' corrective action measures.

p) Inspection or Test Status (not to include operating status)

The provisions identified in ASME NQA-1, Part 1, Requirement 14 shall apply. Measures shall be established to indicate inspection and test status of parts, items, or components during the repair/replacement activity. The system used shall provide positive identification of the part, item, or component by means of stamps, labels, routing cards, or other acceptable methods. The system shall include any procedures or instructions necessary to achieve compliance. Procedures shall be provided for the identification of acceptable and unacceptable items and for the control of status indicators. The authority for application and removal of status indicators shall also be specified.

q) Nonconforming Materials or Items

The provisions identified in ASME NQA-1, Part 1, Requirement 15 shall apply. Measures shall be established to control materials or items that do not conform to requirements to prevent their inadvertent use, including measures to identify and control the proper installation of items and to preclude nonconformance with the requirements of these rules These measures shall include procedures for identification, documentation, segregation when practical, and disposition. Nonconforming items shall be reviewed for acceptance, rejection, or repair in accordance with documented procedures. The responsibility and authority for the disposition of nonconforming items shall be defined. Repaired or replaced items shall be re-examined in accordance with the applicable procedures. Measures that control further processing of a nonconforming or defective item, pending a decision on its disposition, shall be established and maintained. Ultimate disposition of nonconforming items shall be documented.

r) Audits

The provisions identified in ASME NQA-1, Part 1, and Requirement 18 shall apply and shall include the following:

A comprehensive system of planned and periodic internal audits shall be performed by the “NR” Certificate Holder. Audit frequency shall be specified in the organization’s Quality Assurance Manual. Audits shall be conducted at least annually for any ongoing code activity to verify compliance with Quality Assurance Program requirements, performance criteria and to determine the effectiveness of the Quality Assurance Program. When no code work has been performed, the required annual audit need only include those areas of responsibility required to be continually maintained such as training, audits, organizational structure, and Quality Assurance Program revisions. The Quality Assurance Manual shall as a minimum describe the following:

1) Audits shall be performed in accordance with written procedures or checklists by qualified audit personnel not having direct responsibility in areas being audited;

2) Audit personnel shall be qualified in accordance with the current requirements of ASME NQA-1;

3) Audit results shall be documented and reviewed by responsible management;

4) Requirements for follow-up actions shall be specified for any deficiencies noted during the audit;

5) Audit records and applicable documentation shall be made available to the Authorized Nuclear Inspector for review;

6) Audit records shall include as a minimum;

   a. Written procedures;

   b. Checklists;

   c. Reports;

   d. Written replies; and

   e. Completion of corrective actions.

s) Authorized Nuclear Inspector

Measures shall be taken to reference the commissioned rules for National Board Authorized Nuclear Inspector, in accordance with NB-263 *Rules for National Board Inservice and New Construction Commissioned Inspectors*. The “NR” Certificate Holder shall ensure that the latest documents including the Quality Assurance Manual, procedures and instructions are made available to the Authorized Nuclear Inspector. The Authorized Nuclear Inspector shall be consulted prior to the issuance of a repair/replacement plan by the “NR” Certificate Holder in order that the Authorized Nuclear Inspector may select any in-process inspection or hold points when performing repair/replacement activities. The "NR" Certificate Holder shall keep the Authorized Nuclear Inspector informed of progress of the repair/replacement activity so that inspections may be performed. The Authorized Nuclear Inspector shall not sign Form NR-1 or Form NVR-1, as applicable, unless satisfied that all work carried out is in accordance with this Section. The Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor shall have access to areas where work is being performed including subcontractors facilities in order to perform their required duties. The ANI shall be involved in dispositions and verification for non-conformances and corrective actions involving quality or code requirements.

t) Exhibits

Forms and exhibits referenced in the Quality Assurance Manual shall be explained in the text and included as part of the referencing document or as an appendix to the Quality Assurance Manual. Forms shall be controlled and identified to show the latest approved revision, name, and other corresponding references as stated in the Quality Assurance Manual.

## (15) 1.8.7 QUALITY ASSURANCE PROGRAM REQUIREMENTS FOR CATEGORY 2 ACTIVITIES

### (15) 1.8.7.1 SCOPE

Owners or organizations other than owners shall have a written Quality Assurance Program meeting one of the criteria specified in Table 1.8.2 of this section. Organizations applying for a Category 2 "NR" *Certificate of Authorization* shall specify in their written Quality Assurance Program which program criteria their Quality Assurance Program follows. Owners shall have a Quality Assurance Program meeting the requirements of either 10 CFR 50, Appendix B or NQA-1 Part 1 and shall include the additional requirements specified in ASME Section XI, IWA-4142 when applicable. Organizations other than the owner shall comply with requirements specified in either 10 CFR 50, Appendix B supplemented as needed with the owner's QAP; NQA-1 Part 1; or NCA-4000. Organizations may elect to choose to follow all the rules specified in one of the allowed QAP criteria specified in Table 1.8.2 or they may elect to combine or supplement requirements from other specified QAP's. When organizations elect to combine QAP requirements, it shall be clearly specified and understood in the QAM which QAP requirement is being followed for each activity specified in their QAM. The following quality elements shall be specified and described within the QAM.

### (15) 1.8.7.2 QUALITY PROGRAM ELEMENTS

a) Organization

The authority and responsibility for individuals involved in activities affecting quality shall be clearly established and documented throughout the Quality Assurance Program and identified on a functional organizational chart contained within the QA Manual.

b) Quality Assurance Program (QAP)

1) Qualification of non-destructive examination personnel shall be as required by the code or as specified in the owner's Quality Assurance Program.

2) Prior to returning an item to service, the owner shall evaluate the suitability of the item subjected to the repair/replacement activity. Corrective actions shall be taken when an item is determined to be deficient or does not satisfy the requirements of this section.

3) The "NR" Certificate Holder shall provide a copy of the Quality Assurance Manual to the owner for review and acceptance. The "NR" Certificate Holder shall make a current controlled copy of the Quality Assurance Manual available to the Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor. When a repair/replacement activity is split between the owner and an "NR"

Certificate Holder, each Quality Assurance Program shall comply with this section for their respective activities. The owner shall establish interfaces for assuring this section is met for the two Quality Assurance Programs.

4) The “NR” Certificate Holder shall be responsible for advising the Authorized Nuclear Inspection Agency of proposed changes to the Quality Assurance Manual to obtain acceptance of the Authorized Nuclear Inspector Supervisor before putting such changes into effect. The Certificate Holder shall be responsible for notifying the Authorized Nuclear Inspector of QAM changes, including evidence of acceptance by the Authorized Nuclear Inspector Supervisor.

5) The Quality Assurance Manual need not be in the same format or sequential arrangement as the requirements in these rules as long as all applicable requirements have been covered.

6) The “NR” Certificate Holder shall implement and maintain a program for qualification, indoctrination, training and maintaining proficiency of personnel involved with quality functions, including personnel of subcontracted services.

7) The “NR” Certificate Holder shall address in their QAM the requirements for interfacing with the owner specified in 1.8.9 of this section.

c) Design Control

1) Repair/replacement activities, code edition and addenda used shall correspond with the owner’s Inservice Inspection Program unless later code editions and addenda have been accepted by the owner, the Enforcement and/or the Regulatory authority having jurisdiction at the plant site.

2) The repair/replacement plan [see 1.8.7.2 j)] shall identify expected life of the item when less than the intended life as specified in the owner’s requirements and the owner shall be advised of the condition.

3) The “NR” Certificate Holder shall assure that specifications, drawings, procedures and instructions do not conflict with the owner’s requirements. A system must be described in the Quality Assurance Manual to resolve or eliminate such conflicts. Resolution shall consider the design specification requirements, as well as, the owner Requirements, Jurisdictional and Regulatory requirements as applicable.

4) ASME Section XI establishes that the owner is responsible for design in connection with repair/replacement activities. The “NR” Certificate Holder must ensure that the design specification, drawings, or other specifications or instructions furnished by the owner satisfy the code edition and addenda of the owner’s requirements. To satisfy this requirement, the “NR” Certificate Holder shall establish requirements that correctly incorporate the owner’s requirements into their specifications, drawings, procedures, and instructions, which may be necessary to carry out the work. The “NR” Certificate Holder’s system shall include provisions to ensure that the appropriate quality standards are specified and included in all quality records. These records shall be reviewed for compliance with the owner’s requirements and the requirements of ASME Section XI.

d) Procurement Document Control

Procurement documents shall require suppliers to provide a Quality Assurance Program consistent with the applicable requirements of ASME Section III, NCA and this section. Documents for procurement of materials, items, and subcontracted services shall include requirements to the extent necessary to ensure compliance with the owner’s requirements and IWA-4000 of ASME Section XI. To the extent necessary, procurement documents shall require suppliers to maintain a Quality Assurance Program consistent with the applicable requirements of the edition and addenda of the code of construction to which the items are constructed. Measures shall be established to ensure that all purchased material, items, and services conform to these requirements.

e) Procedures and Drawings

Repair/replacement plans and any verification of acceptability (evaluations) shall be subject to review by Jurisdiction and Regulatory Authorities having jurisdiction at the plant site. Activities affecting quality shall be prescribed by documented instructions, procedures or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative and qualitative criteria for determining that activities affecting quality have been satisfactorily accomplished. The "NR" Certificate Holder shall maintain a written description of procedures, instructions, or drawings used by the organization for control of quality and examination requirements detailing the implementation of the Quality Assurance Program requirements. Copies of these procedures shall be readily available to the Authorized Nuclear Inspector and Authorized Nuclear Inservice Inspector, as applicable.

f) Document Control

The program shall include measures to control the issuance, use, and disposition of documents, such as specifications, instructions, procedures, and drawings, including changes thereto. These measures shall ensure that the latest applicable documents, including changes, are reviewed for adequacy and approved for release by authorized personnel and distributed for use at the location where the prescribed activity is performed.

g) Control of Purchased Material, Items, and Services

When the owner performs repair/replacement activities, purchase of materials and small products shall meet the requirements specified in ASME Section XI, IWA 4142. Measures shall be established to ensure that purchased material, items, and services conform to the owner's requirements and applicable edition and addenda of the code of construction and ASME Section XI. These measures shall include identification for material traceability. Provisions shall be identified for source evaluation and objective evidence shall be provided evidencing quality standards for material examination upon receipt.

h) Identification and Control of Items

1) Measures shall be established for identification and control of material and items, including partially fabricated assemblies. These measures shall ensure that identification is maintained and traceable, either on the material or component, or on records throughout the repair/replacement activity. These measures shall be designed to prevent the use of incorrect or defective items and those which have not received the required examinations, tests, or inspections.

2) Identification for traceability shall be applied using methods and materials that are legible and not detrimental to the component or system involved. Such identification shall be located in areas that will not interfere with the function or quality aspects of the item.

3) Certified Material Test Reports shall be identified as required by the applicable material specification in ASME Section II and shall satisfy any additional requirements specified in the original code of construction. The Certified Material Test Report or Certificate of Compliance need not be duplicated for submission with compliance documents when a record of compliance and satisfactory reviews of the Certified Material Test Report and Certificate of Compliance is provided. Quality documents shall provide a record that the Certified Material Test Report and Certificate of Compliance have been received, reviewed, and found acceptable. When the "NR" Certificate Holder authorizes a subcontracted organization to perform examinations and tests in accordance with the original code of construction, the "NR" Certificate Holder shall certify compliance either on a Certified Material Test Report or Certificate of Compliance that the material satisfies the original code of construction requirements.

i) Control of Processes

1) The “NR” Certificate Holder shall operate under a controlled system such as process sheets, checklists, travelers, plans or equivalent procedures. Measures shall be established to ensure that processes such as welding, nondestructive examination, and heat treating are controlled in accordance with the rules of the applicable section of the ASME Code and are accomplished by qualified personnel using qualified procedures.

2) Process sheets, checklists, travelers, or equivalent documentation shall be prepared, including the document numbers and revisions to which the process conforms with space provided for reporting results of completion of specific operations at checkpoints of repair/replacement activities.

j) Examinations, Tests and Inspections

1) A repair/replacement plan shall be prepared in accordance with the Quality Assurance Program whenever repair/replacement activities are performed. As a minimum, the repair/replacement plan shall include the requirements specified in ASME Section XI, IWA-4150.

2) In-process and final examinations and tests shall be established to ensure conformance with specifications, drawings, instructions, and procedures which incorporate or reference the requirements and acceptance criteria contained in applicable design documents. Inspection, test and examination activities to verify the quality of work shall be performed by persons other than those who performed the activity being examined. Such persons shall not report directly to the immediate supervisors responsible for the work being examined.

3) Process sheets, travelers, or checklists shall be prepared, including the document numbers and revision to which the examination or test is to be performed, with space provided for recording results.

4) Mandatory hold/inspection points at which witnessing is required by the “NR” Certificate Holder’s representative or the Authorized Nuclear Inspector/Authorized Nuclear Inservice Inspector shall be indicated in the controlling documents. Work shall not proceed beyond mandatory hold/inspection points without the consent of the “NR” Certificate Holder’s representative or the Authorized Nuclear Inspector/Authorized Nuclear Inservice Inspector, as applicable.

k) Test Control

1) Testing shall be performed in accordance with the owner’s written test procedures that incorporate or reference the requirements and acceptance criteria contained in applicable design documents.

2) Test procedures shall include provisions for ensuring that prerequisites for the given test have been met, that adequate instrumentation is available and used, and that necessary monitoring is performed. Prerequisites may include calibrated instrumentation, appropriate equipment, trained personnel, condition of test equipment, the item to be tested, suitable environmental conditions, and provisions for data acquisition.

3) Test results shall be documented and evaluated to ensure that test requirements have been satisfied.

l) Control of Measuring and Test Equipment

Measures shall be established and documented to ensure that tools, gages, instruments, and other measuring and testing equipment and devices used in activities affecting quality are of the proper range, type, and accuracy to verify conformance to established requirements. A procedure shall be in effect to ensure that they are calibrated and properly adjusted at specified periods or use intervals to maintain accuracy within specified limits. Calibration shall be traceable to known national standards, where these standards exist, or with the device manufacturer’s recommendation.

m) Handling, Storage and Shipping

Measures and controls shall be established to maintain quality requirements for handling, storage, and shipping of parts, materials, items, and components.

n) Quality Assurance Records

Documentation, reports and records shall be in accordance with ASME Section XI, IWA-6000.

1) The owner is responsible for designating records to be maintained. Measures shall be established for the "NR" Certificate Holder to maintain these records [See 1.8.7.2 n) 2)] required for Quality Assurance of repair/replacement activities. These shall include documents such as records of materials, manufacturing, examination, and test data taken before and during repair/replacement activity. Procedures, specifications, and drawings used shall be fully identified by pertinent material or item identification numbers, revision numbers, and issue dates. The records shall also include related data such as personnel qualification, procedures, equipment, and related repairs. The "NR" Certificate Holder shall take such steps as may be required to provide suitable protection from deterioration and damage for records while in his care. Also, it is required that the "NR" Certificate Holder have a system for correction or amending records that satisfies the owner's requirements. These records may be either the original or a reproduced, legible copy and shall be transferred to the owner at his request.

2) Records to be maintained as required in NBIC Part 3, 1.8.7.2 n) 1) above shall include the following, as applicable:

a. An index that details the location and individual responsible for maintaining the records;

b. Manufacturer's Data Reports, properly executed, for each replacement component, part, appurtenance, piping system, and piping assembly, when required by the design specification or the owner;

c. The required as-constructed drawings certified as to correctness;

d. Copies of applicable Certified Material Test Reports and Certificates of Compliance;

e. As-built sketch(es) including tabulations of materials repair/replacement procedures, and instructions to achieve compliance with ASME Section XI;

f. Nondestructive examination reports, including results of examinations, shall identify the ASNT, SNT-TC-1A, CP-189, or ACCP certification level of personnel interpreting the examination results. Final radiographs shall be included where radiography has been performed. Radiographs may be microfilmed or digitally reproduced. The accuracy of the reproduction process shall be verified and monitored for legibility, storage, retrievability and reproduction quality;

g. Records of heat treatments may be either the heat treatment charts or a summary description of heat treatment time and temperature data certified by the "NR" Certificate Holder. Heat treatments performed by the material manufacturer to satisfy requirements of the material specifications may be reported on the Certified Material Test Report; and

h. Nonconformance reports shall satisfy IWA-4000 of ASME Section XI and shall be reconciled by the owner prior to certification of the Form NR-1 or NVR-1, as applicable.

3) After a repair/replacement activity, all records including audit reports required to verify compliance with the applicable engineering documents and the "NR" Certificate Holder's Quality System Program, shall be maintained at a place mutually agreed upon by the owner and the "NR" Certificate Holder. The "NR" Certificate Holder shall maintain records and reports for a period of five years after completion of the repair/replacement activity.

4) When the “NR” Certificate Holder is the owner, designated records and reports received by the owner, shall be filed and maintained in a manner to allow access by the Authorized Nuclear Inservice Inspector. Suitable protection from deterioration and damage shall be provided by the owner. These records and reports shall be retained as specified in the owners QAP for the lifetime of the component or system.

5) The original of the completed Form NR-1 or Form NVR-1, as applicable, shall be registered with the National Board and, if required, a copy forwarded to the Jurisdiction where the nuclear power plant is located.

o) Corrective Action

1) Measures shall be established to ensure that conditions adverse toquality such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and other nonconformances are promptly identified, controlled and corrected.

2) In the case of significant conditions adverse to quality, the measures shall also ensure that the cause of these conditions be determined and corrected to preclude repetition. The identification of significant conditions adverse to quality, the cause, condition, and the corrective action taken shall be documented and reported to the appropriate levels of management.

3) Corrective action requirements shall also extend to the performance of subcontractors’ activities.

p) Inspection or Test Status (not to include operating status)

Measures shall be established to indicate examination and test status of parts, items, or components during the repair/replacement activity. The system used shall provide positive identification of the part, item, or component by means of stamps, labels, routing cards, or other acceptable methods. The system shall include any procedures or instructions necessary to achieve compliance. Also, measures shall be provided for the identification of acceptable and unacceptable items. They shall also include procedures for control of status indicators, including the authority for application and removal of status indicators.

q) Nonconforming Materials or Items

Measures shall be established to control materials or items that do not conform to requirements to prevent their inadvertent use, including measures to identify and control the proper installation of items and to preclude nonconformance with the requirements of these rules. These measures shall include procedures for identification, documentation, segregation, and disposition. Nonconforming items shall be reviewed for acceptance, rejection, or repair in accordance with documented procedures. The responsibility and authority for the disposition of nonconforming items shall be defined. Repaired/replaced or altered items shall be re-examined in accordance with the applicable procedures.

Measures that control further processing of a nonconforming or defective item, pending a decision on its disposition, shall be established and maintained. Ultimate disposition of nonconforming items shall be documented.

r) Audits

A comprehensive system of planned and periodic internal audits shall be performed by each organization, Audit frequency shall be specified in the organization’s Quality Assurance Manual. Audits shall be conducted at least annually to verify compliance with Quality Assurance Program requirements, performance criteria and to determine the effectiveness of the Quality Assurance Program. When no code work has been performed, the required annual audit need only include those areas of responsibility required to be continually maintained such as training, audits, organizational structure, Quality Assurance Program revisions, etc. The Quality Assurance Manual shall as a minimum describe the following:

1) Audits shall be performed in accordance with written procedures or checklists by qualified audit personnel not having direct responsibility in areas being audited;

2) Audit personnel shall be qualified in accordance with the current requirements of NQA-1;

3) Audit results shall be documented and reviewed by responsible management;

4) Requirements for follow-up actions for any deficiencies noted during the audit;

5) Audit records and applicable documentation shall be made available to the Authorized Nuclear Inspector for review;

6) Audit records shall include as a minimum:

   a. written procedures;

   b. checklists;

   c. reports;

   d. written replies; and

   e. completion of corrective actions.

s) Authorized Nuclear Inspector

Measures shall be taken to reference the commissioned rules for National Board Authorized Nuclear Inspector, in accordance with NB-263 *Rules for National Board Inservice and New Construction Commissioned Inspectors*. The "NR" Certificate Holder shall ensure that the latest documents including the Quality Assurance Manual, procedures and instructions are made available to the Authorized Nuclear Inspector. The Authorized Nuclear Inspector shall be consulted prior to the issuance of a repair/replacement plan by the "NR" Certificate Holder in order that the Authorized Nuclear Inspector may select any in process inspection or hold points when performing repair/replacement activities. The "NR" Certificate Holder shall keep the Authorized Nuclear Inspector informed of progress of the repair/replacement activity so that inspections may be performed. The Authorized Nuclear Inspector shall not sign Form NR-1 or Form NVR-1, as applicable, unless satisfied that all work carried out is in accordance with this section. The Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor shall have access to areas where work is being performed including subcontractors facilities in order to perform their required duties. The ANI shall be involved in dispositions and verification for nonconformances and corrective actions involving quality or code requirements.

t) Exhibits

Forms and exhibits referenced in the Quality Assurance Manual shall be explained in the text and included as part of the referencing document or as an appendix to the Quality Assurance Manual. Forms shall be controlled and identified to show the latest approved revision, name, and other corresponding references as stated in the Quality Assurance Manual.

## (15) 1.8.8 QUALITY ASSURANCE PROGRAM REQUIREMENTS FOR CATEGORY 3 ACTIVITIES

### (15) 1.8.8.1 SCOPE

Organizations requesting a Category 3 "NR" *Certificate of Authorization* may elect to follow the requirements specified in ASME NQA-1 Part 1 or follow specific Quality Assurance Program requirements outlined in other specified standards as required by the owner, Regulatory Authority or Jurisdiction. Organizations shall specify in the QAM what QAP requirements are followed. When standards other than ASME NQA-1 are followed, the organization shall have available a copy of that standard for review by the NB Survey Team and the ANIA, as applicable. Each organization shall, as a minimum, include in their written QAM the specified elements listed in Category 1 and/or 2 (1.8.6, 1.8.7) QAP requirements. Additional requirements, as specified within NBIC Part 3, 1.8.8 and 1.8.9 shall be included within the QAP. Also, limitations or additions to ASME NQA-1, as specified for Category 1 or 2 may be incorporated and referenced within the QAM.

### 1.8.8.2 QUALITY PROGRAM ELEMENTS

a) Organization

Persons and organization shall have authority and freedom to identify quality problems; initiate, recommend or provide solutions and verify implementation of solutions.

b) QAP

Shall account for special controls, processes, test equipment, tools and skills to obtain quality and for verification of quality by inspections and tests. Indoctrination, training and maintaining proficiency of personnel effecting quality shall be described. The status and adequacy of the QAP shall be regularly reviewed. The scope shall be included within the written QAM. The “NR” Certificate Holder shall make a current controlled copy of the Quality Assurance Manual available to the Authorized Nuclear Inspector and Authorized Nuclear Inspector Supervisor. The “NR” Certificate Holder shall address in their QAM the requirements for interfacing with the owner specified in 1.8.9 of this section.

c) Design Control

Established measures to assure approximate quality standards are specified and included in design documents. Any deviations shall be identified and controlled.

d) Document Control

Documents for procurement of material, equipment and services shall ensure regulatory requirements, design bases and other quality requirements and are included or referenced. Procurement documents shall require contractors or subcontractors provide a Quality Assurance Program consistent with the provisions specified in this NBIC Part 3, 1.8.8.

e) Instructions, Procedures and Drawings

Activities affecting quality shall be accomplished in accordance with prescribed instructions, procedures or drawings and shall include approximate quantitative or qualified acceptance criteria to determine activities are satisfactorily accomplished.

f) Document Control

Shall define measures to control the preparation, issuance, use, approval, revisions and distribution of all documents related to quality.

g) Control of Purchases, Materials, Items and Services

Purchased material, items and services shall conform to the procurement documents. Measures shall be established for source evaluation and selection, objective evidence of quality, inspections at the source and examination of products upon delivery. Effectiveness of quality shall be assessed by the applicant or designee at specified intervals.

h) Identification and Control of Items

Specified controls shall ensure only correct and acceptable items, parts and components are used and installed.

Control of Processes

Documents used to control processes and conform to specified acceptance criteria shall include spaces for signatures, initials, stamps and dates for activities performed by the Certificate Holders' representative and the Authorized Nuclear Inspector.

i) Examinations, Tests and Inspections

A repair / replacement plan shall address all required information for performing examinations, tests and inspections including but not limited to:

1) Establishing hold points

2) Identifying procedures, methods, acceptance criteria

3) Defects identified, removal methods, welding and material requirements, reference points used for identification

4) Evaluations of results

j) Test Control

Tests performed to written procedures identifying acceptance limits, calibration, equipment, personnel qualifications, environmental conditions, and documentation required.

k) Control of Measuring and Test Equipment

Procedures, methods and frequency of calibration shall be described for all types of measuring and test equipment used to verify quality. Any discrepancies shall be identified and resolved.

l) Handling, Storage and Shipping

Processes or procedures shall be established to prevent damage, deterioration or misuse of material, items or components used and stored.

m) Records

All quality related records shall be classified, identified, verified, maintained, distributed, retraceable, and accessible. When the "NR" Certificate Holder is the owner, designated records and reports received by the owner, shall be filed and maintained in a manner to allow access by the Authorized Nuclear Inservice Inspector (ANII). Suitable protection from deterioration and damage shall be provided by the owner. These records and reports shall be retained as specified in the owner's QAP for the lifetime of the component or system.

n) Corrective Action

Measures established to assure conditions adverse to quality are promptly identified and corrected and action taken to preclude repetition.

o) Inspection or Test Status

Measures shall be established to indicate inspection and test status of parts, items or components during repair/replacement activity. Measures shall include identification, procedures, control indicators (acceptable, unacceptable) and responsibility of personnel.

p) Nonconforming Material or Items

Measures to control material or items, nonconforming to specified criteria shall be established. Measures shall include identifying, controlling, documenting, reviewing, verifying, dispositioning and segregation when practical.

q) Audits

A system of planned and periodic audits shall be established to verify compliance of the Quality Assurance Program. Audits shall include; written procedures, checklists, trained/qualified personnel not having direct responsibility for areas being audited, documentation, review by management and follow up actions when required.

r) Authorized Nuclear Inspector

Qualifications and duties shall be as specified in ASME QAI-1 and NB-263 for the Authorized Inspection Agencies, Authorized Nuclear Inspector and the Authorized Nuclear Inspector Supervisor. Additional requirements are specified in Sections 1.8.6.2 s), 1.8.7.2 s), and 1.8.9.

s) Exhibits

Quality related forms and exhibits described in the Quality Assurance Program shall be identified, controlled and where applicable included as a reference document within the QAM or referenced procedures.

## 1.8.9 INTERFACE WITH THE OWNER'S REPAIR/REPLACEMENT PROGRAM (FOR CATEGORIES 1, 2, AND 3 AS APPLICABLE) (15)

Interface with the owner's repair/replacement program shall meet the following:

a) The "NR" Certificate Holder's repair/replacement plan shall be subject to the acceptance of the owner and the owner's Authorized Nuclear Inservice Inspector (ANII) and shall be subject to review by the Jurisdiction and Regulatory Authorities having jurisdiction at the plant site.

b) Repair/Replacement activities of nuclear components shall meet the requirements of ASME Section III, ASME Section XI, and/or other applicable standard, and the owner's requirements, and shall be subject to verification by the Jurisdiction and Regulatory Authorities having jurisdiction at the plant site.

c) Documentation of the repair/replacement activities of nuclear components shall be recorded on the Report of Repair/Replacement Activities of Nuclear Components and Systems for Nuclear Facilities, Form NR-1, or Report of Repair/Replacement Activities for Nuclear Pressure Relief Devices, Form NVR-1, in accordance with the NBIC Part 3, Section 5. The completed forms shall be signed by a representative of the "NR" Certificate Holder and the Authorized Nuclear Inspector when the repair/replacement activity meets the requirements of this section. For repair/replacement activities that involve design changes, Form NR-1, or Form NVR-1, as applicable, shall indicate the organization responsible for the design or design reconciliation in accordance with the owner's requirements.

d) The "NR" Certificate Holder shall provide a copy of the signed Form NR-1 or Form NVR-1, as appli cable, to the owner, the Enforcement, and the Regulatory Authority if required, and the Authorized Nuclear Inspection Agency. The original Form NR-1 or Form NVR-1, as applicable, shall be registered with the National Board by the "NR" Certificate Holder. A NB registration log shall be maintained by the "NR" Certificate Holder. See NBIC Part 3, Section 5.5 and 5.6.

e) The "NR" Certificate Holder shall provide a nameplate/stamping for repair/replacement activities for each nuclear component unless otherwise specified by the owner's Quality Assurance Program. The required information and format shall be as shown in NBIC Part 3, Section 5.

# PART 3, SECTION 2
# REPAIRS AND ALTERATIONS — WELDING AND HEAT TREATMENT

## 2.1 SCOPE

This section provides general and specific requirements for welding and heat treating when performing welded repairs and alterations to pressure-retaining items. Careful consideration shall be given to pressure-retaining items that have been fabricated of either creep strength enhanced ferritic materials or ferritic materials enhanced by heat treatment. The tensile and creep strength properties of these materials can be degraded by not following specific welding and heat treatment requirements. The user is cautioned to seek technical guidance for welding and heat treating requirements in accordance with the original code of construction.

## 2.2 WELDING

Welding shall be performed in accordance with the requirements of the original code of construction used for the pressure-retaining item whenever possible.

### 2.2.1 WELDING PROCEDURE SPECIFICATIONS

Welding shall be performed in accordance with Welding Procedure Specifications (WPS) qualified in accordance with the original code of construction or the construction standard or code selected. When this is not possible or practicable, the WPS may be qualified in accordance with ASME Section IX.

### 2.2.2 STANDARD WELDING PROCEDURE SPECIFICATIONS (SEE NBIC PART 3, 2.3)

An “R” Certificate Holder may use one or more applicable Standard Welding Procedure Specifications (SWPS) shown in NBIC Part 3, Table 2.3 without supporting Procedure Qualification Records (PQRs) since SWPS are pre-qualified.

### 2.2.3 PERFORMANCE QUALIFICATION

Welders and welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction, the construction standard, code selected or ASME Section IX. Use of a Standard Welding Procedure Specification shown in NBIC Part 3, 2.3 is permitted for performance qualification testing.

### 2.2.4 WELDING RECORDS

The “R” Certificate Holder shall maintain a record of the results obtained in Welding Procedure Qualifications, except for those qualifications for which the provisions of NBIC Part 3, 2.2.2 are used and of the results obtained in welding performance qualifications. These records shall be certified by the “R” Certificate Holder and shall be available to the Inspector.

### 2.2.5 WELDER’S IDENTIFICATION

The “R” Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The “R” Certificate Holder shall also establish a written procedure whereby welded joints are identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and be acceptable to the Inspector. The welder’s or welding operator’s identification mark may be stamped (low stress stamp) adjacent to welded joints made by the individual, or the "R" Certificate Holder may keep a documented record of welded joints and the welders or welding operators used in making the joints.

### 2.2.6 WELDER'S CONTINUITY

The performance qualification of a welder or welding operator shall be affected when one of the following conditions occur:

a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire; or

b) When there is specific reason to question a welder's ability to make welds that meet the specification, the qualification which supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.

### 2.2.6.1 WELDER'S CONTINUITY RECORDS

a) The "R" Certificate Holder shall maintain a welding continuity record and shall make the record available to the Inspector.

b) The method of recording welding continuity and the record retention period shall be described in the "R" Certificate Holder's Quality System Manual.

c) When there is specific reason to question a welder's ability to make welds that meet the specification, the qualification which supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.

### 2.3 STANDARD WELDING PROCEDURE SPECIFICATIONS

One or more SWPSs from NBIC Part 3, Table 2.3 may be used as an alternative to one or more WPS documents qualified by the organization making the repair or alteration, provided the organization accepts by certification (contained therein) full responsibility for the application of the SWPS in conformance with the application as stated in the SWPS. When using SWPSs, all variables listed on the Standard Welding Procedure are considered essential and, therefore, the repair organization cannot deviate, modify, amend, or revise any SWPSs. US Customary Units or metric units may be used for all SWPSs in NBIC Part 3, Table 2.3, but one system shall be used for application of the entire SWPS in accordance with the metric conversation table contained in the SWPS. The user may issue supplementary instructions as allowed by the SWPS. Standard Welding Procedures Specifications shall not be used in the same product joint together with the other Standard Welding Procedure Specifications or other welding procedure specifications qualified by the organization.

The AWS reaffirms SWPSs in accordance with ANSI procedures. When reaffirmation occurs without revision to the SWPS, the letter "R" is added to the SWPS designation following the year. Such designation is considered to be identical with the previously published version and may be used pending incorporation herein, on the same basis as the version listed in NBIC Part 3, Table 2.3.

## TABLE 2.3

### CARBON STEEL — (P1 MATERIALS)

| SMAW — Shielded Metal Arc Welding | |
|---|---|
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel, (M-1/P-1, Group 1 or 2), 3/16 in. (5 mm) through 3/4 in. (19 mm), in the As-Welded Condition, With Backing. | B2.1.001-90 and B2.1-1-001: 90(R2006) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E7018, As-Welded or PWHT Condition. | B2.1-1-016-94 and B2.1-1-016-94R |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E6010, As-Welded or PWHT Condition. | B2.1-1-017-94 and B2.1-1-017-94R |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E6010 (Vertical Uphill) followed by E7018, As-Welded or PWHT Condition. | B2.1-1-022-94 and B2.1-1-022-94R |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E6010 (Vertical Downhill) followed by E7018, As-Welded or PWHT Condition. | B2.1-1-026-94 and B2.1-1-026-94R |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, E6010 (Vertical Downhill) followed by E7018, (Vertical Uphill) As-Welded Condition, Primarily Pipe Applications. | B2.1-1-201-96, and B2.1-1-201-96(R2007) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) thick, E6010 (Vertical Downhill) followed by E7018 (Vertical Uphill), As-Welded Condition, Primarily Pipe Applications. | B2.1-1-202-96(R2007) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, E6010 (Vertical Uphill), As-Welded Condition, Primarily Pipe Applications. | B2.1-1-203-96 and B2.1-1-203-96(R2007) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, E6010 (Vertical downhill root with balance vertical uphill), As-Welded Condition, Primarily Pipe Applications. | B2.1-1-204-96 and B2.1-1-204-96(R2007) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E6010 (Vertical Uphill) followed by E7018 (Vertical Uphill), As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-205-96 and B2.1-1-205-96(R2007) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, E6010 (Vertical Downhill) followed by E7018 (Vertical Uphill), As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-206-96 and B2.1-1-206-96(R2007) |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, E7018, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-208-96 |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through1 ½ in. (38 mm) Thick, E7018, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-208-96(R2007) |
| GTAW — Gas Tungsten Arc Welding | |

| | |
|---|---|
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel, (M-1/P-1, Group 1 or 2), 3/16 in. (5 mm) through 7/8 in. (22 mm) Thick, in the As-Welded Condition, With or Without Backing. | B2.1-002-90, B2.1-002-90(R2006) and B2.1-1-002-90R |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Application. | B2.1-1-207-96 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½in. (38 mm) Thick, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Application. | B2.1-1-207-96 (R2007) |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding (Consumable Insert) of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, INMs1 and ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Application. | B2.1-1-210-96 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding with Consumable Insert Root of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1-1/2 in. (38 mm) Thick, INMs-1, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-210:2001 |
| **FCAW — Flux Core Arc Welding** | |
| Standard Welding Procedure Specification for Self-Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E71T-8, As-Welded Condition. | B2.1-1-018-94 and B2.1-1.018-94R |
| Standard Welding Procedure Specification for CO2 Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E70T-1 and E71T-1, As-Welded Condition. | B2.1-1-019-94 and B2.1-1-019-94R |
| Standard Welding Procedure Specification for 75% Ar/25% CO2 Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1-1/2 in. (38 mm) Thick, E70T-1M and E71T-1M, As-Welded or PWHT Condition. | B2.1-1-020-94 and B2.1-1-020-94R |
| Standard Welding Procedure for Self-Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1/2 in. (13 mm) Thick, E71T-11, As-Welded Condition. | B2.1-1-027:1995 and B2.1-1-027-1998 |
| Standard Welding Procedure Specification (SWPS) for Argon Plus 25% Carbon Dioxide Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 and 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E7XT-XM, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-234: 2006 |
| **GMAW – Gas Metal Arc Welding** | |
| Standard Welding Procedure Specification for Argon Plus 25% Carbon Dioxide Shielded Gas Metal Arc Welding (Short Circuiting Transfer Mode) followed by Argon Plus 2% Oxygen Shielded Gas Metal Arc Welding (Spray Transfer Mode) of Carbon Steel (M-1/P-1/S-1, Groups 1 and 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER70S-3, Flat Position Only, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-233: 2006 |
| Standard Welding Procedure Specification for Argon Plus 2% Oxygen Shielded Gas Metal Arc Welding (Spray Transfer Mode) of Carbon Steel (M-1/P-1/S-1, Groups 1 and 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER70S-3, Flat Position Only, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-235: 2006 |
| **GTAW/SMAW Combination of Welding Processes** | |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½  in. (38 mm) Thick, ER70S-2 and E7018, As-Welded or PWHT Condition. | B2.1-1-021-94 and B2.1-1-021-94R |

| | |
|---|---|
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, ER70S-2 and E7018, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-209-96 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER70S-2 and E7018, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-209-96 (R2007) |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding (Consumable Insert) Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, INMs1 and E7018, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-211-96 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding with Consumable Insert Root Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, INMs-1, ER70S-2, and E7018 As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-211:2001 |
| **GMAW/FCAW – Combination of Welding Processes** | |
| Standard Welding Procedure Specification for Argon Plus 25% Carbon Dioxide Shielded Gas Metal Arc Welding (Short Circuiting Transfer Mode) Followed by Argon Plus 25% Carbon Dioxide Shielded Flux Cored Arc Welding of Carbon Steel (m-1/P-1/S-1, Groups 1 and 2), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER70S-3 and EXT-X, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-232:2006 |

### Austenitic Stainless Steel — (M8/P8/S8 Materials)

| | |
|---|---|
| **SMAW — Shielded Metal Arc Welding** | |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, As-Welded Condition. | B2.1-8-023-94 |
| Standard Welding Procedure Specification for Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, E3XX-XX, As-Welded Condition, Primarily Pipe Application. | B2.1-8-213-97 and B2.1-8-213-96(R2007) |
| **GTAW — Gas Tungsten Arc Welding** | |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition. | B2.1-8-024-94 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) Thick, ER3XX, As-Welded Condition, Primarily Plate and Structural Applications. | B2.1-8-024:2001 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) Thick, ER3XX, As-Welded Condition, Primarily Pipe Applications. | B2.1-8-212-97 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) thick, ER3XX, As-Welded Condition, Primarily Pipe Applications. | B2.1-8-212:2001 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding With Consumable Insert Root of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, IN3XX and ER3XX As-Welded Condition, Primarily Pipe Applications. | B2.1-8-215:1998 B2.1-8-215:2001 |

| Combination Processes GTAW/SMAW | |
|---|---|
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition. | B2.1-8-025-94 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER3XX and E3XX-XX, As-Welded Condition, Primarily Plate and Structural Applications. | B2.1-8-025:2001 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER3XX and E3XX-XX, As-Welded Condition, Primarily Pipe Applications. | B2.1-8-214-97 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, ER3XX and E3XX-XX, As-Welded Condition, Primarily Pipe Applications. | B2.1-8-214:2001 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding With Consumable Insert Followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) thick, IN3XX, ER3XX, and E3XX-XX As-Welded Condition, Primarily Pipe Application. | B2.1-8-216-1998 |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding with Consumable Insert Root followed by Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, IN3XX, ER3XX, and E3XX-XX As-Welded Condition, Primarily Pipe Applications. | B2.1-8-216:2001 |

### Combination of Carbon Steel (P-1 Material) To Austenitic Stainless Steel (P-8 Material)

| SMAW — Shielded Metal Arc Welding | |
|---|---|
| Standard Welding Procedure Specifications for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, E309(L)-15, -16, or -17, As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-228:2002 |
| **GTAW — Gas Tungsten Arc Welding** | |
| Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1 ½ in. (38 mm) Thick, ER309(L), As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-227:2002 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding with Consumable Insert Root of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/16 in. (1.6 mm) through 1½ in. (38 mm) Thick, IN309 and ER309(L), As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-230:2002 |
| **GTAW/SMAW Combination of Welding Processes** | |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1,Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, ER309(L) and E309(L)-15, -16, or -17, As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-229:2002 |

| | |
|---|---|
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding with Consumable Insert Root followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Groups 1 or 2) to Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, IN3009, ER309, and E309-15, -16, or -17 or IN309, ER309(L) and ER309(L)-15, -16, or -17, As-Welded Condition, Primarily Pipe Applications. | B2.1-1/8-231:2002 |

### Chromium Molybdenum Steel (M4/P4 and M5a/P5A Materials)

| | |
|---|---|
| **SMAW — Shielded Metal Arc Welding** | |
| Standard Welding Procedure Specifications for Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), E8018-B2, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-4-218:1999 |
| Standard Welding Procedure Specifications for Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), E9018-B3, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-5A-223:1999 |
| **GTAW — Gas Tungsten Arc Welding** | |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), ER80S-B2, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-4-217:1999 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding (Consumable Insert Root) of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), E8018-B2, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, IN515 and ER80S-B2, Primarily Pipe Applications. | B2.1-4-220:1999 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), ER90S-B3, 1/8 in. (3.2 mm) through 1½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, Primarily Pipe Applications. | B2.1-5A-222:1999 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding (Consumable Insert Root) of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 in. (3.2 mm) through 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 3/4 in. (19 mm) Thick, PWHT Condition, IN521 and ER90S-B3, Primarily Pipe Applications. | B2.1-5A-225:1999 |
| **Chromium-Molybdenum Steel Processes GTAW/SMAW** | |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding (Consumable Insert Root) followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), 1/8 in. (3.2 mm) through 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, PWHT Condition, IN515, ER80S-B2, and E8018-B2, Primarily Pipe Applications. | B2.1-4-221:1999 |
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welded followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, PWHT Condition, ER90S-B3 and E9018-B3, Primarily Pipe Applications. | B2.1-5A-224:1999 |

| | |
|---|---|
| Standard Welding Procedure Specifications for Gas Tungsten Arc Welding (Consumable Insert Root) followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, PWHT Condition, IN521, ER90S-B3, and E9018-B3, Primarily Pipe Applications. | B2.1-5A-226:1999 |
| Standard Welding Procedure Specifications (SWPS) for Gas Tungsten Arc Welded followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4A/P-4, Group 1 or 2), 1/8 in. (3.2 mm) through 1/2 in. (13 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1 ½ in. (38 mm) Thick, PWHT Condition, ER80S-B2 and E9018-B2, Primarily Pipe Applications. | B2.1-4-219:1999 |

## 2.4 AWS REFERENCE STANDARDS

The following AWS Standards have been adopted by the NBIC for use as referenced below:

a) AWS B2.1 - Specification for Welding Procedure and Performance Qualification

b) AWS B2.1 BMG - Base Metal Grouping for Welding Procedure and Performance Qualification

## 2.5 HEAT TREATMENT

### 2.5.1 PREHEATING

a) Preheating may be employed during welding to assist in completion of the welded joint. The need for and the temperature of preheat are dependent on a number of factors such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties. The Welding Procedure Specification for the material being welded shall specify the preheat temperature requirements.

b) See minimum temperatures for preheating given in NBIC Part 3, Table 2.5.1 as a general guide. It is cautioned that the preheating temperatures listed do not necessarily ensure satisfactory completion of the welded joint. Requirements for individual materials within the P-Number listing may have preheating requirements more or less restrictive than this general guide. When reference is made in this section to materials by the ASME designation, P-Number and Group Number, the suggestions of this section apply to the applicable materials of the original code of construction, either ASME or other, which conform by chemical composition and mechanical properties to ASME materials having the ASME P-Number and Group Number designations.

**TABLE 2.5.1**

MINIMUM TEMPERATURES FOR PREHEATING

| Thicknesses referenced are nominal at the weld for the parts to be joined. | |
|---|---|
| a) P-No. 1 Group Nos. 1, 2, and 3 | 1) 175˚F (79˚C) for material that has both a specified maximum carbon content in excess of 0.30% and a thickness at the joint in excess of 1 in. (25 mm).<br><br>2) 50˚F (10˚C) for all other materials in this P-Number. |
| b) P-No. 3 Group Nos. 1, 2, and 3 | 1) 175˚F (79˚C) for material that has either a specified minimum tensile strength in excess of 70,000 psi (480 MPa) or a thickness at the joint in excess of 5/8 in. (16 mm).<br><br>2) 50˚F (10˚C) for all other materials in this P-Number. |
| c) P-No. 4 Group Nos. 1 and 2 | 1) 250˚F (120˚C) for material that has either a specified minimum tensile strength in excess of 60,000 psi (410 MPa) or a thickness at the joint in excess of 1/2 in. (13 mm).<br><br>2) 50˚F (10˚C) for all other materials in this P-Number. |
| d) P-No. 5A Group 1 and 5B, Group 1 and P-No. 15E Group 1 | 1) 400˚F (205˚C) for material that has either a specified minimum tensile strength in excess of 60,000 psi (410 MPa) or has both a specified minimum chromium content above 6.0% and thickness at the joint in excess of 1/2 in. (13 mm).<br><br>2) 300˚F (150˚C) for all other materials in this P-Number. |
| e) P-No. 6 Group Nos. 1, 2, and 3 | 400˚F (205˚C) |
| f) P-No. 7 Group Nos. 1 and 2 | None |
| g) P-No. 8 Group Nos. 1 and 2 | None |
| h) P-No. 9 Group | 1) 250˚F (120˚C) for P-9A Gr. 1 materials<br><br>2) 300˚F (150˚C) for P-9B Gr. 1 materials |
| i) P-No. 10 Group | 1) 175˚F (79˚C) for P-10A Gr. 1 materials<br><br>2) 250˚F (120˚C) for P-10B Gr. 2 materials<br><br>3) 175˚F (79˚C) for P-10C Gr. 3 materials<br><br>4) 250˚F (120˚C) for P-10F Gr. 6 materials<br><br>5) For P-10C Gr. 3 materials, preheat is neither required nor prohibited, and consideration shall be given to the limitation of interpass temperature for various thicknesses to avoid detrimental effects on the mechanical properties of heat treated material.<br><br>6) For P-10D Gr. 4 and P-10E Gr. 5 materials, 300˚F (150˚C) with interpass temperature maintained between 350˚F and 450˚F (175˚C and 230˚C). |

| | |
|---|---|
| j) P-No. 11 Group | 1) P-11A Group<br>Group 1 - None (Note 1)<br>Group 2 - Same as for P-No. 5 (Note 1)<br>Group 3 - Same as for P-No. 5 (Note 1)<br>Group 4 - 250˚F (120˚C)<br><br>2) P-11B Group<br>Group 1 - Same as for P-No. 3 (Note 1)<br>Group 2 - Same as for P-No. 3 (Note 1)<br>Group 3 - Same as for P-No. 3 (Note 1)<br>Group 4 - Same as for P-No. 3 (Note 1)<br>Group 5 - Same as for P-No. 3 (Note 1)<br>Group 6 - Same as for P-No. 5 (Note 1)<br>Group 7 - Same as for P-No. 5 (Note 1) |

**Note 1:**

Consideration shall be given to the limitation of interpass temperature for various thicknesses to avoid detrimental effects on the mechanical properties of heat treated materials.

## 2.5.2 POSTWELD HEAT TREATMENT (PWHT)

a) Postweld heat treatment shall be performed as required by the original code of construction, the construction standard or code selected in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment.

b) Postweld heat treatment shall be performed by heating either the entire item or a circumferential band around the item. When heating a circumferential band, the heat treatment procedure shall specify the soak band (SB) width, the heated band (HB) width, the gradient control band (GCB) width, the location of thermocouples and method of attachment of thermocouples in addition to the heating rate, holding time, temperature and cooling rate. Figures S2.5.2-a and S2.5.2-b show these bands. AWS *010.10, Recommended Practices for Local Heating* of *Welds in Piping and Tubing* may be referred to for further information.

c) When it is impractical or detrimental to Postweld Heat Treat (PWHT) the entire item or band around the item, the following local PWHT method may be performed on spherical or cylindrical pressure-retaining items using the time and temperature parameters in the original code of construction and in accordance with a written procedure acceptable to the Inspector and, when required, by the Jurisdiction.

   1) Heat a local area around the nozzle, welded attachment, or repair area such that the area is brought up uniformly to the required PWHT temperature. The application of local PWHT should be performed with controlled heating methods, such as induction or electric resistance heaters, and employing thermocouples to monitor PWHT temperature. The Soak Band (SB) shall extend tangentially and radially from the edge of the nozzle wall, or attachment weld or repair area equally by a minimum distance as defined by the thickness of the shell, t or 2 in. (50 mm), whichever is less. See Figure 2.5.2-b.

      Soak Band (SB) — this is the region on the spherical or cylindrical shell that will be heated uniformly to the required PWHT temperature. This band encompasses a circular region in the tangential and radial directions starting from the edge of a welded nozzle, or repair area or welded attachment that will be subjected to PWHT.

   2) The length of the Heating Band (HB) shall consist of the SB distance plus $4\sqrt{R * t}$ . In no case shall the distance of the HB that extends beyond the edge of the nozzle weld, attachment weld or repair area be less than $5\sqrt{R * t}$.

Heating Band (HB) – this is the region that encompasses the application of heat for PWHT and is defined in length by the equation, $SB + 4\sqrt{R * t}$ where R is the outer radius of the spherical or cylindrical shell in inches (mm), and t is equal to the nominal thickness of the spherical or cylindrical shell in inches (mm).

3) The Gradient Control Band (GCB) shall be kept as low as possible in all directions to avoid harmful temperature gradients adjacent to nozzles or geometric discontinuities.

Gradient Control Band – this is the region that encompasses the SB, HB and extends beyond the edge of the HB.

4) For PWHT of nozzle welds, repair welds, and external attachment welds on smooth spherical shells, heads, and cylindrical shells, the temperature differential within the GCB measured at the outside edge of the SB and the temperature measured at the outside edge of the HB shall not exceed one-half (1/2) of the peak soak PWHT temperature.

5) The term t, as used above to determine SB, HB and GCB shall be the nominal thickness of either a full penetration weld, or the groove weld depth of a partial penetration repair weld. If a fillet weld is used in combination with a groove weld, the nominal thickness for PWHT shall be the depth of the groove weld.

**FIGURE 2.5.2-a**

LOCAL POSTWELD HEAT TREATMENT TEMPERATURE CONTROL BANDS BUTT WELD IN CYLINDER

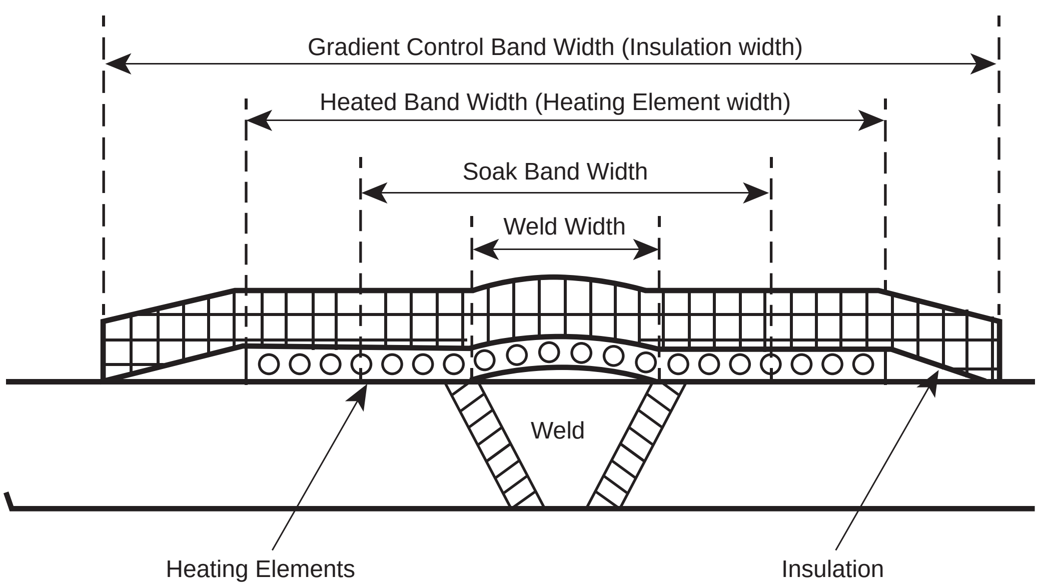
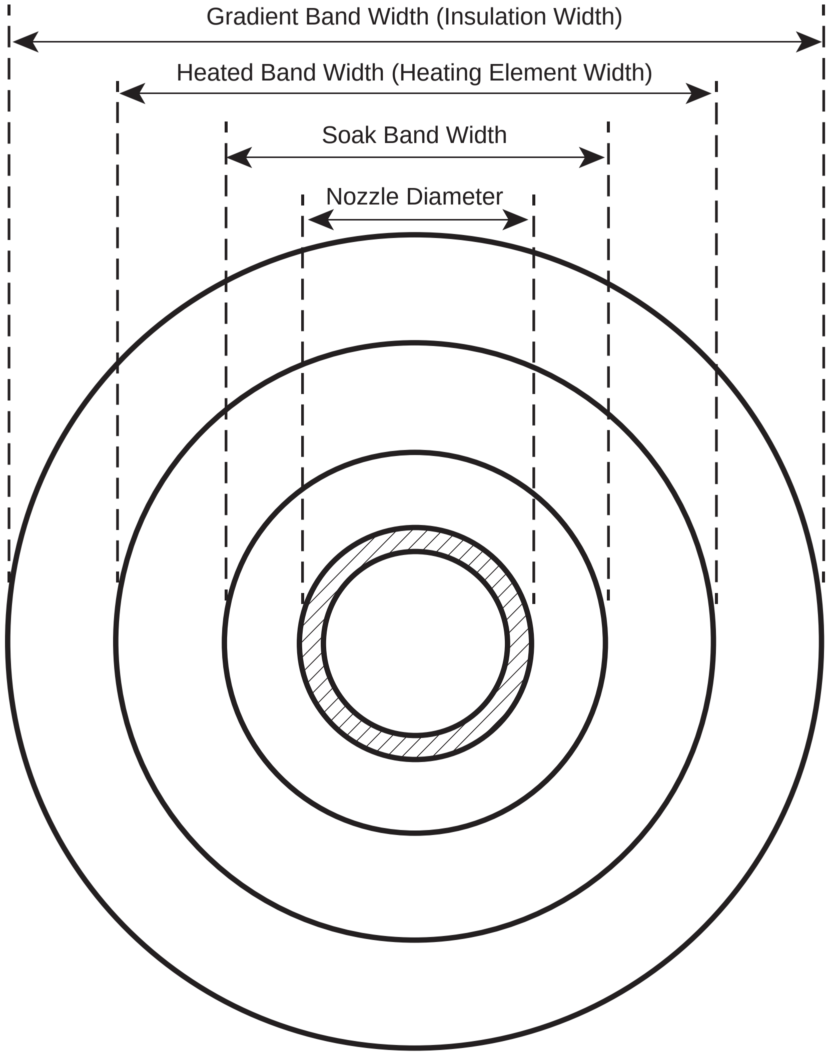


**FIGURE 2.5.2-b**

LOCAL POSTWELD HEAT TREATMENT TEMPERATURE CONTROL BANDS NOZZLE WELD OR ATTACHMENT TANGENTIAL DIRECTION HEATING BANDS




### 2.5.3 ALTERNATIVE WELDING METHODS WITHOUT POSTWELD HEAT TREATMENT

a) Under certain conditions, postweld heat treatment, in accordance with the original code of construction, may be inadvisable or impractical. In such instances, the following alternative methods may be used.

b) Competent technical advice shall be obtained from the manufacturer of the pressure-retaining item or from another qualified source, such advice being especially necessary if the alternative is to be used in highly stressed areas, if service conditions are conducive to stress corrosion cracking, if materials are subject to hydrogen embrittlement, or are operating at temperatures in the creep range, or if the alternative is being considered for “on-stream” repairs or “hot tapping” on piping systems. Selection of the welding method used shall be based on the rules of the original code of construction together with the above mentioned advice concerning the adequacy of the weld in the as-welded condition at operating and pressure test conditions.

c) When reference is made in this section to materials by the ASME designation, P-Number and Group Number, the requirements of this section apply to the applicable materials of the original code of construction, either ASME or other, which conform by chemical composition and mechanical properties to the ASME P-Number and Group Number designations.

d) The detailed welding methods listed in the following subsections may be used as an alternative to postweld heat treatment (PWHT). NBIC Part 3, 2.5.3.1 is a method in which the welding procedure requires an elevation of the preheat temperature. In contrast, NBIC Part 3, 2.5.3.2 through 2.5.3.6, are methods in which the welding procedure requires the use of a temper-bead welding technique. In 2.5.3.5 is a method in which the welding procedure used for joining dissimilar materials requires either an elevation of the preheat temperature or a temper-bead welding technique, depending on the chemical composition of the base metal that is joined to an austenitic steel. Temper-bead welding procedure nomenclature is defined in Section IX of the *ASME Boiler and Pressure Vessel Code*. Typically, this technique minimizes heat input of the initial beads, thus limiting heat beyond the weld heat-affected zone (HAZ) of the base metal. Heat input shall be increased for successive beads in accordance with the rules of QW-290 for temper bead welding in ASME Section IX. The Welding Procedure and Welder Performance Qualifications shall, in all cases, be in accordance with the requirements of the latest Edition of Section IX of the *ASME Boiler and Pressure Vessel Code*.

(15) e) Nondestructive Examination of Welds

Prior to welding, the area prepared for welding shall be examined using either the Magnetic Particle (MT) or the Liquid Penetrant (PT) examination method to determine that no defects exist. After the finished weld has reached ambient temperature, and, when required by the specific welding method, the surface temper bead reinforcement layer has been removed substantially flush with the surface of the base metal, the weld shall be examined again by either of the above methods to determine that no defects exist using acceptance standards acceptable to the Inspector or original code of construction. In addition, welds greater than 3/8 in. (9.6 mm) deep or welds in a boiler, pressure vessel, or piping system that were originally required to be radiographed by the rules of the original code of construction, shall be radiographically examined. In situations where it is not practical to perform radiography, the accessible surfaces of each non radiographed repair weld shall be fully examined using the MT or PT method to determine that no defects exist and the maximum allowable working pressure and/or allowable temperature shall be re-evaluated to the satisfaction of the jurisdiction at the location of installation.

f) Methods that may be used as alternatives to postweld heat treatment are described in the following subsections.

### 2.5.3.1 WELDING METHOD 1

When using this method, the following is required:

a) This method may be used when the applicable rules of the original code of construction did not require notch toughness testing;

b) The materials shall be limited to P-No. 1, Groups 1, 2, and 3 and to P-No. 3, Groups 1 and 2 (excluding Mn-Mo steels in Group 2), as permitted for welded construction by the applicable rules of the original code of construction;

c) The welding shall be limited to the Shielded Metal-Arc welding (SMAW), Gas Metal-Arc Welding (GMAW), Fluxcored Arc Welding (FCAW), and Gas Tungsten-Arc Welding (GTAW) processes;

d) The Welders and Welding Operators, Welding Procedures Specifications shall be qualified in accordance with the applicable rules of the original code of construction, except that no postweld heat treatment shall be applied to the test coupon;

e) The weld area shall be preheated and maintained at a minimum temperature of 300˚F (149˚C) during welding. Alternatively, for P-No.1, Groups 1, 2 and 3 materials, the preheat may be reduced to 175˚F (79˚C) provided:

1) Provided the carbon equivalent of the base material to be welded is determined to be 0.40 or less.

2) The electrodes and filler metals are classified by the filler metal specification with a diffusible hydrogen designator of H4 or lower.

3) When shielding gas is used, it shall have a dew point that is -60˚F (-50˚C) or lower.

f) The preheat temperature shall be checked to assure that 4 in. (102 mm) of the material or four times the material thickness (whichever is greater) on each side of the groove (or full thickness of joint for a groove weld) is maintained at the preheat temperature during welding. When the weld does not penetrate through the full thickness of the material, the preheat need only be maintained at a distance of 4 in. (102 mm) or four times the depth of the repair weld, whichever is greater, on each side of the joint.

### 2.5.3.2 WELDING METHOD 2

When using this method, the following is required:

a) This method shall be used when the applicable rules of the original code of construction required notch toughness testing or shall be used when the applicable rules of the original code of construction did not require notch toughness testing provided the adequacy of the notch toughness of the weld, including the heat-affected zone, in the as-welded condition at operating and pressure test conditions is verified;

b) The materials shall be limited to carbon and low alloy steels permitted for welded construction by the applicable rules of the original code of construction, including those materials conforming to any of the following ASME P-No. designations: P-No. 1, Groups 1, 2, and 3; P-No. 3, Groups 1, 2, and 3; P-No. 4; P-No. 5A; P-No. 9A; P-No. 10A; P-No. 10B; P-No. 10C; P-No. 11A; or P-No. 11B;

c) The welding shall be limited to the Shielded Metal-Arc Welding (SMAW), Gas Metal-Arc Welding (GMAW), Fluxcored-Arc Welding (FCAW), and Gas Tungsten-Arc Welding (GTAW) processes;

d) The Welding Procedures Specifications shall be qualified in accordance with the temper bead procedure qualification requirements in QW-290 of ASME Section IX, and shall include the following additional requirements:

1) For P-No. 1 Groups 1, 2, and 3 and P-No. 3 Groups 1, 2, and 3, the minimum preheat temperature shall be 350°F (177°C), and the maximum interpass shall be 450°F (232°C).

2) For P-No. 9A, P-No. 10A, P-No. 10B, P-No. 10C, P-No. 11A, or P-No. 11B, the minimum preheat and interpass temperature requirements shall be in accordance with the guidelines in NBIC Part 3, 2.5.1.

3) For P-No. 4 and P-No. 5A materials, the minimum preheat, interpass temperature, and technique shall be in accordance with NBIC Part 3, 2.5.3.4. The repair depth for temper bead repairs to pressure retaining items of P-No. 4 and P-No. 5A materials is limited to welds not penetrating through full thickness.

4) For ASME Section VIII, Division 2 pressure vessels, where application of PWHT on in-service vessels has been demonstrated to cause harm to vessel material, full thickness temper bead repairs are permitted to pressure-retaining items of P-No. 4 and P-No. 5A materials. They shall be completed per NBIC Part 3, 3.3.5 with the following requirements:

a. The full thickness repair weld shall be verified as being the full penetration.

b. Volumetric examination of the full thickness weld shall be performed.

e) The test material for the welding procedure qualification shall be of the same material specification (including specification type, grade, class, and condition of heat treatment) as the material being repaired. In the event that the notch toughness of the material to be repaired is unknown, evidence from tests of that material or from another acceptable source (see NBIC Part 3, 2.5.3) may be used for the base metal notch toughness when qualifying the WPS as required in NBIC Part 3, 2.5.3.2 h). In the event that the original material specification is obsolete, the test material used should conform as closely as possible to the original material used for construction based on nominal composition and carbon equivalent (IIW Formula),[9] but in no case shall the material be lower in strength.

(15) f) The qualification thickness for the test plates and repair groove depths shall be in accordance with ASME Section IX; for pressure retaining items repaired using this temper bead method, hardness testing and carbon equivalency requirements may be waived for ASME Section IX temper bead procedure qualification provided the pressure retaining item operates in steam service above 900°F (482°C).

g) The organization making the repair shall include, when qualifying its WPS, sufficient tests to determine that the notch toughness of the weld metal and the heat-affected zone of the base metal in the "as-welded" condition is adequate at the minimum operating and pressure test temperatures (including start-up and shutdown). If for reasons of corrosion resistance, special hardness limits are necessary, such limits shall be included when qualifying the WPS.

h) Notch toughness shall be determined and evaluated by Charpy impact tests in accordance with the provisions of the original code of construction at the temperature determined in accordance with NBIC Part 3, 2.5.3.2 d). Exemptions from impact testing described in the original code of construction are not applicable.

i) For the welding process in NBIC Part 3, 2.5.3.2 c), use of austenitic or ferritic filler metals is permitted. For ferritic filler metals, use only electrodes and filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower. When shielding gases are used with a process, the gas shall exhibit a dew point that is below -60°F (-50°C). Surfaces on which welding will be done shall be maintained in a dry condition during welding and be free of rust, mill scale, and hydrogen producing contaminants such as oil, grease, and other organic materials.

j) After the weld has been deposited flush with the base metal, a surface temper reinforcing weld layer shall be applied.

k) For welds made by SMAW and FCAW, after completion of welding and without allowing the weldment to cool below the minimum preheat temperature, the temperature of the weldment shall be raised to a temperature of 450°F (232°C) minimum for a minimum period of two hours. This hydrogen bake-out treatment may be omitted provided the electrode used is classified by the filler metal manufacturer with a diffusible-hydrogen designator of H4 (e.g., E7018-H4).

l) After the finished repair weld has cooled to ambient temperature, the surface temper reinforcing layer shall be removed substantially flush with the surface of the base material.

### 2.5.3.3 WELDING METHOD 3

When using this method, the following is required:

a) This method may be used when the applicable rules of the original code of construction did not require notch toughness testing;

b) The materials shall be limited to any P-No. 1 or P-No. 3 material as permitted for welded construction by the applicable rules of the original code of construction;

c) The welding shall be limited to the SMAW, FCAW, and GTAW processes;

9 The IIW Carbon Equivalent Formula is CE= C+ Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15. Elements are expressed in Weight Percent Amounts.

d) The test material for the welding procedure qualification shall be of the same P-No. and Group No. as the base material specification of the repair. In the event that the original material specification is obsolete, the test material used should conform to the nominal composition and carbon equivalent (IIW Formula)[10] as the material being repaired, but in no case shall the material be lower in strength;

e) If for reasons of corrosion resistance, special hardness limits are necessary, such limits shall be included when qualifying the WPS. For pressure retaining items repaired using this temper bead method, hardness testing and carbon equivalency requirements may be waived for ASME Section IX temper bead procedure qualification provided the pressure retaining item operates in steam service above 900°F (482°C);

f) The qualification thickness for the test plates and repair groove depths shall be in accordance with ASME Section IX;

g) The WPS shall be qualified in accordance with the temper bead procedure qualification requirements in QW-290 of ASME Section IX, and shall include the following additional requirements:

   1) The minimum preheat temperature for welding shall be 350°F (177°C) and the maximum interpass temperature shall be 450°F (232°C);

   2) For the welding processes in NBIC Part 3, 2.5.3.3 c), use of austenitic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower may be used. When shielding gases are used with a process, the gas shall exhibit a dew point that is below -60°F (-50°C). Surfaces on which welding will be done shall be maintained in a dry condition during welding and be free of rust, mill scale, and hydrogen producing contaminants such as oil, grease, and other organic materials;

   3) After completion of welding using SMAW and without allowing the weldment to cool below the minimum preheat temperature, the temperature of the weldment shall be raised to a temperature of 450°F (232°C) minimum for a minimum period of two hours. This hydrogen bake-out treatment may be omitted, provided the electrode used is classified by the filler metal manufacturer with a diffusible-hydrogen designator of H4 (e.g., E7018-H4);

   4) After the finished repair weld has cooled to ambient temperature, the final temper bead reinforcement layer shall be removed substantially flush with the surface of the base material.

### 2.5.3.4 WELDING METHOD 4

When using this method, the following is required:

a) This method is limited to repair welds in pressure retaining items for which the applicable rules of the original code of construction did not require notch toughness testing. The repair depth for temper bead repairs to pressure retaining items is limited to welds not penetrating though the full thickness.

   For ASME Section VIII Division 2 pressure vessels, where application of PWHT on in-service vessels has been demonstrated to cause harm to vessel material, full thickness temper bead repairs are permitted. They shall be completed per NBIC Part 3, 3.3.5 with the following requirements:

   1) The full thickness repair weld shall be verified as being full penetration.

   2) Volumetric examination of the full thickness weld shall be performed.

b) The materials shall be limited to P-No. 4, Groups 1 and 2, and P-No. 5A steels as permitted for welded construction by the applicable rules of the original code of construction;

10 The IIW Carbon Equivalent Formula is CE= C+ Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15. Elements are expressed in Weight Percent Amounts.

c) The welding shall be limited to the SMAW, FCAW, GMAW or GTAW processes using low-hydrogen electrodes and filler metals classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower, and suitably controlled by maintenance procedures to avoid contamination by hydrogen producing sources. The surface of the metal prepared for welding shall be free of contaminants;

d) The test material for the welding procedure qualification shall be of the same P-No. and Group No. as the original material specification for the repair. In the event that the original material specification is obsolete, the test material used shall conform to the nominal composition and carbon equivalent (IIW formula)[11] as the original material used for construction, and in no case shall the material be lower in strength;

e) If for reasons of corrosion resistance, special hardness limits are necessary, such limits shall be included when qualifying the WPS;

(15) f) The qualification thickness for the test plates and repair groove depths shall be in accordance with ASME Section IX. For pressure-retaining items repaired using thistemper bead method, hardness testing and carbon equivalency requirements may be waived for ASME Section IX temper bead procedure qualification provided the pressure-retaining item operates in steam service above 900°F (482°C);

g) The welding procedures (WPS) shall be qualified in accordance with the temper bead procedure qualification requirements in QW-290 of ASME Section IX, and shall include the following additional requirements:

1) The minimum preheat temperature for welding shall be 300°F (150°C) for P-No. 4 material and 400 °F (200 °C) for P-No. 5A material. The preheat temperature shall be checked to ensure that 4 in. (102 mm) of the material or four times the material thickness (whichever is greater) on each side of the groove (or full thickness of joint for a groove weld) is maintained at the minimum temperature during welding. The interpass temperature shall not exceed 800°F (430°C). When the weld does not penetrate through the full thickness of the material, the minimum preheat and maximum interpass temperature need only be maintained for 4 in. (102 mm) or four times the depth of the repair weld (whichever is greater) on each side of the joint;

2) For the welding processes in NBIC Part 3, 2.5.3.4 c), use of austentic or ferritic filler metal is permitted. For ferritic filler metals, use only electrodes or filler metals that are classified by the filler metal specification with a diffusible-hydrogen designator of H8 or lower. When shielding gases are used with a process, the gas shall exhibit a dew point that is below -60°F (-50°C). Surfaces on which welding be done shall be maintained in a dry condition during welding and be free of rust, mill scale, and hydrogen producing contaminants, such as oil, grease, and other organic materials;

3) After the weld has been deposited flush with the base metal, a surface temper reinforcing weld layer shall be applied;

4) For welds made by the SMAW and FCAW processes, after completion of welding and without allowing the weldment to cool below the minimum preheat temperature, the temperature of the weldment shall be raised to 450°F (232°C) minimum for a minimum period of two hours. This hydrogen bake-out treatment may be omitted, provided the electrode used is classified by the filler metal manufacturer with a diffusible-hydrogen designator of H4 (e.g., E7018 H4);

5) After the finished repair weld has cooled to ambient temperature, the surface temper reinforcing weld layer shall be removed substantially flush with the surface of the base metal (and for a fillet weld to the required size and suitable contour of the toes).

### 2.5.3.5 WELDING METHOD 5

When using this method, the following is required:

11 The IIW Carbon Equivalent Formula is CE=C+ Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15. Elements are expressed in Weight Percent Amounts

a) This welding method may be used when the applicable rules of the original code of construction or the construction standard or code selected permit joining dissimilar materials used in pressure-retaining items;

b) The materials shall be limited to ASME P-No. 1, Groups 1, 2, and 3, P-No. 3, Groups 1, 2, and 3, P-No. 4, P-No. 5A, P-No. 9A, P-No. 10A, P-No. 10B, P-No. 10C, P-No. 11A, P-No. 11B joined to either P-No. 8, P-No. 42, P-No. 43, or P-No. 45, as permitted for welded construction by the applicable rules of the original code of construction;

c) The welding shall be limited to the SMAW, FCAW, GMAW and machine or automatic GTAW processes. The filler metal used for joining the dissimilar materials shall be either A-No 8 or Nickel-Chrome alloy classification (F-No 43). When selecting a filler metal for dissimilar metal weld joints, determine if the weld joint will be exposed to elevated temperature service. A-No 8 filler metals exposed to service temperatures greater than 800°F (427°C) will exhibit reduced creep life along the fusion zone of the ferritic material due to carbon diffusion. Instead, a low hydrogen, Nickel-Chromium alloy classification filler metal shall be used for dissimilar weld joints exposed to service temperatures at or above 800°F (427°C);

d) The WPS shall be qualified in accordance with the temper bead rules of QW-290 in ASME Section IX. (15) For pressure retaining items fabricated to ASME Section I and repaired using this temper bead method, hardness testing and carbon equivalency requirements may be waived for ASME Section IX temper bead procedure qualification provided the pressure retaining item operates in steam service above 900°F (482°C);

e) If the original code of construction did not require notch toughness testing, qualification of welding procedures (WPS) for joining ASME P-No. 1, P-No. 3 ferritic materials to either P-No. 8, P-No. 42, P-No. 43, or P-No. 45 materials shall be in accordance with requirements in either NBIC Part 3, 2.5.3.1, Welding Method 1 or in NBIC Part 3, 2.5.3.3, Welding Method 3;

f) If the original code of construction did not require notch toughness testing, qualification of welding procedures (WPS) for joining ASME P-No. 4, P-No. 5A ferritic materials to either P-No. 8, P-No. 42, P-No. 43, P-No. 45 materials shall be in accordance with the requirements in NBIC Part 3, 2.5.3.4, Welding Method 4;

g) If the original code of construction required notch toughness testing, qualification of welding procedures (WPS) for joining ferritic materials to either P-No. 8, P-No. 42, P-No. 43, or P-No. 45 materials shall be in accordance with the requirements in NBIC Part 3, 2.5.3.2, Welding Method 2.

### 2.5.3.6 WELDING METHOD 6

This welding method provides guidance for welding only Grade 91 tube material within the boiler setting and when it's impracticable to perform local postweld heat treatment (PWHT). This repair method utilizes a controlled fill technique.

When using this welding method, the following is required:

a) This method is limited to butt welds in tubing NPS 5 (DN 125) or less in diameter and ½ in. (13 mm) or less in wall thickness for which the applicable rules of the original code of construction did not require notch toughness testing;

b) Application shall be limited to only boiler tube repairs at a location internal to the boiler setting;

c) Upon the completion of weld repair, the repair region shall be kept from humid or moist environments until the return to service;

   1) The material shall be limited to P-No 15E, Group 1, Grade 91, creep strength enhanced ferritic steel (CSEF).

2) The welding shall be limited to the SMAW or GTAW processes, manual or automatic, using suitably controlled maintenance procedures to avoid contamination by hydrogen producing sources. The surface of the metal shall be free of contaminants and kept dry.

3) The test material for the welding procedure qualification shall be P-No 15 E, Group 1, Grade 91 for the repair.

4) Qualification thickness for the test plates and repair groove depths shall be in accordance with ASME Section IX, QW-451.

5) The Welding Procedure Specification (WPS) shall be qualified in accordance with the requirements of ASME Section IX, except that no postweld heat treatment shall be applied to the test coupon. Additionally, the qualification shall include the following requirements:

   a. The minimum preheat for the GTAW process shall be 200°F (93°C). The minimum preheat for the SMAW process shall be 300°F (150°C). The preheat temperature shall be checked to ensure the minimum preheat temperature is maintained during welding and until welding is completed. The maximum interpass temperature shall be 400°F (200°C).

   b. When the SMAW process is specified for a fill pass layer as a controlled filled welding technique, the electrode diameter is restricted to a maximum size of 1/8 in. (3.2 mm). When the GTAW-process is specified any limits in filler size is to be reflected in the qualified PQR and WPS.

   c. Regardless of the welding process (SMAW or GTAW), only the use of stringer beads shall be permitted.

   d. The filler metal shall be limited to an austenitic, nickel-base filler metal having a designation F-No. 43 and limited to the following consumables: ERNiCr-3 (Filler Metal 82), ENiCrFe-3 (INCONEL Welding Electrode 182), ENiCrFe-2 (INCO-WELD A), ASME B&PV Code Cases 2733 and 2734 (EPRI P87).

# PART 3, SECTION 3
# REPAIRS AND ALTERATIONS — REQUIREMENTS FOR REPAIRS AND ALTERATIONS

## 3.1 SCOPE

This section provides general and specific requirements for materials, replacement parts, and methods used when performing repairs and alterations to pressure-retaining items. Specific repair or alteration methods for other types of pressure equipment are in NBIC Part 3, Section 7.

## 3.2 GENERAL REQUIREMENTS FOR REPAIRS AND ALTERATIONS

### 3.2.1 MATERIAL REQUIREMENTS FOR REPAIRS AND ALTERATIONS

a) The materials used in making repairs or alterations shall conform insofar as possible to the original code of construction or construction standard or code selected, including the material specification requirements used for the work planned. Carbon or alloy steel having a carbon content of more than 0.35% shall not be welded unless permitted by the original code of construction. The “R” Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or pressure-retaining item records, and identification of the materials to be installed. Consideration shall be given to the condition of the existing material, especially in the weld preparation area. If the existing material cannot be verified (unknown), the “R” Certificate Holder shall perform a chemical analysis and hardness testing, as a minimum, of the unknown material to verify its weldability and strength or may elect to qualify a weld procedure. If there is a question with regard to the weldability characteristics of the material, then competent technical advice should be obtained.

b) For corrugating rolls manufactured per the requirements of paragraph UF-7 of ASME Section VIII, Div. 1, weld overlay of the surfaces is permitted for all classes of SA-649 forging material and an exception to the 0.35% carbon limit is permitted. The requirements to qualify welding procedures and welder performance shall be in accordance with ASME Section IX for hard facing (wear resistance) and/or corrosion resistant overlays. Preheat or post weld heat treatment is neither required or prohibited.

### 3.2.2 REPLACEMENT PARTS

Replacement parts to be used in repairs or alterations shall meet the following applicable requirements:

a) Replacement parts that will be subject to internal or external pressure that consist of new materials which should be formed to the required shape by casting, spinning, forging, die forming, and on which no fabrication welding is performed, shall be supplied as material. Such parts shall be marked with the material and part identification and the name or trademark of the parts manufacturer. In lieu of full identification marking on the material or part, the part manufacturer may use a coded marking system traceable to the original marking. Such markings shall be considered as the parts manufacturer’s certification that the part complies with the original code of construction. Examples include seamless or welded tubes or pipe, forged nozzles, heads or tubesheets, or subassemblies attached together mechanically;

b) Replacement parts that will be subject to internal or external pressure that are preassembled by attachment welds shall have the welding performed in accordance with the original code of construction. The supplier or manufacturer shall certify that the material and fabrication are in accordance with the original code of construction. This certification shall be supplied in the form of bills of material and drawings with statement of certification. Examples include boiler furnace wall or floor panel assemblies, prefabricated openings in boiler furnace walls, such as burner openings, air ports, inspection openings, or sootblower openings;

c) When ASME Code is the original code of construction, replacement parts subject to internal or external pressure fabricated by welding, which require inspection by an Authorized Inspector shall be fabricated by an organization having an appropriate ASME *Certificate of Authorization*. The item shall be inspected and stamped as required by the applicable section of the ASME Code. A completed ASME *Manufacturer's Partial Data Report* shall be supplied by the manufacturer;

The "R" Certificate Holder, using replacement parts fabricated and certified to an ASME Code edition and addenda different from that used for the original construction, shall consider and seek technical advice, where appropriate, for change or conflicts in design, materials, welding, heat treatment, examinations and tests to ensure a safe repair/alteration is performed. Note that work once classified as a repair could now be considered an alteration;

d) When the original code of construction is other than ASME Code, replacement parts subject to internal or external pressure, fabricated by welding, shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction, as required by the original code of construction or equivalent, shall be supplied with the item. When this is not possible or practicable, the organization fabricating the part shall have a National Board "R" *Certificate of Authorization*; replacement parts shall be documented on Form R-3 and the "R" Symbol Stamp applied as described in NBIC Part 3, Section 5.

### 3.2.3 DRAWINGS

As appropriate, drawings shall be prepared to describe the repair or alteration. Drawings shall include sufficient information to satisfactorily perform the repair or alteration.

### 3.2.4 DESIGN REQUIREMENTS FOR REPAIRS AND ALTERATIONS

a) Many repairs may not require drawings or design calculations when the original code of construction is known and drawings and/or a Manufacturer's Data Report is available;

b) The "R" Certificate Holder performing repairs and alterations shall establish the construction standard or code and sufficient controls to ensure that all required design information, applicable drawings, design calculations, specifications, and instructions are prepared, obtained, controlled, and interpreted to provide the basis for a repair or an alteration in accordance with the original code of construction. When a *Manufacturer's Data Report* is required by the original construction standard, a copy of the original data report shall be obtained, where available, for use in the design of the repair or alteration. When the original *Manufacturer's Data Report* cannot be obtained, agreements on the method of establishing design basis for the repair or alteration shall be obtained from the Inspector and the Jurisdiction, when required.

### 3.2.5 CALCULATIONS

For alterations, calculations shall be completed prior to the start of any physical work. All design calculations shall be completed by an organization experienced in the design portion of the standard used for construction of the item. All calculations shall be made available for review by the Inspector accepting the design.

### 3.2.6 REFERENCE TO OTHER CODES AND STANDARDS

Other codes, standards, and practices pertaining to the repair and alteration of pressure retaining items can provide useful guidance. Use of these codes, standards and practices is subject to review and acceptance by the Inspector, and when required, by the Jurisdiction. The user is cautioned that the referenced codes, standards and practices may address methods categorized as repairs; however, some of these methods are considered alterations by the NBIC.

In the event of a conflict with the requirements of the NBIC, the requirements of the NBIC take precedence. Some examples are as follows:

a) National Board *BULLETIN* - National Board Classic Articles Series;

b) ASME PCC-1, Guidelines for Pressure Boundary Bolted Flange Joint Assembly;

c) ASME PCC-2, Repair of Pressure Equipment and Piping.

### 3.2.7 CHANGE OF SERVICE (15)

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

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

## 3.3 REPAIRS TO PRESSURE-RETAINING ITEMS

### 3.3.1 DEFECT REPAIRS

Before a repair is made to a defect in a welded joint or base metal, care should be taken to investigate its cause and to determine its extent and likelihood of recurrence.

### 3.3.2 ROUTINE REPAIRS

a) Routine repairs are repairs for which the requirements for in-process involvement by the Inspector and stamping by the “R” Certificate Holder may be waived as determined appropriate by the Jurisdiction and the Inspector. All other applicable requirements of this code shall be met. Prior to performing routine repairs, the “R” Certificate Holder should determine that routine repairs are acceptable to the Jurisdiction where the pressure-retaining item is installed;

b) The Inspector, with the knowledge and understanding of jurisdictional requirements, shall be responsible for meeting jurisdictional requirements and the requirements of this code;

c) The “R” Certificate Holder’s Quality System Program shall describe the process for identifying, controlling, and implementing routine repairs. Routine repairs shall be documented on Form R-1 with this statement in the Remarks section: “Routine Repair”;

d) Alternative welding methods without posteweld heat treatment as described in NBIC Part 3, 2.5.3 shall not be used for routine repairs.

e) Repairs falling within one or more of the following categories may be considered routine:

   1) Welded repairs or replacements of valves, fittings, tubes, or pipes NPS 5 (DN 125) in diameter and smaller, or sections thereof, where neither postweld heat treatment nor NDE other than visual is required by the original code of construction. This includes their attachments such as clips, lugs, skirts, etc., but does not include nozzles to pressure-retaining items;

   2) The addition or repair of nonload bearing attachments to pressure-retaining items where postweld heat treatment is not required;

   3) Weld buildup of wasted areas in heads, shells, flanges and fittings not exceeding an area of 100 sq. inches (64,520 sq. mm) or a thickness of 25% of nominal wall thickness or ½ inch (13 mm), whichever is less;

4) Corrosion resistance weld overlay not exceeding 100 sq. in. (64,520 sq. mm).

### 3.3.3 EXAMPLES OF REPAIRS

a) Weld repairs or replacement of pressure parts or attachments that have failed in a weld or in the base material;

b) The addition of welded attachments to pressure parts, such as:

1) Studs for insulation or refractory lining;

2) Hex steel or expanded metal for refractory lining;

3) Ladder clips;

4) Brackets having loadings that do not affect the design of the pressure-retaining item to which they are attached; and

5) Tray support rings.

c) Corrosion resistant strip lining, or weld overlay;

d) Weld buildup of wasted areas;

e) Replacement of heat exchanger tubesheets in accordance with the original design;

f) Replacement of boiler and heat exchanger tubes where welding is involved;

g) In a boiler, a change in the arrangement of tubes in furnace walls, economizers, or super heater sections;

h) Replacement of pressure-retaining parts identical to those existing on the pressure-retaining item and described on the original *Manufacturer's Data Report*. For example:

1) Replacement of furnace floor tubes and/or sidewall tubes in a boiler;

2) Replacement of a shell or head in accordance with the original design;

3) Rewelding a circumferential or longitudinal seam in a shell or head;

4) Replacement of nozzles of a size where reinforcement is not a consideration.

i) Installation of new nozzles or openings of such a size and connection type that reinforcement and strength calculations are not a consideration required by the original code of construction;

j) The addition of a nozzle where reinforcement is a consideration may be considered to be a repair, provided the nozzle is identical to one in the original design, located in a similar part of the vessel, and not closer than three times its diameter from another nozzle. The addition of such a nozzle shall be restricted by any service requirements;

k) The installation of a flush patch to a pressure-retaining item;

l) The replacement of a shell course in a cylindrical pressure vessel;

m) Welding of gage holes;

n) Welding of wasted or distorted flange faces;

o) Replacement of slip-on flanges with weld neck flanges or vice versa;

p) Seal welding of buttstraps and rivets;

q) Subject to the administrative procedures of the Jurisdiction and approval of the Inspector, the replacement of a riveted section or part by welding;

r) The repair or replacement of a pressure part with a code-accepted material that has a nominal composition and strength that is equivalent to the original material, and is suitable for the intended service; and

s) Replacement of a pressure-retaining part with a material of different nominal composition and, equal to or greater in allowable stress from that used in the original design, provided the replacement material satisfies the material and design requirements of the original code of construction under which the vessel was built. The minimum required thickness shall be at least equal to the thickness stated on the original *Manufacturer's Data Report.*

t) The replacement of a pressure relieving device (PRD) attached by welding, provided the replacement device's relieving capacity is equal to or greater than the PRD capacity required by the original code of construction.

## 3.3.4 REPAIR METHODS

### 3.3.4.1 SCOPE

Except as provided in NBIC Part 3, 3.3.4.8, a repair of a defect in a welded joint or base material shall not be made until the defect has been removed. A suitable nondestructive examination (NDE) method, such as magnetic particle (MT) or liquid penetrant (PT), may be necessary to ensure complete removal of the defect. If the defect penetrates the full thickness of the material, the repair shall be made with a full penetration weld such as a double buttweld or single buttweld with or without backing. Where circumstances indicate that the defect is likely to recur, consideration should be given to removing the defective area and installing a flush patch or taking other corrective measures acceptable to the Inspector, and when required, by the Jurisdiction.

### 3.3.4.2 DEFECT REPAIRS

a) Cracks

Except as provided in NBIC Part 3, 3.3.4.8, a repair of a crack in a welded joint or base material shall not be made until the defect has been removed. A suitable nondestructive examination method such as a MT or PT may be necessary to ensure complete removal of the defect. If the defect penetrates the full thickness of the material, the repair shall be made with a full penetration weld such as a double buttweld or single buttweld with or without backing, as allowed by the original code of construction.

b) Unstayed Boiler Furnace Cracks

Cracks at the knuckle or at the turn of the flange of the furnace opening require immediate replacement of the affected area or specific approval of repairs by the Jurisdiction (See NBIC Part 3, Figure 3.3.4.2-a).

c) Rivet or Staybolt Hole Cracks

Cracks radiating from rivet or staybolt holes may be repaired if the plate is not seriously damaged. If the plate is seriously damaged, it shall be replaced. For suggested methods of repair, see NBIC Part 3, Figure 3.3.4.2-b.

d) Minor Defects

Minor cracks, isolated pits, and small plate imperfections should be examined to determine the extent of the defect and whether repair by welding is required. Except as provided in NBIC Part 3, 3.3.4.8 prior to repair by welding, the defects shall be removed to sound metal. Liquid penetrant or magnetic particle examination may be used before or after welding.

e) Defective Bolting

Defective bolting material shall not be repaired but shall be replaced with suitable material that meets the specifications of the original code of construction.

f) Bulges

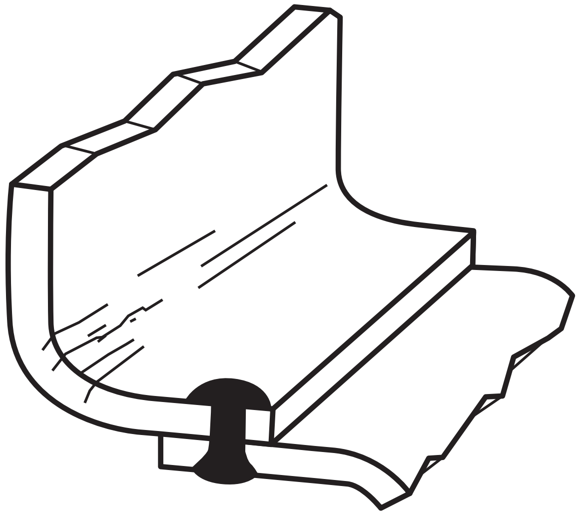
1) A bulge on a watertube shall be investigated to determine the cause and extent of damage to the tube prior to repair. If the bulge has resulted in metallurgical changes to the original tube material, as determined by field metallography, installation of a new length of tubing or tube patch (see NBIC Part 3, 3.3.4.6 b) is required. If the bulge has cracks as determined by NDE, installation of a new length of tubing or a tube patch is required. If the bulge does not exhibit cracks and has not resulted in metallurgical changes to the original tube material, a mechanical repair may be considered subject to the concurrence of the Inspector or Jurisdiction.

2) A bulge on a plate shall be investigated to determine the cause and extent of damage to the plate prior to repair. If the bulge has resulted in metallurgical changes to the original plate material, as determined by field metallography, installation of a flush patch (see NBIC Part 3, 3.3.4.6 a)) is required. If the plate has cracks as determined by NDE, installation of a flush patch is required. If the bulge does not exhibit cracks and has not resulted in metallurgical changes to the original plate material, a mechanical repair may be considered, subject to the concurrence of the Inspector or Jurisdiction.

g) Blisters

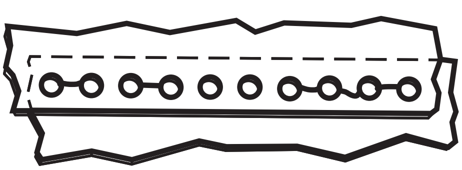
A blister may be caused by a defect in the metal such as lamination where one side exposed to the fire overheats but the other side retains its strength due to the cooling effect of the water. After the blistered material has been removed, the remaining wall thickness shall be determined by ultrasonic thickness testing. A surface examination using liquid penetrant testing or magnetic particle testing shall be made to ensure the remaining material contains no defects. If the remaining wall thickness is adequate, in the judgment of the Inspector, the area may be repaired by welding as covered in NBIC Part 3, 3.3.4.3. If the remaining wall thickness is not adequate, a plate will require a flush patch (See NBIC Part 3, 3.3.4.6 a)) and a tube will require a new length of tube or tube patch (see NBIC Part 3, 3.3.4.6 b)).

**FIGURE 3.3.4.2-a**
UNSTAYED BOILER FURNACES

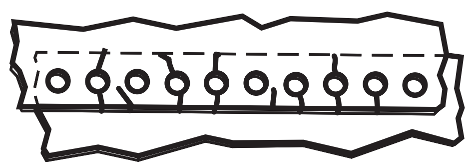


Cracks at the knuckle or at the turn of the furnace opening require immediate replacement of the affected area. If repairs are attempted, specific approval of the jurisdiction is required.

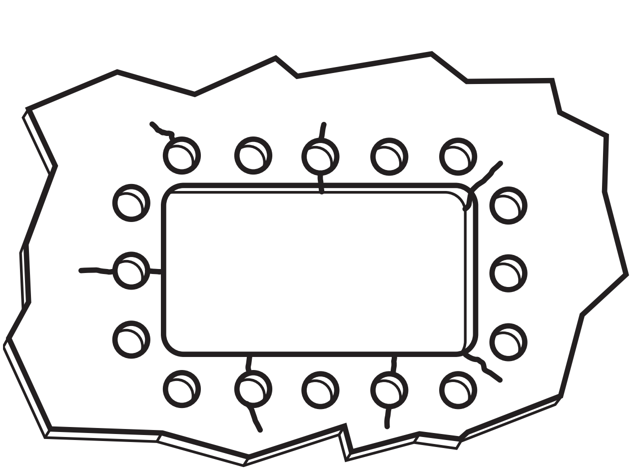
**FIGURE 3.3.4.2-b**
RIVET AND STAYBOLT HOLE CRACKS

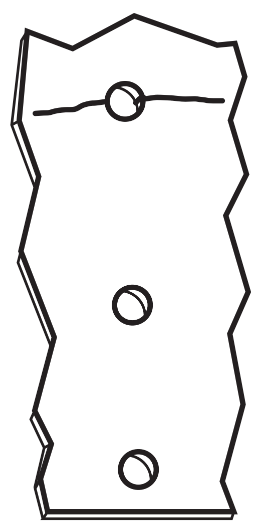


Circumferential Cracks at Girth Seams



Fire Cracks at Girth Seams





Cracks radiating from rivet or staybolt holes should be repaired if the plate is not seriously damaged. If the plate is seriously damaged, it shall be replaced. A suggested repair method is described below:

a) Prior to welding, the rivets or staybolts from which the cracks extend and the adjacent rivets (or staybolts if appropriate) should be removed;

b) In riveted joints, tack bolts should be placed in alternate holes to hold the plate laps firmly;

c) The cracks should then be prepared for welding by chipping, grinding, or gouging;

d) In riveted joints, cracks which extend past the inner edge of the plate lap should be welded from both sides;

e) Rivet holes should be reamed before new rivets are driven;

f) Threaded staybolt holes should be retapped and new staybolts properly driven and headed.

### 3.3.4.3 WASTED AREAS

a) Shells, Drums, Headers

Wasted areas in stayed and unstayed shells, drums, and headers may be built up by welding, provided that in the judgment of the Inspector the strength of the structure has not been impaired. Where extensive weld buildup is employed, the Inspector may require an appropriate method of NDE for the completed surface of the repair. For suggested methods of building up wasted areas by welding. (See NBIC Part 3, Figure 3.3.4.3-a).

b) Access Opening

Wasted areas around access openings may be built up by welding or they may be repaired as described in NBIC Part 3, Figure 3.3.4.3-b.

c) Flanges

Wasted flange faces may be cleaned thoroughly and built up with weld metal. They should be machined in place, if possible, to a thickness not less than that of the original flange or that required by calculations in accordance with the provisions of the original code of construction. Wasted flanges may also be re-machined in place without building up with weld metal, provided the metal removed in the process does not reduce the thickness of the flange to a measurement below that calculated above. Flanges that leak because of warpage or distortion and which cannot be re-machined shall be replaced with new flanges that have at least the dimensions conforming to the original code of construction.

d) Tubes

1) Wasted areas on tubes may be repaired by welding, provided that, in the judgment of the Inspector the strength of the tube has not been impaired. Where deemed necessary, competent technical advice should be obtained from the manufacturer or from another qualified source. This may be necessary when considering such items as size limitations of repaired areas, minimum tube thickness to be repaired, tube environment, location of the tube in the boiler, and other similar conditions.

2) The WPS followed shall be qualified for weld metal buildup in accordance with ASME Section IX. When the code of construction required postweld heat treatment (PWHT) for butt welds, the WPS followed for the weld buildup, shall be qualified with PWHT.

e) External Weld Metal Buildup

1) Pressure-retaining items that have localized internal thinning due to erosion and/or corrosion and where the internal surface is not readily accessible may be weld repaired by depositing weld metal on the external surface of the item as shown in NBIC Part 3, Figure 3.3.4.3-c. This method of repair is subject to approval by the Inspector and the Jurisdiction, where required.

2) All of the following conditions shall apply for this repair method to be permitted:

   a. The component to be repaired shall be a ferrous material;

   b. The maximum design temperature of the repaired component shall not exceed 650°F (340°C), and the minimum design temperature shall not be less than -20°F (-29°C);

   c. The pressure-retaining item shall be volumetrically examined for cracks in the area to be weld repaired. If cracks are detected, this repair method shall NOT be used;

   d. The WPS followed shall be qualified for weld metal buildup in accordance with ASME Section IX. The nominal chemical analysis of the deposited weld metal shall be equivalent to the base material that is to be repaired. In addition, the nominal tensile strength of the deposited weld metal shall be equal to or exceed the specified minimum tensile strength and shall be based on the requirements of the welding consumable. If butt welds in the component being overlaid required postweld heat treatment by the code of construction, the WPS followed for the weld buildup shall be qualified with PWHT;

   e. The pressure-retaining item shall be taken out of service prior to performing the weld metal buildup. The owner of the pressure-retaining item shall evaluate the flammability, volatility, or potential reaction of the contents that were in the vessel to ensure safe working conditions during weld repair. When required by the results of this evaluation, the pressure-retaining item shall be drained of its contents to the extent necessary to make the repair;

   f. This method may be used more than once in the same areas to repair locally thinned areas; however, the cumulative weld buildup for all repairs shall not exceed the thickness (t) of the component at any point;

   g. Repairs using this method shall not cover more than 25% of the circumference of the component.

3) External weld buildup shall be applied in accordance with the following requirements:

   a. The area to be repaired shall be ultrasonically scanned for wall thickness, and the location and size of the thinned region shall be mapped;

   b. The area requiring repairs and the boundaries of the weld buildup shall be marked on the external surface of the component;

   c. The general design of the external weld buildup shall be in accordance with NBIC Part 3, Figure 3.3.4.3-c. The finished weld buildup shall be circular, oval, or rectangular in shape;

   d. The weld buildup shall extend, at full thickness, a minimum distance B in each direction beyond the boundaries of the thinned base metal area.

      1. $B = 3/4 \sqrt{(Rt_{nom})}$

      2. R = outer radius of the component, or D/2

      3. $t_{nom}$ = nominal wall thickness of the component

      The thickness shall be sufficient to maintain the predicted life of the repair. Any corrosion allowance that is determined to be necessary shall be added to the value of B.

   e. All edges of the weld buildup shall be tapered to the existing contour of the component, at a maximum angle (a) of 45°;

f. The thickness of the weld buildup shall be uniform except along tapered edges as welded surfaces are acceptable, provided they are free of coarse ridges and valleys and are suitable for any required nondestructive examinations;

g. All corners of the weld buildup shall have a minimum radius (r), not less than the overlay thickness.

h. Any corrosion allowance that is determined to be necessary shall be added to the thickness of the weld buildup;

i. The thickness (W) of the weld deposit plus the remaining wall thickness in the affected area (μ) of the component at its thinnest point shall not exceed the nominal wall thickness (t) of the component. This shall be verified by ultrasonic methods;

j. Final dimension and contour of the weld buildup may be achieved by grinding or machining. This work may be done before or after any PWHT;

k. The weld buildup shall be examined by liquid penetrant inspection or wet fluorescent magnetic particle inspection. If the buttwelds in the component being built up were required to be volumetrically examined during the original construction, the built-up area shall be similarly volumetrically examined;

l. For each repair, the maximum dimension (L, length along axis) compensated by a circular or oval weld buildup shall not exceed the lesser of 1/4 the nominal outside diameter or the component of 8 in. (200 mm). The length of a rectangular patch is not limited;

m. The distance between the weld toes of the multiple weld buildup regions on a component outer diameter surface area shall not be less than 3/4 $\sqrt{(Rt)}$.

**FIGURE 3.3.4.3-a**

WELD BUILDUP OF WASTED AREA

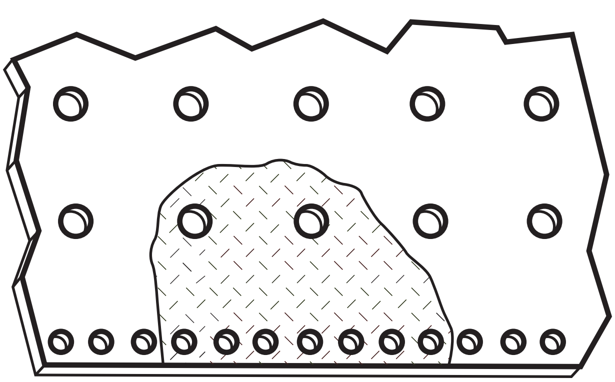
Rivets and Staybolts

a. Prior to welding, the rivets or staybolts in the wasted area should be removed.

b. Threaded staybolt holes should be retapped after welding.

c. Rivet holes should be reamed after welding.

d. Welding should not cover rivet or staybolt heads.

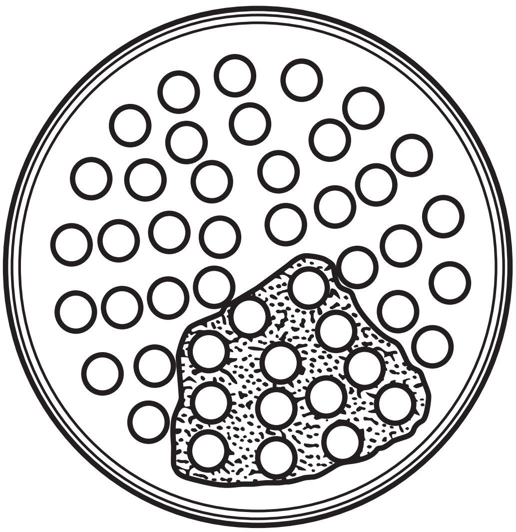


Rivets and Stay Bolts

Tubesheet

a. Prior to welding, the tubes in the wasted area should be removed.

b. After welding, the tube holes may be reamed before new tubes are installed.



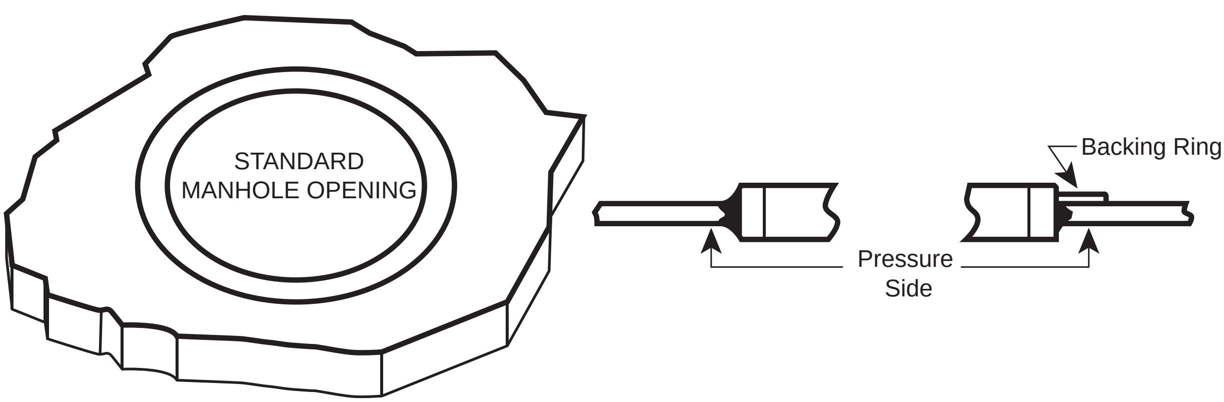
Tubesheet

Wasted areas in stayed and unstayed surfaces may be repaired by weld buildup, provided that in the judgment of the inspector the strength of the structure will not be impaired. Where extensive weld buildup is employed, the inspector may require an appropriate method of NDE for the complete surface of the repair.

**FIGURE 3.3.4.3-b**

REPAIRS FOR ACCESS OPENINGS

A badly wasted manhole flange may be removed and replaced with a ring-type frame as shown below. The requirements for flush patches shall be met. A full penetration weld is required. May be either double groove weld or welded from one side with or without a backing ring.




A badly wasted area around a handhole opening may be repaired by adding a ring, as shown below, on the inside of the object.

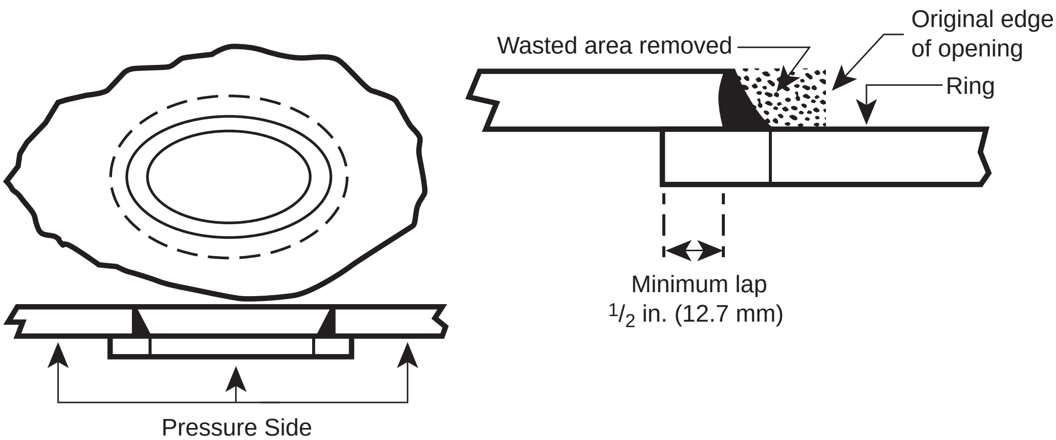
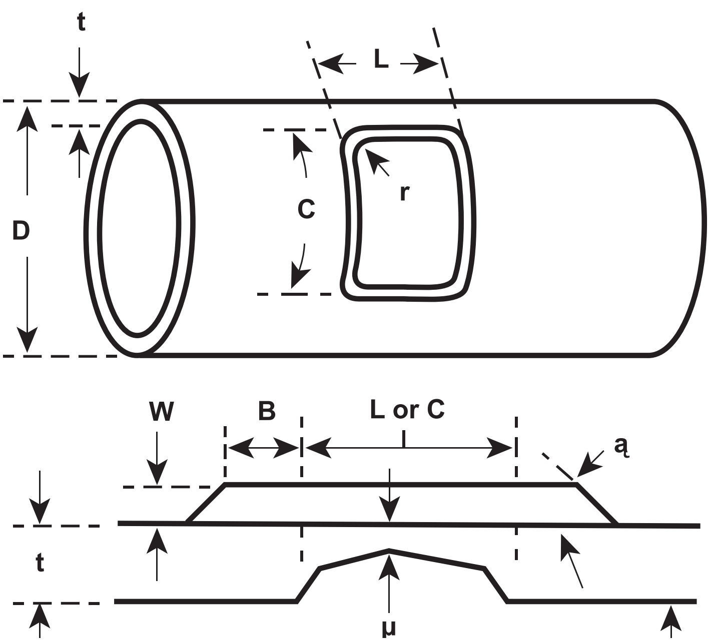



**FIGURE 3.3.4.3-c**

EXTERNAL OVERLAY TERMS AND DEFINITIONS




L = length of area to be repaired along the axis of the component

C = length of area to be repaired along outside circumference of the component

W = the completed thickness of the overlay

ą = the angle between the component and the overlay (maximum 45°)

B = 3/4 $(R+ t)^{0.5}$ minimum

R = nominal outside radius of the component

D = the nominal outside diameter of the component

t = nominal wall thickness of the component

μ = remaining wall thickness of the component shall be 1/16 or greater

r = minimum radius, not less than the overlay thickness

### 3.3.4.4 SEAL WELDING

a) Seal Welding of Tubes

Tubes may be seal welded, provided the ends of the tubes have sufficient wall thickness to prevent burn-through and the requirements of the original code of construction are satisfied as shown in NBIC Part 3, Figure 3.3.4.4-a.

b) Seal Welding of Riveted Joints

Edges of buttstraps, plate laps, and nozzles, or of connections attached by riveting, may be restored to original dimensions by welding. Seal welding of riveted joints, buttstraps, or rivets shall require the approval of the Jurisdiction. If seal welding is approved, suggested methods and precautions are shown in NBIC Part 3, Figure 3.3.4.4-b.

**FIGURE 3.3.4.4-a**

TYPICAL EXAMPLES OF SEAL WELDING TUBES

Tubes may be seal welded provided the ends of the tubes have sufficient wall thickness to prevent burn-through. Seal welding shall be applied in strict accordance with the original code of construction for the requirements of the tube projection, welding, and tube expanding. Seal welding shall not be considered a strength weld.

In watertube boilers, tubes may be seal welded on the inside or outside of the tubesheet.

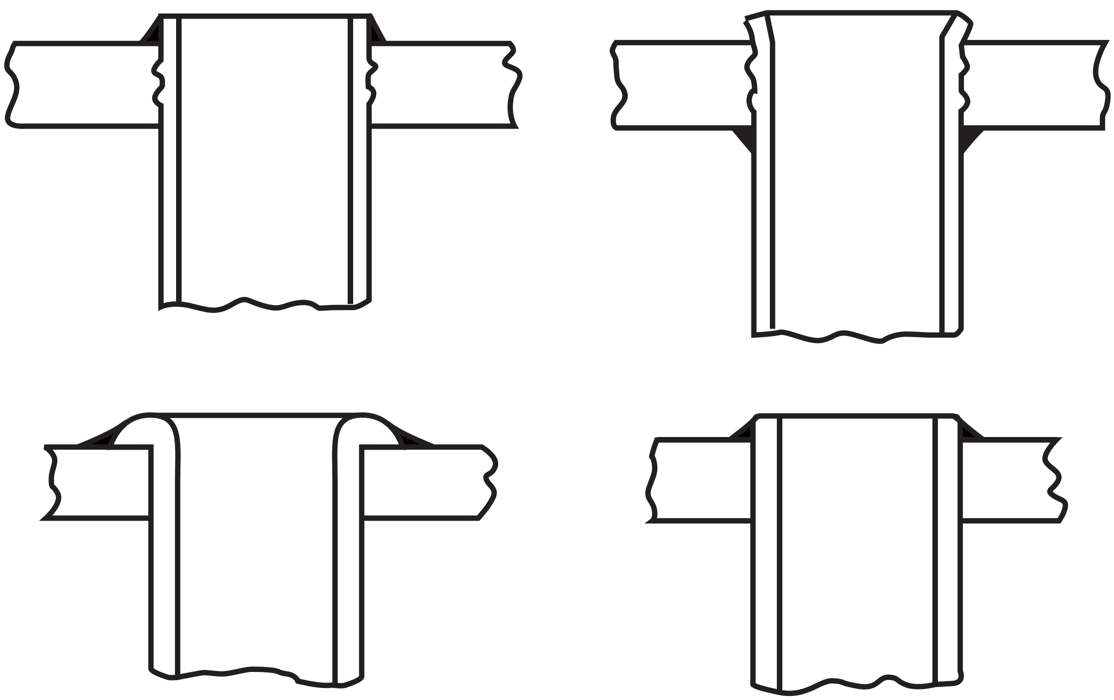
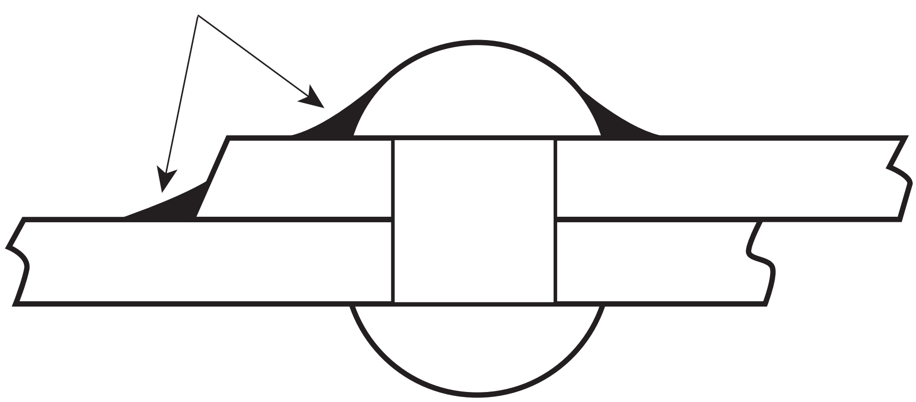


**FIGURE 3.3.4.4-b**

SEAL WELDING OF RIVETED JOINTS

Seal welding of riveted joints requires the approval of the Jurisdiction. Seal welding shall not be considered a strength weld. Prior to welding, the area should be examined by an appropriate method of NDE to ensure that there are no cracks radiating from the rivet holes. If necessary, the rivets should be removed to ensure complete examination of the area. Seal welding should not be performed if cracks are present in riveted areas.



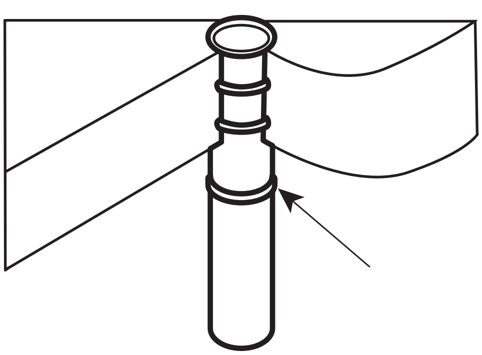

Typical Rivet Joint Showing Seal Weld

### 3.3.4.5 RE-ENDING OR PIECING PIPES OR TUBES

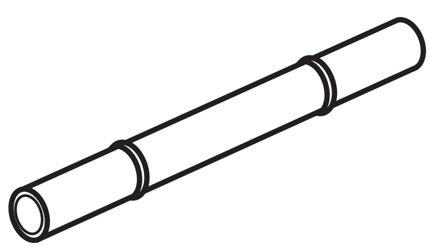
Re-ending or piecing pipes or tubes is permitted, provided the thickness of the remaining pipe or tube is not less than the minimum thickness required by the original code of construction. (See NBIC Part 3, Figure 3.3.4.5).

**FIGURE 3.3.4.5**

RE-ENDING OR PIECING OF PIPES OR TUBES



Re-ending



Piecing

### 3.3.4.6 PATCHES

a) Flush Patches

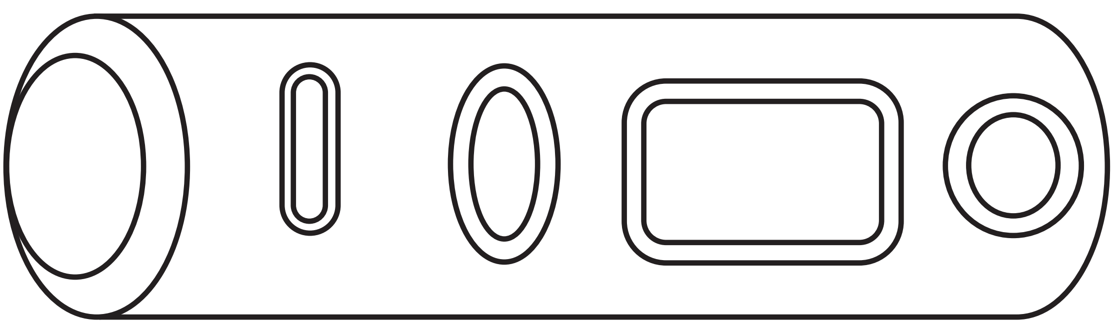
1) The weld around a flush patch shall be a full penetration weld and the accessible surfaces shall be ground flush where required by the applicable original code of construction. Examples of flush welded patches are shown in NBIC Part 3, Figure 3.3.4.6-a. The welds shall be subjected to the nondestructive examination method used in the original code of construction or an alternative acceptable to the Inspector.

2) Before installing a flush patch, the defective material should be removed until sound material is reached. The patch should be rolled to the proper shape or curvature. The edges should align without overlap. In stayed areas, the weld seams should come between staybolt rows or riveted seams. Patches shall be made from a material whose composition and thickness meet the intended service. Patches may be any shape or size. If the patch is rectangular, an adequate radius should be provided at the corners. Square corners should be avoided. The completed welds shall meet the requirements of the original code of construction.

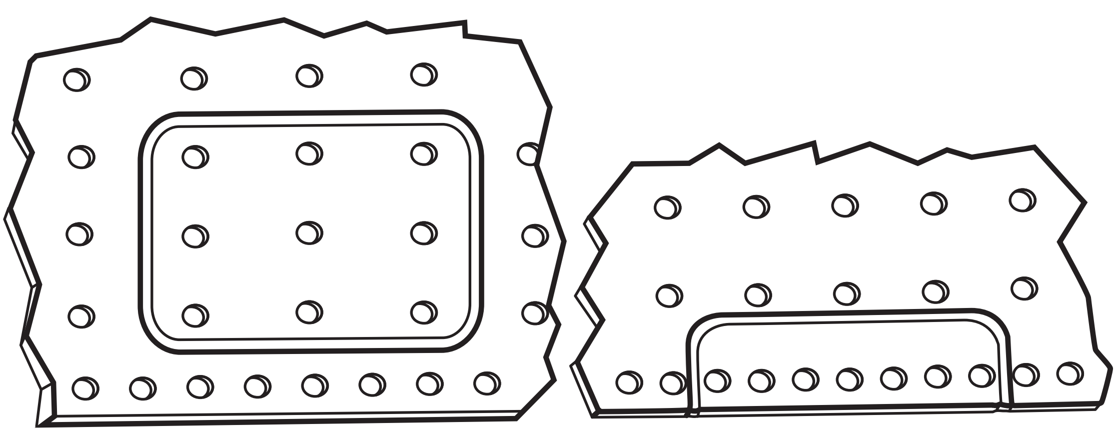
b) Tube Patches

In some situations it is necessary to weld a flush patch on a tube, such as when replacing tube sections and accessibility around the complete circumference of the tube is restricted, or when it is necessary to repair a small bulge. This is referred to as a window patch. Suggested methods for window patches are shown in NBIC Part 3, Figure 3.3.4.6-b.

**FIGURE 3.3.4.6-a**
FLUSH PATCH CONFIGURATIONS IN UNSTAYED AREAS



FLUSH PATCHES IN STAYED AREAS



## FIGURE 3.3.4.6-b
TUBE WINDOW PATCHING METHOD

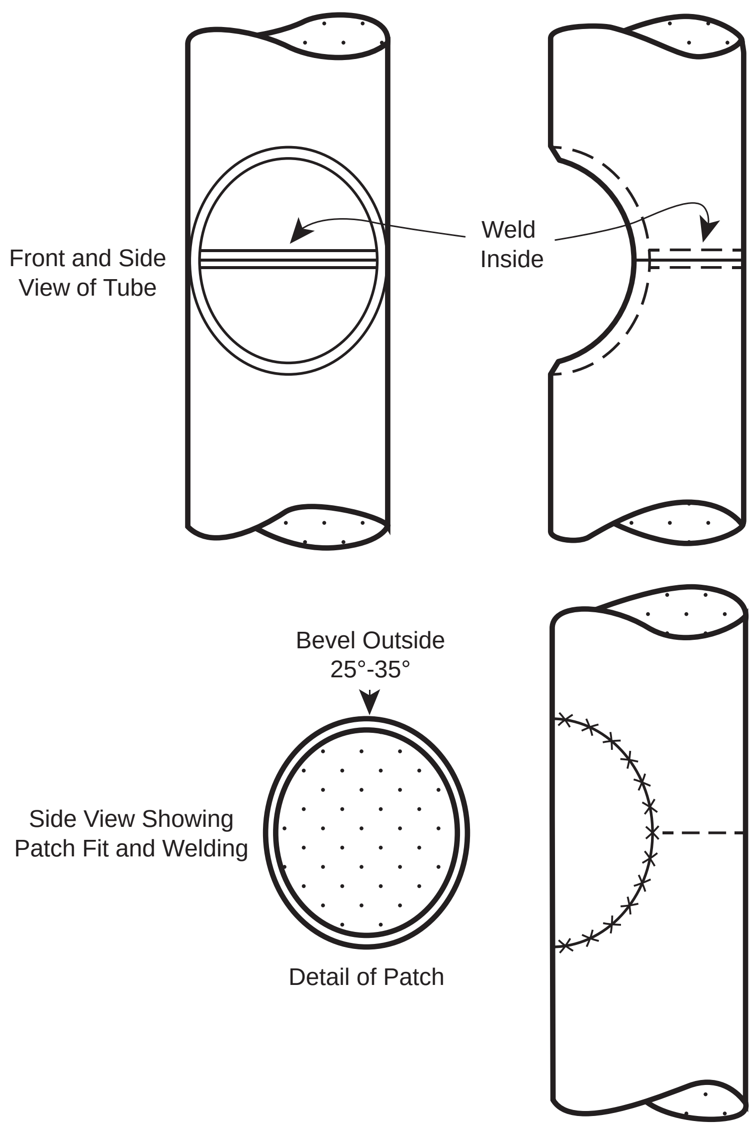
It may be necessary to weld a flush patch on a tube since, in some situations, accessibility around the complete circumference of the tube is restricted. Listed below are the suggested methods for making window patches:

1) The patch should be made from tube material of the same type, diameter, and thickness as the one being repaired.

2) Fit-up of the patch is important to weld integrity. The root opening should be uniform around the patch.

3) The gas tungsten-arc welding process should be used for the inital pass on the inside of the tube and for the inital pass joining the patch to the tube.

4) The balance of the weld may be completed by any appropriate welding process.



### 3.3.4.7 STAYS

Threaded stays may be replaced by welded-in stays provided that, in the judgement of the Inspector, the material adjacent to the staybolt has not been materially weakened by deterioration or wasting away. Requirements of the original code of construction governing welded-in stays shall be met.

### 3.3.4.8 REPAIR OF PRESSURE-RETAINING ITEMS WITHOUT COMPLETE REMOVAL OF DEFECTS

a) There may be cases where removal of a defect in a pressure-retaining item is not practical at the time the defect is found. In such cases, with approval of the Inspector and, when required, the Jurisdiction, an engineering evaluation shall be performed to determine the scope of the repair and impact to safety prior to returning the pressure-retaining item to service for a specified period of time. The engineering evaluation shall be performed by an organization with demonstrated competency in defect (and flaw) characterization of pressure-retaining items. The method of defect evaluation and time interval for returning the pressure-retaining item back to service shall be as agreed upon by the Inspector, and when required, the Jurisdiction. The specified period of time the defect can remain in service after weld repair shall be based on no measureable defect growth during subsequent inspections, or a period of time as specified by the Jurisdiction, if applicable. This repair method is not permitted for vessels used in lethal service, vessels designed for high-cycle operation or fatigue service, compressed air storage, and in cases where high stress concentration cannot be reduced by weld repair. This repair method is not permitted for DOT vessels.

b) One or more fitness-for-service engineering evaluation methods as described in NBIC Part 2, 4.4 shall be used to determine whether the defect may remain, either in part or in whole, in the pressure-retaining item. If it is determined that the defect can remain in the item, a risk-based inspection program shall be developed to assure inspection of the defect and monitoring of defect growth over time. This program shall be a controlled and documented inspection program that specifies inspection intervals as agreed upon with the Inspector and, when required, the Jurisdiction, and shall be maintained until the defect can be completely removed and the item repaired.

c) The following requirements shall apply to the weld repair of pressure-retaining items without complete removal of defects:

1) Engineering evaluation of the defect in the pressure-retaining item shall be conducted using one or more fitness-for-service condition assessment method(s) as described in NBIC Part 2, 4.4. Engineering evaluation of the condition assessment results shall be performed by an organization that has demonstrated industry experience in evaluating pressure-retaining items as referenced in NBIC, Part 2, S5.3.

2) If engineering evaluation indicates a defect can remain in the pressure-retaining item, a risk-based inspection program shall be developed and implemented based on review and acceptance by the Inspector and, when required, the Jurisdiction. The risk-based inspection program shall be in accordance with the requirements in NBIC, Part 2 4.4.

3) The fitness-for-service condition assessment and risk-based inspection programs shall remain in effect for the pressure-retaining item until such time that the defect can be completely removed and the item repaired. The fitness-for-service condition assessment method, results of assessment, and method of weld repair shall be documented on a Report of Fitness for Service Assessment (FFSA) Form as described in NBIC Part 2, 4.4.1 and shall be filed with the Jurisdiction, when required.

4) When weld repairs are performed without complete removal of the defect(s), this shall be noted on the Form R-1 in the description of the work. The "R" Stamp Holder performing the weld repairs shall provide detailed information on the Form R-1, describing the method and extent of repair and include the specific location of the repair on the item.

5) The interval to either re-inspect or remove the item from service for repair shall be determined based on a risk-based inspection program developed and implemented as required by NBIC Part 3, 3.3.4.8. The inspection interval shall not exceed the remaining life of the item, and shall be documented on the FFSA Form and in the Remarks section of the Form R-1. The FFSA Form shall be affixed to the Form R-1 when weld repairs are performed in NBIC Part 3, 3.3.4.8.

6) A copy of the completed Form R-1 with the completed FFSA Form attached may be registered with the National Board, and when required, filed with the Jurisdiction where the item was installed.



(15) **3.3.4.9 TUBE PLUGGING IN FIRETUBE BOILERS**

When the replacement of a tube in a firetube boiler is not practicable at the time the defective tube is detected, with the concurrence of the owner, Inspector, and when required, the Jurisdiction, the tube may be plugged using the following course of repair:

a) The scope of work, type of plug and method of retention; whether welded or mechanical interface, shall be evaluated by the "R" Certificate Holder performing the repair and reviewed with the Inspector, and when required, the Jurisdiction.

b) When the method of plugging is by welding, strength calculations for the size of the weld shall be in accordance with the original code of construction. The "R" Certificate Holder performing this repair shall weld the plug to the tube, or to the tube sheet, or a combination of both.

c) Plugging a tube in a firetube boiler is recognized as an alternative to the replacement of a firetube and may be further limited as a method of repair by the number of tubes plugged and their location; scattered or clustered. The operational effects on the waterside pressure boundary or membrane and the effects on the combustion process throughout the boiler should be considered prior to plugging.

d) The boiler may be returned to service for a period of time agreed upon by the owner, the Inspector, and when required, the Jurisdiction.

e) The Form R-1 shall be completed for the plugging of firetubes, identifying the means of plug retention; mechanical or by welding.

## 3.3.5 REPAIR OF ASME SECTION VIII, DIVISION 2 OR 3, PRESSURE VESSELS

### 3.3.5.1 SCOPE

The following requirements shall apply for the repair of pressure vessels constructed to the requirements of Section VIII, Division 2 or 3, of the ASME Code.

### 3.3.5.2 REPAIR PLAN

The user shall prepare, or cause to have prepared, a detailed plan covering the scope of the repair.

a) Engineer Review and Certification

The repair plan shall be reviewed and certified by an engineer meeting the criteria of ASME Section VIII, Division 2 or 3, as applicable, for an engineer signing and certifying a Manufacturer's Design Report. The review and certification shall be such as to ensure the work involved in the repair is compatible with the User's Design Specification and the Manufacturer's Design Report.

**Note:** The engineer qualification criteria of the Jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

b) Authorized Inspection Agency Acceptance

Following review and certification, the repair plan shall be submitted for acceptance to the Authorized Inspection Agency/Owner-User Inspection Organization whose Inspector will make the acceptance inspection and sign the Form R-1.

## 3.4 ALTERATIONS

### 3.4.1 RE-RATING[12]

Re-rating of a pressure-retaining item by increasing the maximum allowable working pressure (internal or external) or temperature or decreasing the minimum design metal temperature below which notch toughness testing is required by the original code of construction, shall be done only after the following requirements have been met to the satisfaction of the Jurisdiction at the location of the installation:

a) Revised calculations verifying the new service conditions shall be prepared in accordance with the "R" Certificate Holder's Quality Control System. Establishing a higher joint efficiency to re-rate a pressure-retaining item is not permitted;

b) All re-ratings shall be established in accordance with the requirements of the construction standard to which the pressure-retaining item was built;

c) Current inspection records verify that the pressure-retaining item is satisfactory for the proposed service conditions;

d) The pressure-retaining item has been pressure tested, as required, for the new service conditions. Any insulation, coatings, or coverings that may inhibit or compromise a meaningful pressure test shall be removed, to the extent identified by the Inspector;

e) In lieu of pressure testing, alternative methods can be used to ensure the structural integrity of the re-rated pressure-retaining item. The alternative methods shall be documented and subject to review and approval by the Jurisdiction.

### 3.4.2 ALTERATIONS BASED ON ALLOWABLE STRESS VALUES

For re-rating or re-calculating a new minimum wall thickness for a pressure-retaining item using a later edition/addenda of the original code of construction or selected construction standard or code that permits use of higher allowable material stress values than were used in the original construction, the following requirements shall apply:

a) The "R" Certificate Holder shall verify, by calculations and other means, that the re-rated item can be satisfactorily operated at the new service condition (e.g., stiffness, buckling, external mechanical loadings);

b) The pressure-retaining item shall not be used in lethal service;

c) The pressure-retaining item shall not be used in high-cycle operation or fatigue service (i.e., loadings other than primary membrane stress are controlling design considerations) unless the pressure-retaining item was originally designed for fatigue service and a fatigue analysis is performed;

d) The pressure-retaining item shall have been constructed to the 1968 edition or later edition/addenda of the original code of construction;

12 Re-rating: Except as provided for Yankee dryers in Supplement 5, this code does not provide rules for de-rating boilers or pressure vessels; however, when the MAWP and/or allowable temperature of a boiler or pressure vessel is reduced, the Jurisdiction where the object is installed should be contacted to determine if specific procedures should be followed.

e) The pressure-retaining item shall be shown to comply with all relevant requirements of the edition/addenda of the code of construction, which permits the higher allowable stress values (e.g., reinforcement, toughness, examination, pressure testing);

f) The pressure-retaining item shall have a satisfactory operating history and current inspection of the pressure-retaining item shall verify the item exhibits no unrepaired damage (e.g., cracks, corrosion, erosion). Areas of corrosion or erosion may be left in place provided the remaining wall thickness is greater than the minimum thickness for the new design conditions;

g) The re-rating shall be acceptable to the Inspector and, where required, the Jurisdiction;

h) All other requirements of Part 3, as applicable, and jurisdictional requirements shall be met;

i) Use of this paragraph shall be documented in the "Remarks" section of Form R-2.

### 3.4.3 EXAMPLES OF ALTERATIONS

a) An increase in the maximum allowable working pressure (internal or external) or temperature of a pressure-retaining item regardless of whether or not a physical change was made to the pressure-retaining item;

b) A decrease in the minimum temperature;

c) The addition of new nozzles or openings in a boiler or pressure vessel except those classified as repairs;

d) A change in the dimensions or contour of a pressure-retaining item;

e) In a boiler, an increase in the heating surface or steaming capacity as described on the original Manufacturer's Data Report;

f) The addition of a pressurized jacket to a pressure vessel;

g) Except as permitted in NBIC Part 3, 3.3.3 s); replacement of a pressure retaining part in a pressure retaining item with a material of different allowable stress or nominal composition from that used in the original design;

h) The addition of a bracket or an increase in loading on an existing bracket that affects the design of the pressure-retaining item to which it is attached;

i) The replacement of a pressure relieving device (PRD) as a result of work completed on a pressure-retaining item (PRI) that changes the resultant capacity to exceed the minimum requiredrelieving capacity (MRRC) required by the original code of construction as described on the original Manufacturer's Data Report.

### 3.4.4 ALTERATION OF ASME CODE SECTION VIII, DIVISION 2 OR 3, PRESSURE VESSELS

#### 3.4.4.1 ALTERATION PLAN

a) Engineer Review and Certification

The alteration plan shall be reviewed and certified by an engineer meeting the criteria of ASME Section VIII, Division 2 or 3, as applicable, for an engineer signing and certifying a Manufacturer's Design Report. The review and certification shall be such as to ensure the work involved in the alteration is compatible with the user's design specification and the Manufacturer's Design Report.

**Note**: The engineer qualification criteria of the jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

b) User's Design Specification

If the alteration is such that the work is not compatible with, or changes one or more requirement(s) of the original user's design specification, the user's design specification shall be revised by the user with the new parameters or changes. The revisions shall be certified by an engineer meeting the criteria of ASME Section VIII, Division 2 or 3, as applicable, for an engineer signing and certifying a Manufacturer's Design Report.

**Note:** The engineer qualification criteria of the Jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

c) Manufacturer's Design Report

The "R" Certificate Holder shall prepare, or cause to have prepared a supplement to the *Manufacturer's Design Report* to reconcile the new parameters or changes with the user's design specification.

The supplement to the Manufacturer's Design Report shall be certified by an engineer meeting the criteria of ASME Section VIII, Division 2 or 3, as applicable, for an engineer signing and certifying a Manufacturer's Design Report.

**Note:** The engineer qualification criteria of the Jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

d) Authorized Inspection Agency Acceptance

Following review and certification, the alteration plan shall be submitted for acceptance to the Authorized Inspection Agency/Owner-User Inspection Organization whose inspector will make the acceptance inspection and sign the Form R-2.

# PART 3, SECTION 4
# REPAIRS AND ALTERATIONS — EXAMINATION AND TESTING

## 4.1 SCOPE

This section provides requirements and guidelines for performing examinations and tests for repairs and alterations to pressure-retaining items.

## 4.2 NONDESTRUCTIVE EXAMINATION

a) The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction for the pressure-retaining item. Weld repairs and alterations shall be subjected to the same nondestructive examination requirements as the original welds. Where this is not possible or practicable, alternative NDE methods acceptable to the Inspector and the Jurisdiction where the pressure-retaining item is installed, where required, may be used.

b) NDE personnel shall be qualified and certified in accordance with the requirements of the original code of construction. When this is not possible or practicable, NDE personnel may be qualified and certified in accordance with their employer's written practice. ASNT SNT-TC-1A, *Recommended Practice Nondestructive Testing Personnel Qualification and Certification* (2006 edition), or ASNT CP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel* (2006 edition), shall be used as a guideline for employers to establish their written practice. The ASNT Central Certification Program (ACCP, Rev. 3, Nov. 1997) may be used to fulfill the examination and demonstration requirements of the employer's written practice. Provisions for training, experience, qualification, and certification of NDE personnel shall be described in the "R" Certificate Holder's written quality system.

## 4.3 PRESSURE GAGES, MEASUREMENT, EXAMINATION, AND TEST EQUIPMENT

The calibration of pressure gages, measurement, examination, and test equipment, and documentation of calibration shall be performed, as required, by the applicable standard used for construction.

## 4.4 EXAMINATION AND TEST FOR REPAIRS AND ALTERATIONS

The following requirements shall apply to all repairs and alterations to pressure-retaining items:

a) The integrity of repairs, alterations, and replacement parts used in repairs and alterations shall be verified by examination or test;

b) Testing methods used shall be suitable for providing meaningful results to verify the integrity of the repair or alteration. Any insulation, coatings, or coverings that may inhibit or compromise a meaningful test method shall be removed, to the extent identified by the Inspector;

c) The "R" Certificate Holder is responsible for all activities relating to examination and test of repairs and alterations;

d) Examinations and tests to be used shall be subject to acceptance of the Inspector and, where required, acceptance of the Jurisdiction.

### 4.4.1 TEST OR EXAMINATION METHODS APPLICABLE TO REPAIRS

Based on the nature and scope of the repair activity, one or a combination of the following examination and test methods shall be applied to repairs and replacement parts used in repairs.

a) Liquid Pressure Test

Pressure testing of repairs shall meet the following requirements:

1) Pressure tests shall be conducted using water or other liquid medium. The test pressure shall be the minimum required to verify the leak tightness integrity of the repair, but not more than 150% of the maximum allowable working pressure (MAWP) stamped on the pressure-retaining items, as adjusted for temperature. When original test pressure included consideration of corrosion allowance, the test pressure may be further adjusted based on the remaining corrosion allowance.

2) During a pressure test where the test pressure will exceed 90% of the set pressure of the pressure relief device, the device shall be removed whenever possible. If not possible, a spindle restraint may be used following the valve manufacturer's instructions and recommendations. 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 the proper operation of the valve. The spindle restraint shall be removed following the test.

   The organization that performs the pressure test and applies a spindle restraint shall attach a metal tag that identifies the organization and 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 the pressure-retaining items are installed.

3) The metal temperature for the pressure test shall be in accordance with the original code of construction, but not less than 60°F (16°C) unless the owner provides information on the toughness characteristics of the material to indicate the acceptability of a lower test temperature. For thick walled pressure retaining items, it is recommended to seek technical guidance in establishing the notch toughness characteristics of the steel prior to pressure testing so that the metal temperature may be warmed above 60° F (16°C) to avoid brittle fracture. During close examination the metal temperature shall not exceed 120°F (49°C), unless the owner specified requirements for a higher test temperature, and it is acceptable to the Inspector.

4) Table 4.4.1 may be used for liquid pressure testing of steels supplied as coarse-grained under the following specifications;
   ASME SA 212,
   ASME SA 515, and
   ASME SA 299

   If supplied as coarse-grained, the above steels can exhibit low toughness at room temperature and in lieu of conducting notch toughness tests, Table 4.4.1 and Table 4.4.1 M can be used to establish a temperature for the liquid to reduce the risk of brittle fracture. Table 4.4.1 and Table 4.4.1 M contain minimum liquid temperature requirements based on metal thickness of the pressure retaining part.

5) Hold-time for the pressure test shall be a minimum of 10 minutes prior to examination by the Inspector. Where the test pressure exceeds the MAWP of the item, the test pressure shall be reduced to the MAWP for close examination by the Inspector. Hold-time for close examination shall be as necessary for the Inspector to conduct the examination.

## TABLE 4.4.1

| Minimum Liquid Temperature for Pressure Testing (°F) | Thickness (inches) of Pressure-Retaining Object (Note 1) |
|---|---|
| 60 | t <= 0.5 |
| 70 | t > 0.5 <= 1 |
| 85 | t > 1 <= 2 |
| 100 | t > 2 <= 4 |
| 110 | t > 4 |

**Note 1:**

Thickest section of the pressure-retaining object.

## TABLE 4.4.1.4 M

| Minimum Liquid Temperature for Pressure Testing (°C) | Thickness (mm) of Pressure-Retaining Object (Note 1) |
|---|---|
| 15 | t <= 13 |
| 20 | 13 < t <= 25 |
| 29 | 25 < t <= 50 |
| 38 | 50 < t <= 100 |
| 43 | t > 100 |

**Note 1:**

Thickest section of the pressure-retaining object

b) Pneumatic Test

A pneumatic test may be conducted. Concurrence of the owner shall be obtained in addition to that of the Inspector and Jurisdiction where required. The test pressure shall be the minimum required to verify leak tightness integrity of the repair, but shall not exceed the maximum pneumatic test pressure of the original code of construction. Precautionary requirements of the original code of construction shall be followed;

c) Initial Service Leak Test

When an initial service leak test is permitted by the original code of construction, such testing may also be used to verify the leak tightness integrity of repairs;

d) Vacuum Test

A vacuum test may be conducted. Vacuum test methods used shall be suitable to verify the leak tightness integrity of the repair.

e) Nondestructive Examination (NDE)

NDE may be conducted. NDE methods used shall be suitable for providing meaningful results to verify the integrity of the repair. Exclusive use of visual examination (VT) is only permitted with the following considerations:

1) When a pressure test or alternative NDE methods other than visual examination, are not practicable the exclusive use of direct VT as an NDE method shall be limited to routine repairs, as identified in NBIC Part 3, 3.3.2.

2) For each repair being considered, the exclusive use of direct VT as an NDE method shall be acceptable to the Inspector, and where required, the Jurisdiction.

3) As a minimum, direct VT shall be performed after the root weld layer or first-pass is deposited, and the final weld surface. Other weld layers shall be examined as identified by the Inspector and, where required, the Jurisdiction.

4) Personnel completing direct VT shall be qualified and certified in accordance with paragraph NBIC Part 3, 4.2- b), AWS QC-1, or any nationally recognized standard acceptable to the Jurisdiction. Visual acuity shall be demonstrated using as a minimum, standard J-2 letters on standard Jaeger test type charts for near vision.

5) Direct VT shall be performed in accordance with a written procedure meeting the procedure and reporting requirements listed in the original code of construction or ASME Section V, Article 9.

### 4.4.2 TEST OR EXAMINATION METHODS APPLICABLE TO ALTERATIONS

Based on the nature and scope of the alterations activity, one or a combination of the following examination and test methods shall be applied to alterations and replacement parts used in alterations.

a) Liquid Pressure Test

Pressure testing of alterations shall meet the following requirements:

1) A pressure test as required by the original code of construction shall be conducted. The test pressure shall not exceed 150% of the maximum allowable working pressure (MAWP) stamped on the pressure-retaining item, as adjusted for temperature. When the original test pressure included consideration of corrosion allowance, the test pressure may be further adjusted based on the remaining corrosion allowance. The pressure test for replacement parts may be performed at the point of manufacture or point of installation;

2) As an alternative to pressure testing connecting welds in accordance with the original code of construction, connecting welds may be tested or examined in accordance with the rules for repairs (see NBIC Part 3, 4.4.1). Connecting welds are defined as welds attaching the replacement part to the pressure-retaining item;

3) During a pressure test where the test pressure will exceed 90% of the set pressure of the pressure relief device, the device shall be removed whenever possible. If not possible, a spindle restraint may be used following the valve manufacturer's instructions and recommendations. 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 the proper operation of the valve. The spindle restraint shall be removed following the test.

a. The organization that performs the pressure test and applies a spindle restraint shall attach a metal tag that identifies the organization and 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 the pressure-retaining items are installed;

4) The metal temperature for the pressure test shall be in accordance with the original code of construction, but not less than 60°F (16°C), unless the owner provides information on the toughness characteristics of the material to indicate the acceptability of a lower test temperature. For thick walled pressure-retaining items, it is recommended to seek technical guidance in establishing the notch toughness characteristics of the steel prior to pressure testing so that the metal temperature may be warmed above 60°F (16°C) to avoid brittle fracture. During close examination, the metal temperature shall not exceed 120°F (49°C), unless the owner specifies requirements for a higher test temperature and it is acceptable to the Inspector;

5) Unless it can be demonstrated that the material has been supplied as fine grained, it is recommended that Table 4.4.1.4 or 4.4.1.4 M be followed for pressure testing of steels supplied under the following specifications:

   ASME SA 212,

   ASME SA 515, and

   ASME SA 299

6) Hold-time for the pressure test shall be a minimum of 10 minutes prior to examination by the Inspector. Where the test pressure exceeds the MAWP of the item, the test pressure shall be reduced to the MAWP for close examination by the Inspector. Hold-time for close examination shall be as necessary for the Inspector to conduct the examination.

b) Pneumatic Test

   A pneumatic test may be conducted when contamination of the pressure-retaining item by liquids is possible or when liquid pressure testing is not practicable. Concurrence of the owner shall be obtained in addition to the Inspector and Jurisdiction where required. Pneumatic test requirements and precautions shall be in accordance with the original code of construction.

c) Nondestructive Examination

   NDE may be conducted when contamination of the pressure-retaining item by liquids is possible or when pressure testing is not practicable. Concurrence of the owner shall be obtained in addition to the Inspector, and where required, the Jurisdiction. Exclusive use of Visual Examination (VT) shall not be permitted. In all cases NDE methods or combination of methods used shall be suitable for providing meaningful results to verify the integrity of the alteration.

## ~~4.5 PRESSURE RELIEF VALVE PERFORMANCE TESTING AND TESTING EQUIPMENT~~

~~Each pressure relief valve to which the “VR” repair symbol stamp is to be applied shall be subjected to the following tests by the repair certificate holder.~~

### ~~4.5.1 TEST MEDIUM AND TESTING EQUIPMENT~~

~~Valves marked for steam service, or having special internal parts for steam service, shall be tested on steam. Valves marked for air, gas, or vapor service shall be tested with air or gas. Valves marked for liquid service shall be tested with water or other suitable liquid. ASME Code, Section IV hot water valves, shall be tested on water, steam, or air.~~

~~a) Each valve shall be tested to demonstrate the following:~~

1) ~~Set pressure (as defined by the valve manufacturer and as listed in NB-18, *Pressure Relief Device Certifications*);~~

2) ~~Response to blowdown, when required by the original code of construction;~~

3) ~~Seat tightness; and~~

4) ~~For valves designed to discharge to a closed system, the tightness of the secondary pressure zone shall be tested as required by the original code of construction.~~

b) ~~The equipment used for the performance testing prescribed above shall meet the following requirements:~~

1) ~~The performance testing equipment shall include a pressure vessel of adequate volume and pressure source capacity to ensure compliance with NBIC Part 3, 4.5.1 a) 1).~~

2) ~~Prior to use, all performance testing equipment shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark testing, comparisons to equipment used for verification testing as specified in the quality system, or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation for a period of at least five years after the testing equipment is retired. Documentation of this qualification shall include, but not be limited to:~~

a. ~~Schematic of the performance test equipment;~~

b. ~~Size and pressure ranges of valves to be tested and the test fluid to be used;~~

c. ~~Dimensions of test vessels;~~

d. ~~Accuracy of pressure measuring equipment;~~

e. ~~Size and design type of valves used to control flow; and~~

f. ~~Method of qualifying.~~

3) ~~Prior to the implementation of any addition or modification to the testing equipment that would alter the contents of the document required in NBIC Part 3, 4.5.1 b) 2), the certificate holder shall re qualify the performance test equipment in accordance with NBIC Part 3, 4.5.1 b) 2). If the equipment changed was used to satisfy the requirements of verification testing, the certificate holder shall notify the National Board and additional verification testing, in accordance with the quality system, may be required.~~

### ~~4.5.2 OWNER-USER ASME CODE SECTION VIII STEAM TESTING~~

~~When ASME Code Section VIII valves are repaired by the owner for the owner's own use, valves for steam service may be tested on air for set pressure and, if possible, blowdown adjustment, provided the valve manufacturer's corrections for differential in set pressure between steam and air are applied to the set pressure.~~

### ~~4.5.3 LIFT ASSIST TESTING~~

a) ~~A device may be used to apply an auxiliary lifting load on the spring of a repaired valve to establish the set pressure in lieu of the tests required in NBIC Part 3, 4.5.1 a) 1) when such testing at full pressure:~~

1) ~~May cause damage to the valve being tested; or~~

2) ~~Is impractical when system design considerations preclude testing at full pressure.~~

~~b) While actual valve blowdown and valve performance characteristics cannot be verified, valve set pressure may be determined to an acceptable degree of accuracy using this testing technique provided, as a minimum, that:~~

~~1) equipment utilized is calibrated as required in the quality system; including, but not limited to:~~

~~a. System pressure measurement equipment;~~

~~b. Lifting force measurement equipment; and~~

~~c. Other measuring elements required by the device manufacturer.~~

~~2) the device and test procedures that have proved to give accurate results are used and followed;~~

~~3) a static inlet pressure is applied with the test medium specified in NBIC Part 3, 4.5.1; and~~

~~4) adjustments are made in accordance with the valve manufacturer's recommendations to ensure proper lift and blowdown.~~

~~c) Prior to use, all lift assist devices shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation for a period of at least five years after the lift assist device is retired. Documentation of this qualification shall include but not be limited to:~~

~~1) A description of the lift assist device including model number, serial number and manufacturer.~~

~~2) Size and pressure ranges of valves to be tested with the lift assist device and the test fluid to be used.~~

~~**Note**: Maximum set pressure is determined by available lift force and system pressure.~~

~~3) Accuracy of pressure measuring equipment.~~

~~4) Method of qualifying.~~

~~d) After initial qualification of the device the device shall be re-qualified if:~~

~~1) Modifications or repairs to the device are made which would affect test results.~~

~~2) The manufacturer issues a mandatory recall or modification to the device which will affect test results.~~

### ~~4.5.4 PRESSURE TEST OF PARTS~~

~~a) Parts used in repaired valves shall be pressure tested and documentation provided according to the following categories:~~

~~1) Replacement Parts~~

~~The "VR" Certificate Holder is responsible for documentation that the appropriate pressure test has been completed as required by the original code of construction.~~

~~2) Parts Repaired by Welding~~

~~These parts shall be subjected to a pressure test required by the original code of construction. The "VR" Certificate Holder shall be responsible for documentation of such test.~~

~~b) Parts repaired by re-machining within part specifications, lapping, or polishing do not require a pressure test.~~

# PART 3, SECTION 5
# REPAIRS AND ALTERATIONS —
# CERTIFICATION/DOCUMENTATION AND STAMPING

## 5.1 SCOPE

This section provides requirements for certification, stamping, and documentation of repairs and alterations to pressure-retaining items. Applicable forms are provided in this section for reference. Forms may be obtained from the National Board website.

## 5.2 DOCUMENTATION

a) Repairs that have been performed in accordance with the NBIC shall be documented on a Form R-1, *Report of Repair*, as shown in this section. A Form R-4, *Report Supplementary Sheet*, shall be used as needed to record additional data when the space provided on Form R-1 is not sufficient.

b) Alterations performed in accordance with the NBIC shall be documented on a Form R-2, *Report of Alteration*, as shown in this section. A Form R-4, *Report Supplementary Sheet*, shall be used as needed to record additional data when the space provided on Form R-2 is not sufficient.

c) The organization performing repairs and alterations shall retain a copy of the completed Form "R" Report on file and all records and documentation substantiating the summary of work as described throughout Section 5, and as identified in the "R" Certificate Holder's Quality System Manual.

### 5.2.1 PREPARATION OF FORM R-1 (REPAIRS)

a) Using the instructions found at NBIC Part 3, 5.13.4.1 preparation of Form R-1 shall be the responsibility of the "R" Certificate Holder performing the repair.

b) Information describing the scope of work used to repair a pressure-retaining item (PRI) shall be documented on a Form R-1 and extended to a Form R-4 as needed to fully describe the repair activities completed per the instructions at NBIC Part 3, 5.13.4.1.

c) An Inspector shall indicate acceptance by signing Form R-1, and Form R-4, if attached.

d) The Form R-3, Manufacturer's Data Reports, and Certificates of Compliance described in this section shall be a part of the completed Form R-1 and shall be attached thereto.

### 5.2.2 PREPARATION OF FORM R-2 (ALTERATIONS)

a) Initial preparation of Form R-2 shall be the responsibility of the "R" Certificate Holder responsible for the design portion of the alteration. The design organization shall complete and sign the "Design Certification" section of the Form R-2. An Inspector shall indicate acceptance of the design by signing the "Certificate of Design Change Review" section of the Form R-2.

b) The information describing an alteration to a pressure-retaining item shall be identified on Form R-2 with a complete description of the scope of work for physical or non-physical changes. When the scope of work represents a change that will increase the Minimum Required Relieving Capacity (MRRC) of a pressure-retaining item, such as a change in heating surface, Maximum Designed Steaming Capacity (MDSC), or Btu/hr (W) heating capacity, the new MRRC shall be documented on Form R-2 and indicated on the appropriate nameplate of NBIC Part 3, Figure 5.7.5-b or NBIC Part 3, Figure 5.7.5-c.

c) Final preparation of Form R-2, including gathering and attaching supporting reports, shall be the responsibility of the "R" Certificate Holder that performed the construction portion of the alteration. The construction organization shall complete the Form R-2 provided by the design organization, including the "Construction Certification" section of the form. An Inspector shall indicate that the work complies with the applicable requirements of this code by completing and signing the "Certificate of Inspection" section of the form. When no construction work is performed (e.g., a re-rating with no physical changes), the "R" Certificate Holder responsible for the design shall prepare the Form R-2, including gathering and attaching of supporting reports.

d) The following shall be attached to and become a part of completed Form R-2:

1) For ASME boilers and pressure vessels, a copy of the original Manufacturer's Data Report, when available;

2) Form R-3, Report of Fabricated Parts Manufacturer's Partial Data Reports, or Certificates of Compliance; and

3) For other than ASME, the manufacturer's reports (i.e., reports required by the original code of construction, etc.), when available.

## 5.3 DISTRIBUTION OF FORM R-1

a) Legible copies of completed Form R-1, together with attachments, shall be distributed to the owner or user, the Inspector, the Jurisdiction, if required, and the Authorized Inspection Agency responsible for inservice inspection.

b) Distribution of Form R-1 and attachments shall be the responsibility of the organization performing the repair.

## 5.4 DISTRIBUTION OF FORM R-2

a) Distribution of completed Form R-2 shall be the responsibility of the "R" Certificate Holder who performed the construction portion of the alteration. When no construction work is performed (e.g., a re-rating with no physical changes), the "R" Certificate Holder responsible for the design shall distribute the form.

b) Legible copies of the completed Form R-2, together with attachments, shall be distributed to the Inspector, the authorized inspection agency responsible for the inservice inspection of the pressure-retaining item, the owner-user, the "R" Certificate Holder responsible for design, and the Jurisdiction, if required.

## 5.5 REGISTRATION OF "R" FORMS — GENERAL

a) When registration of the Form "R" Report is required, the "R" Certificate Holder performing a repair or alteration shall submit the completed Form "R" Report, meeting the requirements of the code, to the National Board.

b) When registration of the Form "R" Report is not required by the code, the "R" Certificate Holder may register the completed Form "R" Report , meeting the requirements of the code, with the National Board.

c) The "R" Certificate Holder should be aware that some Jurisdictions may require registration of repairs and alterations with the National Board.

### 5.5.1 REGISTRATION FOR REPAIRS

Form R-1 may be registered with the National Board as noted in NBIC Part 3, 5.5.

### 5.5.2 REGISTRATION FOR ALTERATIONS

a) If the pressure-retaining item is originally registered with the National Board, an original Form R-2, together with attachments, shall be registered with the National Board.

b) If the item was not registered with the National Board, one original Form R-2, together with attachments, may be registered with the National Board or retained as required by the Quality System Manual.

### 5.5.3 REGISTRATION FOR FIBER-REINFORCED VESSELS

Organizations performing repairs or alterations under an “R” stamp program shall register such repairs or alterations with the National Board.

### 5.5.4 REGISTRATION FOR NUCLEAR REPAIR/REPLACEMENT ACTIVITIES

Organizations performing repair/replacement activities under the “NR” stamp program shall register forms with the National Board.

### 5.5.5 REGISTRATION FOR GRAPHITE VESSELS

Organizations performing repair/replacement activities under the “R” stamp program shall register such repairs or alterations with the National Board.

## 5.6 FORM “R” LOG

The “R” Certificate Holder shall maintain a single log documenting unique and sequentially numbered Form “R” Reports (e.g., R-1, R-2, and R-3) that are registered with the National Board.

## 5.7 STAMPING REQUIREMENTS FOR REPAIRS AND ALTERATIONS

### 5.7.1 GENERAL

The stamping of or attachment of a nameplate to a pressure-retaining item shall indicate that the work was performed in accordance with the requirements of this code. Such stamping or attaching of a nameplate shall be done only with the knowledge and authorization of the Inspector. The “R” Certificate Holder responsible for repair or the construction portion of the alteration shall apply stamping. For a re-rating where no physical changes are made to the pressure-retaining item, the “R” Certificate Holder responsible for design shall apply stamping.

### 5.7.2 STAMPING REQUIREMENTS FOR REPAIRS

a) Pressure-retaining items repaired in accordance with the NBIC shall be stamped as required by this section.

b) Subject to the acceptance of the Jurisdiction and the concurrence of the Inspector, nameplates and stamping may not be required for routine repairs (see NBIC Part 3, 3.3.2). In all cases, the type and extent of repairs necessary shall be considered prior to waiving the requirement.

c) Stamping or nameplate shall be applied adjacent to the original manufacturer’s stamping or nameplate. A single repair nameplate or stamping may be used for more than one repair to a pressure-retaining item, provided each is carried out by the same certificate holder. The date of each repair, corresponding with the date on associated Form R-1, shall be stamped on the nameplate.

### 5.7.3 STAMPING REQUIREMENTS FOR ALTERATIONS

Pressure-retaining items altered in accordance with this code shall have a nameplate or stamping applied adjacent to the original manufacturer's stamping or nameplate in accordance with this section. For an alteration where physical changes are made to the pressure-retaining item, the "R" Certificate Holder responsible for the construction portion of the alteration shall apply the stamping or nameplate. For an alteration where no physical changes are made to the pressure-retaining item (e.g., a re-rating) the "R" Certificate Holder, assuming responsibility for the design, shall apply the stamping or nameplate.

### 5.7.4 STAMPING REQUIREMENTS FOR PARTS

Stamping or nameplate shall be applied in a conspicuous location on the part.

### 5.7.5 SPECIFIC REQUIREMENTS FOR STAMPING AND NAMEPLATES

a) Required data shall be in characters of at least 5/32 in. (4 mm) high, except that characters for pressure relief valve repair nameplates may be smaller. Markings may be produced by casting, etching, embossing, debossing, stamping, or engraving. The selected method shall not result in any harmful contamination, or sharp discontinuities to, the pressure-retaining item. See NBIC Part 3, Figures 5.7.5–a through 5.7.5-g.

b) The National Board Code Symbols ("R","VR", and "NR") are to be stamped; do not emboss.

c) Stamping directly on items, when used, shall be done with blunt-nose continuous or blunt-nose interrupted dot die stamps. If direct stamping would be detrimental to the item, required markings may appear on a nameplate affixed to the item.

d) The certificate holder shall use its full name as shown on the *Certificate of Authorization* or an abbreviation acceptable to the National Board.

e) The letters "RP" shall be stamped below the "R" Symbol Stamp to indicate organizations accredited for performing repairs or alterations to fiber-reinforced plastic items.

f) The letter "G" shall be stamped below the "R" Symbol Stamp to indicate organizations accredited for performing repairs or alterations to graphite pressure equipment.

(15) g) The subject nameplate shall be securely attached using a method compatible with the structure or stand-off bracket supporting the nameplate, in a manner that will impede easy removal. The method of attaching this nameplate, as permitted by the original code of construction, may include, but is not limited to:

1) Welding

2) Adhesive, bonding or cementing

3) Tamper-resistant mechanical fasteners of suitable metal construction

**FIGURE 5.7.5-a**

REQUIRED MARKINGS FOR REPAIRS, WITH USE OF NATIONAL BOARD FORM R-1

REPAIRED BY

CERTIFICATE HOLDER

R®

NATIONAL BOARD "R" CERTIFICATE NUMBER

DATE REPAIRED

**FIGURE 5.7.5-b**

REQUIRED MARKINGS FOR ALTERATIONS, WITH USE OF NATIONAL BOARD FORM R-2

ALTERED BY

CERTIFICATE HOLDER

R®

M.A.W.P. P.S.I.

AT °F

NATIONAL BOARD "R" CERTIFICATE NUMBER

DATE ALTERED

**FIGURE 5.7.5-c**

REQUIRED MARKINGS FOR RE-RATINGS, WITH USE OF NATIONAL BOARD FORM R-2

RE-RATED BY

CERTIFICATE HOLDER

R®

M.A.W.P. P.S.I.

AT °F

NATIONAL BOARD "R" CERTIFICATE NUMBER

DATE ALTERED

## FIGURE 5.7.5-d

REQUIRED MARKINGS FOR PARTS FABRICATED BY WELDING, WITH USE OF NATIONAL BOARD FORM R-3

PART

R®

CERTIFICATE HOLDER

P.S.I. AT °F

M.A.W.P.

MANUFACTURER'S SERIAL NO.

NATIONAL BOARD "R" CERTIFICATE NUMBER

YEAR BUILT

## ~~FIGURE 5.7.5-e~~

~~REQUIRED MARKINGS FOR REPAIR OF ASME/NATIONAL BOARD "V," "UV," AND "HV" STAMPED PRESSURE RELIEF VALVES~~

~~REPAIRED BY~~

~~VR®~~

~~CERTIFICATE HOLDER~~

~~(1)~~
~~TYPE/MODEL NUMBER~~

~~(1)~~
~~SET PRESSURE~~ ~~CAPACITY~~

~~(1)~~ ~~(1)~~
~~CDTP~~ ~~BP~~

~~REPAIR IDENTIFICATION~~

~~NATIONAL BOARD "VR" CERTIFICATE NUMBER~~

~~DATE REPAIRED~~

~~**Note** 1: To be indicated only when changed.~~

## FIGURE 5.7.5-f

REQUIRED MARKINGS FOR NUCLEAR REPAIRS OR REPLACEMENTS

NR®

CERTIFICATE HOLDER

NATIONAL BOARD "NR" CERTIFICATE NUMBER

COMPLETED IN ACCORDANCE WITH ASME SECTION XI

REPAIR ☐

REPLACEMENT ☐

EDITION ADDENDA CODE CASE(S)

DATE OF REPAIR OR REPLACEMENT

~~FIGURE 5.7.5-g~~

~~REQUIRED MARKINGS FOR REPAIR OR REPLACEMENT OF NUCLEAR PRESSURE RELIEF VALVES~~

~~NR~~ ~~VR~~

~~CERTIFICATE HOLDER~~

~~NATIONAL BOARD CERTIFICATE NOS.~~

~~COMPLETED IN ACCORDANCE WITH ASME SECTION XI~~

~~NR~~ ~~VR~~ ~~EDITION~~ ~~ADDENDA~~ ~~CODE CASE(S)~~

~~REPAIR~~ ☐

~~REPLACEMENT~~ ☐

~~SET PRESSURE~~

~~CAPACITY (IF CHANGE IN SET PRESSURE)~~

~~DATE OF REPAIR OR REPLACEMENT~~

**Note 1:**

Not required when the scope of work does not change the Minimum Required Relieving Capacity.

**Note 2:**

If the line identifying Minimum Required Relieving Capacity is represented on the nameplate and the scope of work does not affect the Minimum Required Relieving Capacity, the line shall be“X’d” to represent “no change.”

**Note 3:**

Minimum Required Relieving Capacity may be abbreviated to M.R.R.C.

## 5.8 STAMPING FOR FIBER-REINFORCED VESSELS

The attachment of a nameplate to a repaired or altered vessel or tank shall indicate that work was performed in accordance with requirements of this code. The attachment of a nameplate shall be done only with knowledge and authorization of the Inspector. The certificate holder responsible for repair or alteration shall apply the stamping nameplate. Required stamping and nameplate information are shown in NBIC Part 3, 5.7.

### 5.8.1 STAMPING FOR REPAIRS

Pressure-retaining items repaired in accordance with the NBIC shall have a nameplate as required by NBIC Part 3, 5.7. Subject to the acceptance of the Jurisdiction and the concurrence of the Inspector, nameplates may not be required for routine repairs (See NBIC Part 3, 5.7.2 b). In all cases, the type and extent of repairs necessary shall be considered prior to waiving the requirement.

### 5.8.2 STAMPING FOR ALTERATIONS

The nameplate shall be applied in accordance with NBIC Part 3, 5.7. Location of nameplate shall be documented under “Remarks” on NBIC Form R-2 line 9.

## 5.9 STAMPING REQUIREMENTS FOR YANKEE DRYERS

a) Stamping is not required for repairs that do not affect pressure-retaining capability of the Yankee shell, as indicated on the De-rate Curve, or other pressure-retaining parts, as indicated on the original Manufacturer’s Data Report.

b) Stamping is required for repairs that affect pressure-retaining capability of the Yankee Dryer shell, as indicated on the De-rate Curve, or other pressure-retaining parts as indicated on the original Manufacturer's Data Report.

c) Stamping is required for alterations as listed in NBIC Part 3, S5.7.2.

d) Stamping, when required, shall meet the requirements for stamping in NBIC Part 3, 5.7.2. The location of stamping shall be described in the "Remarks" section of Form R-2.

## 5.10 ALTERNATIVE MARKING AND STAMPING FOR GRAPHITE PRESSURE EQUIPMENT

a) General Requirements

1) This procedure may be used in lieu of the stamping and nameplate requirements defined in this section.

2) The required data as defined in this section shall be 5/32 in. (4 mm) high, minimum.

3) The National Board Code Symbol "R" shall be used to make the impression in the cement.

b) Application of the "R" Code Symbol

1) The graphite surface shall be clean and smooth.

2) Apply a thin coating of cement onto the code part. The cement should have the consistency of toothpaste.

3) Apply sufficient heat to the cement so that it begins to form a skin.

4) Apply a coating of a thinned release agent, such as "anti-seize," to the tip of the "R" stamp with a brush.

5) Press the coated stamp all the way to the bottom of the cement and remove by pulling straight out before the cement hardens.

6) Cure or heat the impression as required.

7) When cured, the part may be washed to remove any excess release agent.

c) Application of characters directly to graphite

1) Use a very thin template of a flexible material (stainless steel; flexible and easily cleaned).

2) Place the template over a clean smooth surface.

3) Hold the template securely and trowel over with approved cement to fill all of the template area.

4) Carefully lift the template from the graphite part and examine the detail of the characters.

5) If acceptable, cure the cement.

6) If the characters are incorrect or damaged, wipe off the cement with a compatible solvent and reapply.

**Note:** The preceding methods can be applied jointly to identify the graphite part and to transfer the "R" stamp.

## 5.11 REMOVAL OF ORIGINAL STAMPING OR NAMEPLATE

If it becomes necessary to remove original stamping, the Inspector shall, subject to the approval of the Jurisdiction, witness making of a facsimile of stamping, the obliteration of old stamping, and transfer of stamping to the new item. When stamping is on a nameplate, the Inspector shall witness transfer of nameplate to the new location. Any relocation shall be described on the applicable NBIC "R" Form. The re-stamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

## ~~5.12 STAMPING REQUIREMENTS FOR PRESSURE RELIEF DEVICES~~

### ~~5.12.1 NAMEPLATES~~

~~Proper marking and identification of tested or repaired valves is critical to ensuring acceptance during subsequent inspections, and also provide for traceability and identification of any changes made to the valve. All operations that require the valve's seals to be replaced shall be identified by a nameplate as described in NBIC Part 3, 5.12.2 or 5.12.4.~~

### ~~5.12.2 REPAIR NAMEPLATE~~

~~When a pressure relief valve is repaired, a metal repair nameplate stamped with the information required below shall be securely attached to the valve adjacent to the original manufacturer's stamping or nameplate. If not mounted directly on the valve, the nameplate shall be securely attached so as not to interfere with valve operation and sealed in accordance with the quality system.~~

~~a) Prior to attachment of the repair nameplate, the previous repair nameplate, if applicable, shall be removed from the repaired valve.~~

~~b) As a minimum, the information on the valve repair nameplate (see NBIC Part 3, Figure 5.7.5-e) shall include:~~

~~1) The name of the repair organization preceded by the words "repaired by;"~~

~~2) The "VR" repair symbol stamp and the "VR" certificate number;~~

~~3) Unique identifier (e.g., repair serial number, shop order number, etc.);~~

~~4) Date of repair;~~

~~5) Set pressure;~~

~~6) Capacity and capacity units (if changed from original nameplate due to set pressure or service fluid change);~~

~~7) Type/Model number (if changed from original nameplate by a conversion. See NBIC Part 3, S7.2); and~~

~~8) When an adjustment is made to correct for service conditions of superimposed back pressure and/or temperature or the differential between popping pressure between steam and air (see NBIC Part 3, 4.5.2), the information on the valve repair nameplate shall include the:~~

~~a. Cold Differential Test Pressure (CDTP); and~~

~~b. Superimposed Back Pressure (BP) (only when applicable).~~

### ~~5.12.3 CHANGES TO ORIGINAL PRESSURE RELIEF VALVE NAMEPLATE INFORMATION~~

~~a) If the set pressure is changed, the set pressure, capacity, and blowdown, if applicable, on the original nameplate or stamping shall be marked out, but left legible. The new capacity shall be based on that for which the valve was originally certified.~~

~~b) If service fluid is changed, the capacity, including units, on the original nameplate or stamping shall be marked out, but left legible. The new capacity shall be based on that for which the valve was originally certified, or if a conversion has been made, as described in NBIC Part 3, S7.2 on the capacity certification for the valve as converted.~~

~~c) If the Type/Model number is changed, the Type/Model number on the original nameplate shall be marked out, but left legible.~~

~~d) If the blowdown is changed, the blowdown on the original nameplate or stamping shall be marked out, but left legible. The new blowdown may be based on the current ASME Code requirements.~~

~~e) Incorrect information on the original manufacturer's nameplate shall be marked out, but left legible. Corrected information shall be indicated on the repair nameplate and noted on the document as required by the quality system.~~

### ~~5.12.4 TEST ONLY NAMEPLATE~~

~~a) Where a valve has been tested and adjusted to restore the nameplate set pressure , as permitted by NBIC Part 3, S7.10.1, but not otherwise repaired, a "Test Only" nameplate shall be applied that contains the following information:~~

~~1) Name of responsible organization;~~

~~2) Date of test;~~

~~3) Set Pressure; and~~

~~4) Identification, such as "Test Only."~~

~~b) A "Test Only" nameplate is also recommended when periodic testing has been performed, even when no adjustments have been made, for the purpose of identifying the date the valve was tested.~~

~~c) The existing repair nameplates, if applicable, shall not be removed during such testing.~~

### ~~5.12.5 REPLACEMENT OF ILLEGIBLE OR MISSING NAMEPLATES~~

~~a) Illegible Nameplates~~

~~When information on the original manufacturer's or assembler's nameplate or stamping is illegible, but traceability can be confirmed, the nameplate or stamping will be augmented by a nameplate furnished by the "VR" Stamp Holder stamped "Duplicate." It shall contain all information that originally appeared on the nameplate or valve, as required by the applicable section of the ASME Code, except the "V," "HV," or "UV" symbol and the National Board mark. The repair organization's nameplate, with the "VR" stamp and other required data specified in NBIC Part 3, 5.12.2, will make the repairer responsible to the owner and the Jurisdiction that the information on the duplicate nameplate is correct.~~

~~b) Missing Nameplates~~

~~When the original valve nameplate is missing, the repair organization is not authorized to perform repairs to the valve under the "VR" program, unless positive identification can be made to that specific valve and~~

~~verification that the valve was originally stamped with an ASME "V" or "UV" symbol or marked with an ASME "HV" symbol. Valves that can be positively identified will be equipped with a duplicate nameplate, as described in this section, in addition to the repairer's "VR" stamped nameplate. The repairer's responsibilities for accurate data, as defined in NBIC Part 3, 5.12.5 a) shall apply.~~

~~c) Marking of Original Code Stamp~~

~~When a duplicate nameplate is affixed to a valve, as required by this section, it shall be marked "Sec. I," "Sec. IV," or "Sec. VIII," as applicable, to indicate the original ASME Code stamping.~~

## 5.13 REPAIR AND ALTERATION FORMS AND INSTRUCTIONS FOR COMPLETING FORMS

The following forms may be used for documenting specific requirements as indicated on the top of each form.

### 5.13.1 FORM R-1, REPORT OF REPAIR, see Pg. 97

### 5.13.2 FORM R-2, REPORT OF ALTERATIONS, see Pg. 98

### 5.13.3 FORM R-3, REPORT OF PARTS FABRICATED BY WELDING, see Pg. 99

### 5.13.4 FORM R-4, REPORT SUPPLEMENTARY SHEET, see Pg. 101

### 5.13.4.1 INSTRUCTIONS FOR COMPLETING NATIONAL BOARD FORM "R" REPORTS

These instructions are to be used when completing the National Board Form "R" Reports. When computer generated, the format of the form shall replicate the type and relative location of the information depicted on the Form "R" Reports shown in NBIC Part 3, 5.13.1 through 5.13.4.

1) The name and address of the "R" Certificate Holder performing the work as it appears on the "*Certificate of Authorization*". On a Form R-2, the organization that performed the design work will complete line 1a) and the organization completing the construction activities will complete line 1b).

2) When registering a Form "R" Report with the National Board, this line is solely designated for a unique sequential number assigned by the "R" Certificate Holder. When the "R" Form is not to be registered, indicate so by "N/A". As described in NBIC Part 3,5.6, a log shall be maintained identifying sequentially, any Form "R" registered with the National Board. For re-rating only, the Design Organization registers the Form R-2. Where physical work is also performed, the Construction Organization registers the Form R-2.

3) Name and address of the owner of the pressure-retaining item.

4) Name and address of plant or facility where the pressure-retaining item is installed.

5) Description of the pressure-retaining item, such as boiler or pressure vessel, or piping. Include the applicable unit identification.

6) Name of the original manufacturer of the pressure-retaining item. If the original manufacturer is unknown, indicate by, "unknown."

7) Document the serial number of the pressure-retaining item if assigned by the original manufacturer. If there is no serial number assigned or is unknown, indicate "unknown."

8) When the pressure-retaining item is registered with the National Board, document the applicable registration number. If the pressure-retaining item is installed in Canada, indicate the Canadian design registration number (CRN), and list the drawing number under "other." If the item is not registered, indicate, "none."

9) Identify the year in which fabrication/construction of the item was completed.

10) Indicate edition and addenda of the NBIC under which this work is being performed.

11) Indicate the name, section, division, edition, and addenda of the original code of construction for the pressure-retaining item. Also indicate the name, section, division, edition, and addenda of the construction code used for the work being performed. If code cases are used, they shall be identified in the "Remarks" section.

12) Provide a detailed summary describing the scope of work that was completed to a pressure retaining item (PRI). The information to be considered when describing the scope of work should include such items as, the nature of the repair or alteration (i.e. welding, bonding, cementing), the specific location of the work performed to the PRI, the steps taken to remove a defect or as allowed by 3.3.4.8 to remain in place, the method of repair or alteration described as listed in the examples of Part 3, Section 3 or supplemental section if applicable, and the acceptance testing and or examination method used in accordance with the NBIC. When additional space is needed to describe the scope of work, a Form R-4 shall be used and attached. Information determined to be of a proprietary nature need not be included, but shall be stated on the form.

13) Indicate test pressure applied.

14) As applicable, identify what parts manufactured by welding or bonding were introduced as needed to complete the scope of work. Indicate part, item number, manufacturer's name, stamped identification, and data report type or Certificate of Compliance.

15) Indicate any additional information pertaining to the work involved (e.g., routine repairs, code cases). For Form R-3, the part manufacturer is to indicate the extent he has performed any or all of the design function. If only a portion of the design, state which portion.

16) Type or print name of authorized representative of the "R" Certificate Holder attesting to accuracy of the work described.

17) Indicate National Board "R" Certificate or Authorization number.

18) Indicate month, day, and year that the "R" certificate expires.

19) Enter date certified.

20) Record name of "R" Certificate Holder who performed the described work, using full name as shown on the Certificate of Authorization or an abbreviation acceptable to the National Board.

21) Signature of authorized representative.

22) Type or print name of Inspector.

23) Indicate Inspector's Jurisdiction.

24) Indicate Inspector's employer.

25) Indicate address of Inspector's employer (city and state or province).

26) Indicate month, day, and year of inspection by Inspector. In case of routine repairs this shall be the month, day, and year the Inspector reviews the completed routine repair package.

27) Signature of Inspector.

28) National Board commission number of Inspector, and when required by the Jurisdiction, the applicable State or Provincial numbers.

29) Document name and address of organization that purchased the parts for incorporation into the repair or alteration. If the part's origin is unknown or the part was built for stock, so state.

30) Document name of organization responsible for specifying the code design conditions, if known. If origin of design conditions are unknown, state "unknown."

31) Document name of organization responsible for performing the code design, if known. If code design organization is unknown, state "unknown."

32) Name, section, and division of the design code, if known. If the design is unknown, state "unknown"

33) Indicate code edition year used for fabrication.

34) Indicate code addenda date used for fabrication.

35) Indicate the code paragraph reference for formula used to establish the MAWP, if known. If the code reference of the formula is unknown, state "unknown."

36) If available, identify component by part's original name, function, or use the original equipment manufacturer's "mark or item number."

37) Indicate quantity of named parts.

38) Match line number references for identification of parts and description of parts.

39) Indicate manufacturer's serial number for the named part.

40) Indicate drawing number for the named part.

41) Indicate maximum allowable working pressure for the part, if known.

42) Use inside diameter for size: indicate shape as square, round, etc.

43) Indicate the complete material specification number and grade.

44) Indicate nominal thickness of plate and minimum thickness after forming.

45) Indicate shape as flat, dished, ellipsoidal, or hemispherical.

46) Indicate minimum thickness after forming.

47) Indicate outside diameter.

48) Indicate minimum thickness of tubes.

49) Complete information identical to that shown on the Form "R" to which this sheet is supplementary.

50) Indicate the Form "R" type. Example: Form R-1, Form R-2, Form R-3.

51) Indicate the reference line number from the Form R to which this sheet is supplementary.

52) Complete information for which there was insufficient space on the reference Form "R".

53) If applicable, document the unique purchase order, job, or tracking number, assigned by organization performing work.

54) Indicate the maximum allowable working pressure of the pressure-retaining item.

55) Indicate the type of repair, e.g., welded, graphite pressure equipment, or fiber-reinforced plastic pressure equipment.

### 5.13.5 FORM NR-1, NUCLEAR COMPONENTS AND SYSTEMS IN NUCLEAR POWER PLANTS see Pg. 102

### (15) 5.13.5.1 GUIDE FOR COMPLETING NATIONAL BOARD FORM NR-1 REPORTS

Title Block: Check Category of Activity: 1, 2, or 3

Check type of activity, repair, replacement, alteration/modification, and/or re-rating, as applicable.

1) Name and address of the organization, as shown on the National Board "NR" Certificate of Authorization, which performed the activity.

2) Indicate "NR" Form Registration Number.

3) Indicate the purchase order number, job number, etc., as applicable, assigned by the organization that performed the work.

4) Name and address of the owner of the nuclear power plant.

5) Name and address of the nuclear power plant and, if applicable, identification of the unit.

6) Identify the system (e.g., residual heat removal, reactor coolant) with which the repair, replacement, alteration/modification, or rerating activity is associated.

7) ASME Code Section XI or Section III, as applicable to the repairs, alterations/modification, replacement or rerating activity performed.

8) Name of the organization, as shown on the Certificate of Authorization, which performed the design activity including:

    a. Original Design Specification Number and Revision Number.

    b. Original Design Report Number and Revision Number.

    c. Revised Design Specification Number and Revision Number.

    d. Revised Design Report Number and Revision Number.

    e. Design Reconciliation Number and Revision Number.

    f. Applicable Code Edition and Addenda Date(s).

9) Check the type of test conducted (e.g., hydrostatic, pneumatic, system leakage, exempt, or other) and indicated the pressure applied when applicable.

10) Sequential number assigned to each item reported.

11) Indicate the type of component (e.g., vessel, line valve, pump, piping system).

12) Manufacturer's name of the affected item.

13) Manufacturer's serial number.

14) National Board number, if applicable, of the affected item.

15) Indicate Jurisdictional number, if applicable, of the affected item.

16) Indicate plant tag or identification number, if applicable, of the affected item.

17) Year the affected item was manufactured.

18) Identify the name, section, and division of the original construction code for the affected item.

19) Identify the edition, addenda, and as applicable, code cases, and class of the original construction code for the affected item.

20) Indicate the activity performed on this item (e.g., repair, alteration or modification).

21) Manufacturer's name of this replacement item.

22) Manufacturer's serial number of this replacement item.

23) National Board number, if applicable, of this replacement item.

24) Indicate plant tag or identification number, if applicable, of this replacement item.

25) Year this replacement item was manufactured.

26) Identify the name, section, and division of the original construction code for this replacement item.

27) Identify the edition, addenda, and as applicable, code cases and class of the original construction code for this replacement item.

28) Provide a detailed summary describing the scope of work completed. Information to be considered should include type of work (e.g. welding, brazing, fusing), location, steps taken for removal or acceptance of defects, examinations, testing, heat treat, and other special processes or methods utilized. If necessary, attach additional data, sketch, drawing, Form R-4, etc. If additional data is attached, so state in the "remarks" section.

29) Indicate any additional information pertaining to the work.

30) Type or print name of authorized representative from the certificate holder.

31) Indicate ASME Section III or Section XI as applicable to the repair, replacement, alteration/modification, and/or rerating activity performed.

32) Indicate National Board Certificate of Authorization number.

33) Indicate month, day, and year the certificate expires.

34) Name of the organization that performed the identified work, using the full name as shown on the Certificate of Authorization, or an abbreviation acceptable to the National Board.

35) Indicate month, day and year of signature by the Authorized Representative.

36) Signature of authorized representative from the certificate holder defined in item 30 above.

37) Title of authorized representative as defined in the Quality Program.

38) Type or print name of Authorized Nuclear Inspector.

39) Indicate the Jurisdiction where the activity is performed, when required.

40) Indicate Authorized Nuclear Inspector's employer.

41) Indicate address of Authorized Nuclear Inspector's employer (city and state or province).

42) Indicate month, day, and year of inspection by the Authorized Nuclear Inspector.

43) Indicate month, day, and year of signature by the Authorized Nuclear Inspector.

44) Signature of Authorized Nuclear Inspector defined in item 38 above.

45) National Board Commission number and required endorsements.

### 5.13.6 FORM NVR-1, NUCLEAR PRESSURE RELIEF DEVICES

#### (15) 5.13.6.1 GUIDE FOR COMPLETING NATIONAL BOARD FORM NR-1 AND NVR-1 REPORTS

Title Block: Check Category of Activity: 1, 2, or 3

Check type of activity, repair, replacement, alteration/modification, and/or re-rating, as applicable.

1) Name and address of the organization, as shown on the National Board "VR" and "NR" Certificates of Authorization, which performed the activity.

2) Indicate "NVR" Form Registration Number.

3) Indicate the purchase order number, job number, etc., as applicable, assigned by the organization that performed the work.

4) Name and address of the organization for which the work was performed.

5) Name and address of the owner of the nuclear power plant.

6) Name and address of the nuclear power plant and, if applicable, identification of the unit.

7) Describe the type of pressure relief device (e.g., safety valve, safety relief valve, pressure relief valve).

8) Manufacturer's name of the affected item.

9) Indicate the pressure relief device by the manufacturer's valve series or catalog number.

10) Manufacturer's serial number of the affected item.

11) National Board number, if applicable, of the affected item.

12) Indicate the service as steam, liquid, air/gas, etc.

13) Indicate the pressure relief device by inlet size, in inches.

14) Year the affected item was manufactured.

15) Indicate the name, section and division of the original construction code for the affected item.

16) Identify the edition, addenda, and as applicable, code cases, and class of the original construction code for the affected item.

17) Identify the edition, addenda, and as applicable, code cases of the ASME Section XI code for the inservice inspection activity.

18) Identify the edition, addenda, and as applicable, code cases of the ASME Section XI code for the repair/replacement activity.

19) Identify the edition, addenda, and as applicable, code cases of the construction code for the repair/replacement activity.

20) Identify the organization responsible for design or design reconciliation, if applicable.

21) Indicate the set pressure of the valve.

22) Indicate the blowdown, if applicable, as a percentage of set pressure.

23) Indicate repair organization's name and address.

24) Indicate medium (steam, air, etc.) used for the adjustment of the set pressure and, if applicable, blowdown.

25) Provide a detailed summary describing the scope of work completed. Information to be considered should include type of work (welding, brazing, fusing), location, steps taken for removal or acceptance of defects, examinations, testing, heat treat, and other special processes or methods utilized. If necessary, attach additional data, sketch, drawing, Form R-4, etc. If additional data is attached, so state in the remarks section.

26) Indicate any additional information pertaining to the work.

27) Type or print name of authorized representative from the certificate holder.

28) Indicate ASME Section XI or construction code as applicable to the repair, replacement, and/or rerating activity performed.

29) Indicate National Board Certificate of Authorization number.

30) Indicate month, day, and year the certificate expires.

31) Indicate month, day, and year of signature by the authorized representative.

32) Signature of authorized representative from the certificate holder defined in item 27 above.

33) Title of authorized representative as defined in the Quality Program.

34) Type or print name of Authorized Nuclear Inspector.

35) Indicate the Jurisdiction where the activity is performed, when required.

36) Indicate Authorized Nuclear Inspector's employer.

37) Indicate address of Authorized Nuclear Inspector's employer (city and state or province).

38) Indicate month, day, and year of inspection by the Authorized Nuclear Inspector.

39) Indicate month, day, and year of signature by the Authorized Nuclear Inspector.

40) Signature of Authorized Nuclear Inspector identified in item 34 above.

41) National Board Commission number and required endorsements.

# FORM R-1 REPORT OF REPAIR

in accordance with provisions of the *National Board Inspection Code*

1. Work performed by ① ________ (name of repair organization) ② ________ (Form Registration No.)
________ ㊾53 ________ (PO No., Job No., etc.)

2. Owner ③ ________ (name)
④ ________ (address)

3. Location of installation ④ ________ (name)
________ (address)

4. Unit identification ⑤ ________ (boiler, pressure vessel) Name of original manufacturer ⑥ ________

5. Identifying nos.: ⑦ ________ (mfg serial no.) ⑧ ________ (National Board No.) ⑧ ________ (Jurisdiction No.) ⑧ ________ (other) ⑨ ________ (year built)

6. NBIC Edition/Addenda: ⑩ ________ (edition) ⑩ ________ (addenda)

Original Code of Construction for Item: ⑪ ________ (name/section/division) ⑪ ________ (edition/addenda)

Construction Code Used for Repair Performed: ⑪ ________ (name/section/division) ⑪ ________ (edition/addenda)

7. Repair Type: 55 ☐ Welded ☐ Graphite Pressure Equipment ☐ FRP Pressure Equipment

8. Description of work: ⑫ ________ (use Form R-4, if necessary)
________
________
________ Pressure Test, if applied ⑬ ________ psi MAWP 54 ________ psi

9. Replacement Parts. Attached are Manufacturer's Partial Data Reports or Form R-3s properly completed for the following items of this report:
⑭ ________ (name of part, item number, data report type or Certificate of Compliance, mfg. name, and identifying stamp)
________
________

10. Remarks: ⑮ ________
________

## CERTIFICATE OF COMPLIANCE

I, ⑯ ________, certify that to the best of my knowledge and belief the statements in this report are correct and that all material, construction, and workmanship on this Repair conforms to the *National Board Inspection Code*.
National Board "R" Certificate of Authorization No. ⑰ ________ expires on ⑱ ________, ________
Date ⑲ ________, ________ ⑳ ________ (name of repair organization) Signed ㉑ ________ (authorized representative)

## CERTIFICATE OF INSPECTION

I, ㉒ ________, holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency where required, issued by the jurisdiction of ㉓ ________ and employed by ㉔ ________ ㉕ ________ of ________ have inspected the work described in this report on ㉖ ________, ________ and state that to the best of my knowledge and belief this work complies with the applicable requirements of the *National Board Inspection Code*.
By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.
Date ⑲ ________, ________ Signed ㉗ ________ (inspector) Commissions ㉘ ________ (National Board and Jurisdiction No.)

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-66 Rev. 12

# FORM R-2 REPORT OF ALTERATION

in accordance with provisions of the National Board Inspection Code

(Form "R" Registration no.)

(P.O. No., Job No., etc.)

1a. Design performed by:
(name of "R" organization responsible for design)

(address)

1b. Construction performed by:
(name of "R" organization responsible for construction)

(address)

2. Owner of Pressure Retaining Item:
(name)

(address)

3. Location of Installation:
(name)

(address)

4. Item identification: (boiler, pressure vessel, or piping) Name of original manufacturer:

5. Identifying nos: (mfg. serial no.) (National Board No.) (Jurisdiction No.) (other) (year built)

6. NBIC Edition / Addenda: (edition) (addenda)

Original Code of Construction for Item: (name / section / division) (edition / addenda)

Construction Code Used for Alteration Performed: (name / section / division) (edition / addenda)

7a. Description of Design Scope:

☐ Form R -4, Report Supplementary Sheet is attached

7b. Description of Construction Scope:

☐ Form R -4, Report Supplementary Sheet is attached

Pressure Test, if applied ________ psi MAWP ________ psi

8. Replacement Parts. Attached are Manufacturer's Partial Data Reports or Form R-3's properly completed for the following items of this report:

(name of part, item number, data report type or Certificate of Compliance, mfg's. name and identifying stamp)

# FORM R-3 REPORT OF PARTS FABRICATED BY WELDING

in accordance with provisions of the *National Board Inspection Code*

1. Manufactured by (1) ______________________ (2) __________
   ______________________ (53) __________

2. Manufactured for (29) ______________________
   ______________________

3. Design Condition specified by (30) __________ Code design by (31) __________

4. Design Code (32) __________ (33) __________ (34) __________ (35) __________

5. Identification of Parts

| Name of Part | Qty. | Line No. | Manufacturer's Identifying No. | Manufacturer's Drawing No. | MAWP | Shop Hydro PSI | Year Built |
|---|---|---|---|---|---|---|---|
| (36) | (37) | (38) | (39) | (40) | (41) | (13) | (9) |
| | | | | | | | |
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6. Description of Parts

| | (a) Connections other than tubes | | | Heads or Ends | | | (b) Tubes | | |
|---|---|---|---|---|---|---|---|---|---|
| Line No. | Size and Shape | Material Spec. No. | Thickness (in.) | Shape | Thickness (in.) | Material Spec. No. | Diameter (in.) | Thickness (in.) | Material Spec. No. |
| (38) | (42) | (43) | (44) | (45) | (46) | (43) | (47) | (48) | (43) |
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7. Remarks (15) ______________________

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

NB-230 Rev. 2

Form R-3 (back)

2
(Form "R" No.)

**CERTIFICATE OF COMPLIANCE**

I, 16 ____________________, certify that to the best of my knowledge and belief the statements in this report are correct and that all material, fabrication, construction, and workmanship of the described parts conforms to the *National Board Inspection Code* and standards of construction cited.

National Board "R" Certificate of Authorization No. 17 ____________________ expires on 18 __________, __________

Date 19 __________, __________ 20 ____________________ Signed 21 ____________________
(name of "R" Certificate Holder) (authorized representative)

**CERTIFICATE OF INSPECTION**

I, 22 ____________________,holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency issued by the jurisdiction of 23 ____________________ and employed by 24 ____________________ of 25 ____________________ have inspected the parts described in this report on 26 __________, __________ and state that to the best of my knowledge and belief the parts comply with the applicable requirements of the *National Board Inspection Code*.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.

Date 26 __________, __________ Signed 27 ____________________ Commissions 28 ____________________
(inspector) (National Board and jurisdiction no.)



SECTION 5

(15)

# FORM R-4 REPORT SUPPLEMENTARY SHEET

in accordance with provisions of the *National Board Inspection Code*

1. Work performed by 1 49 ________________ 2 49 ________________
(name) (Form "R" referenced)
53 49 ________________
(address) (PO No., Job No., etc.)

2. Owner 3 or 29 49 ________________
(name)
________________
(address)

3. Location of installation ________________
(name)
________________
(address)

Reference Line No. 51 ________ Continued from Form R– 50 ________ 52 ________________

Date 19 ____, ____ Signed 21 ________________ Name 20 49 ________________
(authorized representative) (authorized representative)

Date 19 ____, ____ Signed 27 ________________ Commissions 20 49 ________________
(inspector) (National Board and jurisdiction no.)

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-231 Rev. 2

**FORM NR–1 REPORT OF REPAIR ☐ OR REPLACEMENT ☐**
**TO NUCLEAR COMPONENTS AND SYSTEMS IN NUCLEAR POWER PLANTS**

1. Work performed by 1 ____________________ 2 ____________
   name of "NR" certificate holder — PO no., job no., etc.
   ____________________
   address
2. Owner 4 ____________________
   name
   ____________________
   address
3. Name, address, and identification of nuclear power plant 5 ____________________
   ____________________
4. System 6 ____________________

5a. Items that Required Repair or Replacement Activities

| Identification | | | | | | | | Construction Code | | | | Activity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Type of Item | Mfg. Name | Mfg. Serial No. | Nat'l Bd No. | Juris. No. | Other | Year Built | Name/ Section/ Division | Edition/ Addenda | Code Case(s) | Code Class | Repair/ Replace |
| 1 | 8 | 9 | 11 | 12 | 15 | 16 | 17 | 18 | 19 | 19 | 19 | 20 |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
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| 10 | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |

5b. Items Installed During Replacement Activities

| Identification | | | | | | | | Construction Code | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of Item | Installed or Replaced 5a Item No. | Mfg. Name | Mfg. Serial No. | Nat'l Bd No. | Juris. No. | Other | Year Built | Name/ Section/ Division | Edition/ Addenda | Code Case(s) | Code Class |
| 10 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 29 | 29 |
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6. ASME Code Section XI applicable for inservice inspection: 30 ________ 30 ________ 30 ________
7. ASME Code Section XI used for repairs, modifications, or replacements: 31 ________ 31 ________ 31 ________
8. Construction Code used for repairs or replacements: 32 ________ 32 ________ 32 ________
9. Design responsibilities 33 ____________________
10. Tests conducted: ☐ hydrostatic ☐ pneumatic ☐ design pressure pressure 34 ______ psi (MPa) Code Case(s) 34 ______

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-81

11. Description of work 39
(use of properly identified additional sheet[s] or sketch[es] is acceptable)

12. Remarks 40

**CERTIFICATE OF COMPLIANCE**

I, 41, certify that to the best of my knowledge and belief the statements made in this report are correct and the repair or replacement activities described above conform to Section XI of the ASME Code and the *National Board Inspection Code* "NR" rules.

National Board Certificate of Authorization No. 42 to use the "NR" stamp expires 43,

"NR" Certificate Holder 44 (name)

Date 45, Signed 46 (authorized representative) 47 (title)

**CERTIFICATE OF INSPECTION**

I, 48, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency issued by the jurisdiction of 49 and employed by 50 of 51

have inspected the repair or replacement described in this report on 52, and state that to the best of my knowledge and belief, this repair or replacement activity has been completed in accordance with

Section XI of the ASME Code and the *National Board Inspection Code* "NR" rules.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage, or a loss of any kind arising from or connected with this inspection.

Date 52, Signed 53 (inspector) Commissions 54 (National Board and jurisdiction no.)

This form may be obtained from The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229 NB-81

# PART 3, SECTION 6
# REPAIR AND ALTERATION SUPPLEMENTS

## SUPPLEMENT 1
## STEAM LOCOMOTIVE FIRETUBE BOILER REPAIRS

### S1.1 SCOPE

This supplement applies to all boilers attached to steam locomotives operating on track gaged 24 in. (610 mm) or greater.

### S1.1.1 FEDERAL RAILROAD ADMINISTRATION (FRA)

The FRA rules for steam locomotive boilers are published in the *Code of Federal Regulations* (CFR) 49CFR Part 230, dated November 17,1999.[13] All locomotives under FRA jurisdiction are documented on FRA Form 4 as defined in 49CFR Part 230. This document is the formal documentation of the steam locomotive boiler and is required to be completed prior to the boiler being placed in service. This document shall be used as the data report for the boiler, applicable to all repairs and alterations performed. National Board "R" Certificate Holders shall document their repairs and/or alterations on National Board Forms R-1 or R-2. These reports shall be distributed to the owner-user of the boiler, who is required to incorporate them into a FRA Form 19, which becomes an attachment to the FRA Form 4. The design margin for all such repairs or alterations shall not be less than four, based on ultimate tensile strength of the material.

### S1.1.2 REQUIREMENTS FOR WELDING ACTIVITIES

a) Before performing any welding activities, consideration shall be given to ensure the weldability of locomotive boiler materials.

b) Special jurisdictional approval may be required prior to starting welding activity on locomotive boilers.

### S1.1.3 MATERIALS

a) The older steels used in riveted construction were frequently rimmed steels, high in carbon, sulfur, phosphorus and hydrogen. The older steels were not melted to a fine grain practice and will typically have poor toughness properties.

b) If welding is to be used to repair a pressure-retaining item that was manufactured using riveted construction, the repair organization should perform a chemical composition analysis on the steel plate base metal and rivet material to determine weldability. Specific quantities of carbon, manganese, sulfur, phosphorus, and aluminum shall be identified and included in the analysis. The result of the analysis shall be acceptable to the Inspector and Jurisdiction when required.

### S1.1.3.1 MATERIAL LIST FOR STEAM LOCOMOTIVE BOILERS

Table S1.1.3.1 is intended as a basic guideline only and covers basic carbon steel and some alloy steel material specifications. Other alloy materials may be available for these applications if necessary. (15)

a) SA-516 steel is recommended for firebox repairs. It is a fine grain steel that accepts flanging and bending with less tendency to crack than coarse grain steels such as SA-515 or SA-285 Grade C.

SUPPL. 1



13 Steam locomotive inspection and maintenance standards, which is now codified at 49 CFR Part 230, may be obtained at the FRA website.

Coarse grain steels have, on occasion, been found to crack or split after complicated flanging, bending, and forming.

b) SA-36 shall not be used to make any pressure-retaining part such as shells, staybolt sleeves, or caps.

c) When rivets are made from SA-675, the finished rivets must meet the physical requirements of the original rivet specification or SA-31 Grade A or B.

d) When staybolt material tensile strength is greater than that of the firebox sheets, the firebox sheets deflect instead of the staybolts, which can result in the sheets developing cracks and leaking staybolts. In addition, high tensile strength steels are difficult to drive. Maximum allowable tensile strength shall be 7,500 psi (51.71 MPa).

### TABLE S1.1.3.1

| **Application** | **Specification** |
|---|---|
| Boiler Tubes & Flues, Arch Tubes Superheater Units | SA-178 Grade A, SA-192, SA-210 |
| Boiler & Firebox Plate, Pressure Retaining Plate | SA-285 Grade C, SA-515, SA-516, SA-203, SA-204 |
| Welded Staybolts | SA-675, SA-36, SA-31 Grade B |
| Threaded Staybolts | SA-31 Grade A<br>SA-675 with a tensile strength of 47,000 psi to 65,000 psi inclusive |
| Staybolt Sleeves and Caps | SA-105 Forging, SA-675 |
| Boiler Braces | SA-675, SA-36 |
| Rivets | SA-675, SA-31 |
| Forged Parts & Fittings | SA-105, SA-181 |
| Pressure-Retaining Steel Castings | SA-216, A-217 |
| Hollow Cylindrical Pressure-Retaining Parts | SA-105 Forgings, SA-675 Bar Stock |
| Superheater Unit Bolts & Nuts | Bolts - SA-193, Nuts - SA-194 |
| Pipe Flanges | SA-181, SA-105 |
| Bolts & Studs | SA-307 Grades A&B |
| Pipe | SA-106, SA-53 seamless |
| Bronze Castings & Washout Plugs | SB-61, SB-62, SB-148 |

## S1.1.4 FORMULA AND CALCULATIONS FOR STEAM LOCOMOTIVE BOILERS

a) Most steam locomotive boilers were manufactured in the first half of the 20th century or before. The calculations, formula, and shop practices used are now distant history and quite difficult to obtain. The rules for riveted construction were last published by ASME in Section I Code, 1971 Edition.

b) This supplement herein, is based in part on the ASME Code, Section III, 1952 Edition,[14] which was the last published edition of the Steam Locomotive Code. The railroad industry has attempted to collect the old formula and some shop practices. These have been published by The Engineering Standards Committee for Steam Locomotives, Inc. (ESC) as Compendium, Volume 1, Compilation of Calculations.[15]

## S1.2 LOCOMOTIVE FIRETUBE BOILER REPAIRS

## S1.2.1 REPAIR OF STAYBOLT HOLES

a) Staybolt holes may be repaired by welding, reaming, or retapping to a larger size or by installing a flush patch.

b) If the staybolt hole was threaded and is to be repaired by welding, the threads shall be removed prior to welding.

## S1.2.2 THREADED STAYBOLTS

a) All threaded staybolts shall have either 11- or 12-thread pitch. Staybolt threads shall have a good close fit in sheets. Changing the staybolt thread pitch from 11 to 12 or the reverse shall be considered a repair.

b) All staybolts shorter than 8 in. (200 mm) in length shall have telltale holes. Staybolt telltale holes in existing staybolts shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (32 mm) deep in the outer end. When staybolts 8 in. (200 mm) or less in length are replaced, they shall be replaced with staybolts that have a telltale hole 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter their entire length, or with ones that have a 3/16 in. (5 mm) to 7/32 in. (5.5 mm) diameter hole in each end, drilled a minimum of 1-1/4 in. (32 mm) deep. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Ball socket-type flexible staybolts may have telltale holes that extend from the threaded end of the bolt into the bolt head for a distance of one-third the spherical bolt head diameter.

c) Telltale holes shall be reopened after driving and riveting heads.

d) Staybolt length shall be sized so the length of bolt projecting through the sheet is not less than 1/8 in. (3 mm) and is sufficient to produce a full head after driving and riveting the head.

e) The thread lead of both bolt ends and both firebox sheets shall be synchronized to permit the staybolt to be installed without stripping the threads.

f) When riveting staybolt heads, the bolt's opposite end shall be bucked or braced to prevent damaging the staybolt's threads. Bracing can be done several ways, such as using a pneumatic holder or a heavy steel bucking bar. Driving the heads on both ends of the staybolt simultaneously, using two pneumatic rivet hammers (double gunning), is acceptable. Staybolts are to be driven in such a manner as to expand radially the staybolt body and threads into the sheet prior to forming the head. Merely driving over the head is not acceptable.

14 This code is available from the National Board.
15 Copies of *The Engineering Standards Committee for Steam Locomotives, Inc., Compendium, Volume 1, Compilation of Calculations,* may be obtained from the Strasburg Rail Road, P.O. Box 96, Strasburg, PA 17579, 717.687.8421.

g) Ball socket-type flexible staybolts shall not be braced by inserting a spacer under the cap.

h) Installation of larger diameter staybolts shall be considered a repair.

i) If the ends of staybolts are heated to facilitate forming the head or expanding the threads into the sheet, the lower critical temperature of the sheet and staybolt material shall not be exceeded.

j) The minimum height of the staybolt head measured at its highest point shall be 1/16 in. (1.5 mm).

k) When the diameter of the staybolt head has been reduced to the major diameter of the staybolt thread at any location either because of erosion during service or problems during installation, the staybolt shall be replaced. Repair is prohibited.

**FIGURE S1.2.2-a**
THREADED STAYBOLTS

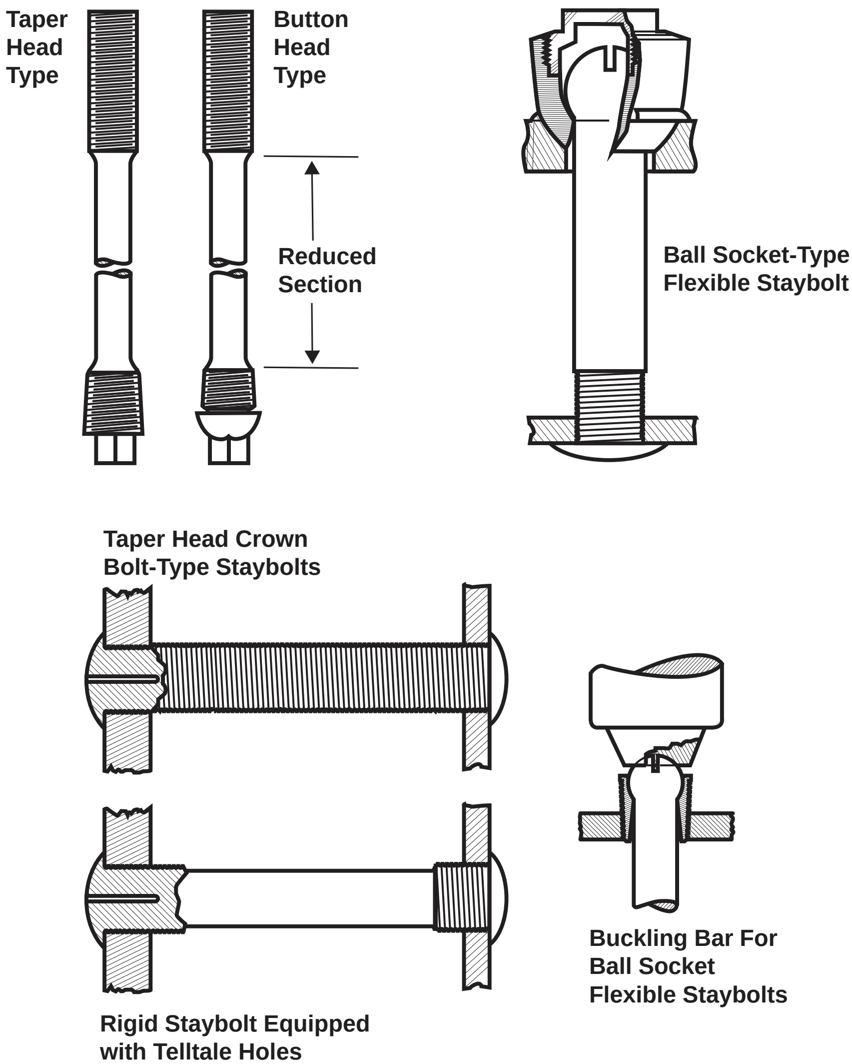
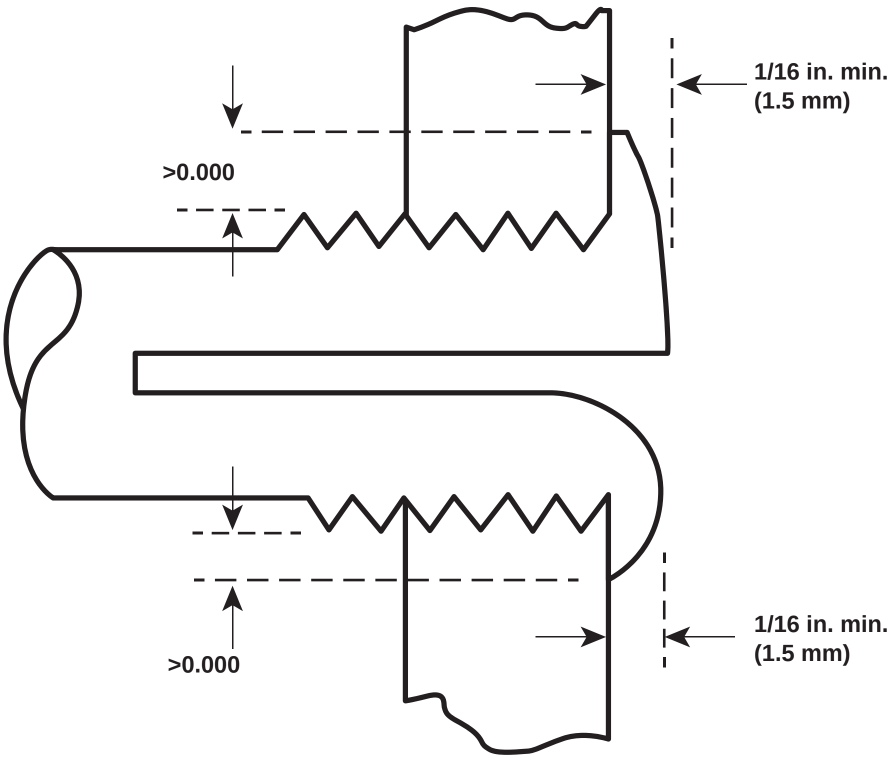


**FIGURE S1.2.2-b**
RIVETED STAYBOLT HEAD DIMENSIONS




Minimum diameter of staybolt riveted or upset head shall be greater than the staybolt major thread diameter at all points.





### S1.2.3 BALL SOCKET-TYPE FLEXIBLE STAYBOLTS, SLEEVES, AND CAPS

a) Welded flexible staybolt sleeves shall be applied as shown in NBIC Part 3, Figures S1.2.3-a through S1.2.3-e. Sleeve axis shall be in alignment with centerline through holes in wrapper and firebox sheets.

b) Welded sleeves and welded caps that leak at the welds or the sleeve shall be repaired.

c) Wasted caps and sleeves shall not be repaired by weld buildup.

d) Welded sleeves that have damaged cap threads shall be repaired or replaced. If the sleeve has wasted to less than 60% of the original thickness at the threaded cap section, it may be repaired by cutting off the threaded section and welding on a replacement section using full penetration welds.

e) Threaded or welded sleeves that are cracked or have wasted to less than 60% of the original thickness at any section other than the threaded cap section shall be replaced.

f) Threaded sleeves that leak where screwed into the boiler shell or wrapper sheet shall be repaired. Seal welding of one pass not exceeding 3/16 in. (5 mm) leg size is permissible for caulking purposes only. If seal welding is applied, the sleeve threads in the weld zone shall be removed prior to welding.

g) New threaded sleeves seal welded after installation shall have the threads removed from the weld zone of the sleeve prior to welding.

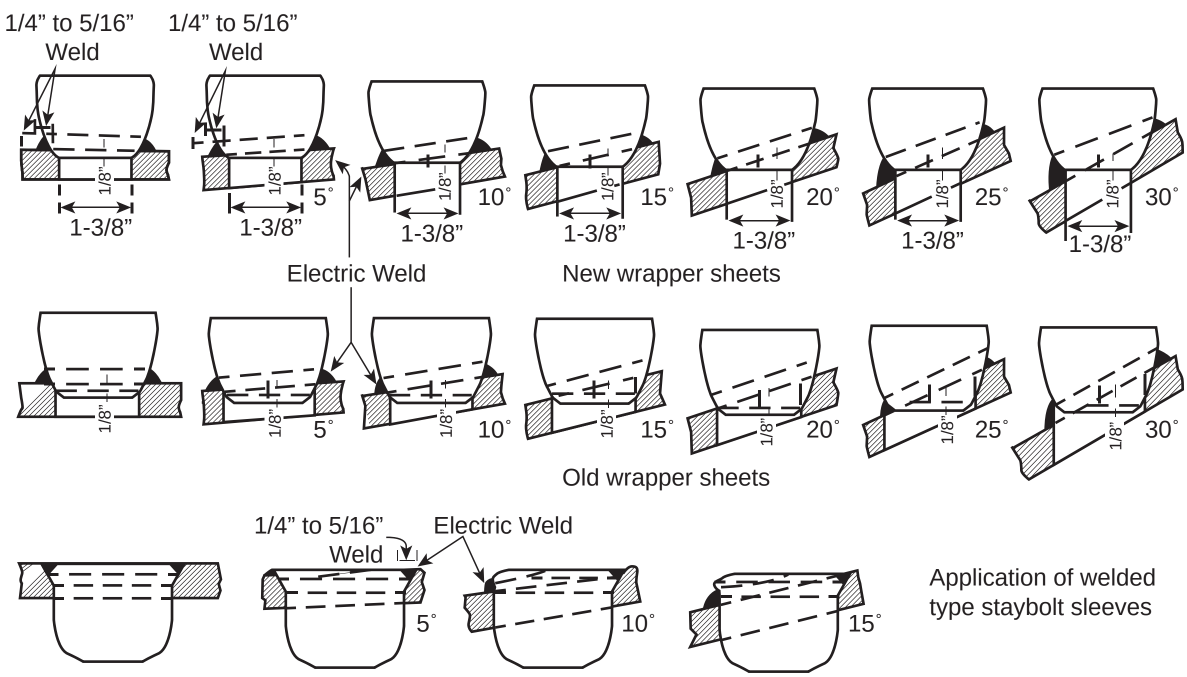
h) Threaded staybolt caps that leak shall not be seal welded.

i) Substitution of one type of flexible staybolt sleeve by another type shall be considered a repair.

j) Where necessary for boiler expansion, ball socket-type flexible staybolts shall be positioned in such a manner as to not interfere with boiler expansion. Where individual bolts are replaced, care should be taken to ensure that the stress load of the new bolt is compatible to the loading on adjacent bolts.

**Note:** Some locomotive boiler designs positioned the bolts by backing the bolt head away from the sleeve socket bottom a certain amount.

### FIGURE S1.2.3-a




### FIGURE S1.2.3-b
BALL SOCKET-TYPE FLEXIBLE STAYBOLTS

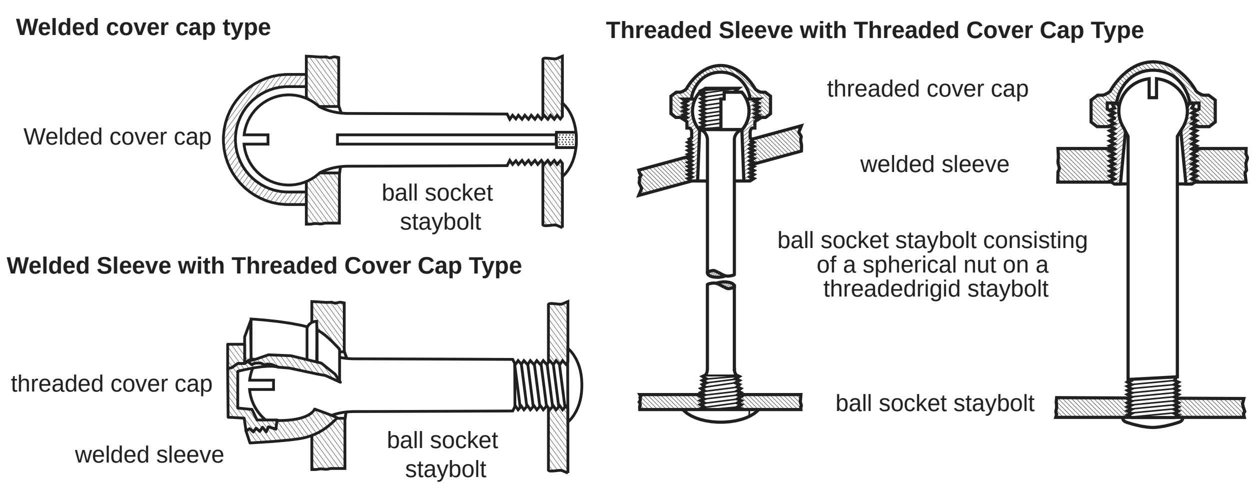


**FIGURE S1.2.3-c**

HALF SLEEVE REPAIR PROCEDURE FOR DAMAGED BALL SOCKET FLEXIBLE STAYBOLT WELDED SLEEVE

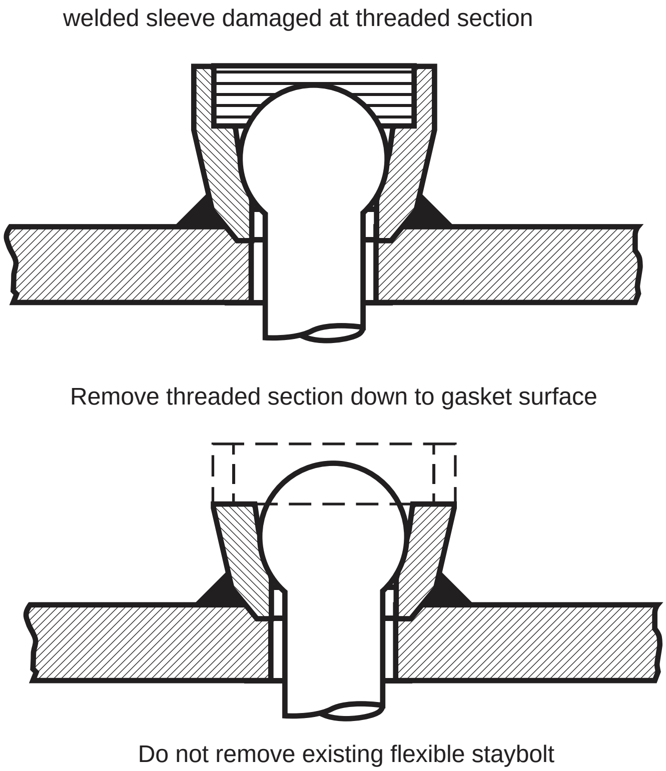



**FIGURE S1.2.3-d**

HALF SLEEVE REPAIR PROCEDURE FOR DAMAGED BALL SOCKET FLEXIBLE STAYBOLT WELDED SLEEVE

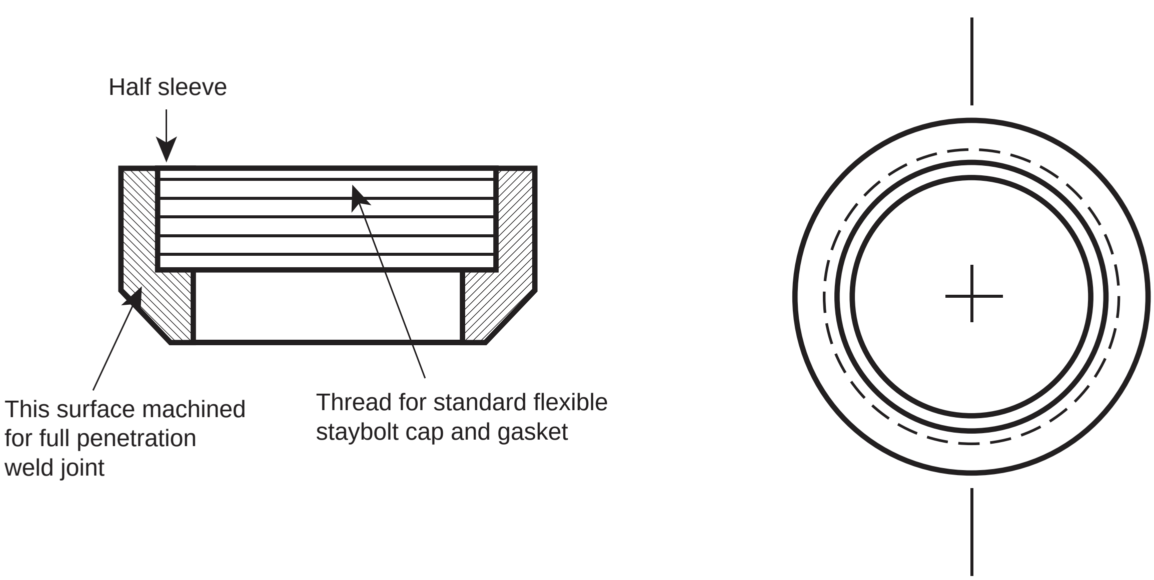
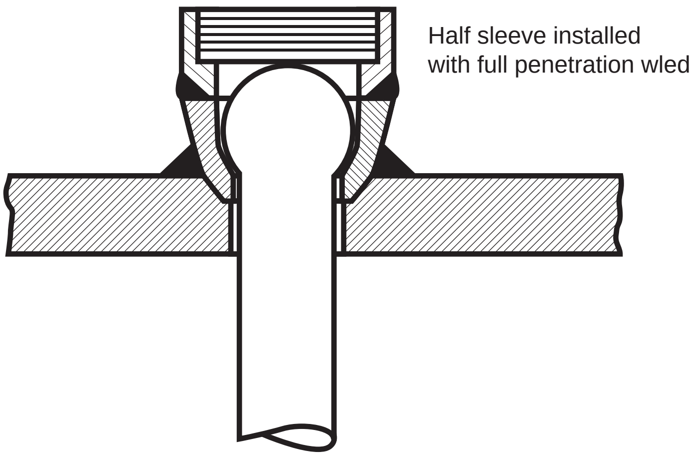


**FIGURE S1.2.3-e**
HALF SLEEVE REPAIR PROCEDURE FOR DAMAGED BALL SOCKET FLEXIBLE STAYBOLT WELDED SLEEVE

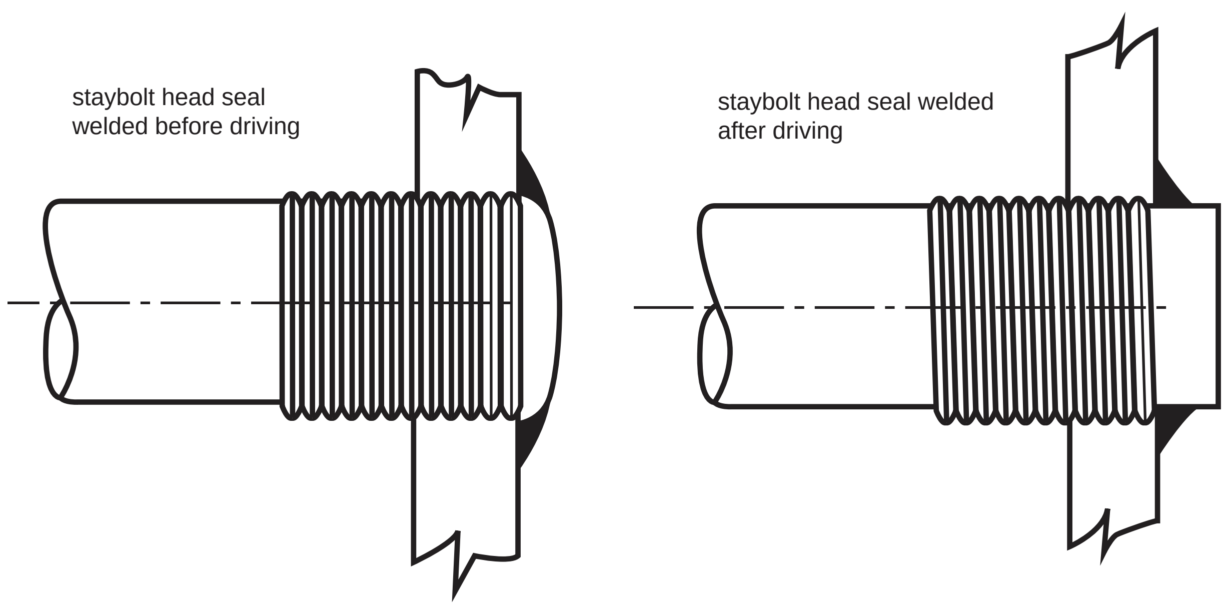



### S1.2.4 SEAL WELDED STAYBOLTS

a) Replacement threaded staybolts may be seal welded before or after driving.

b) Existing threaded staybolts that leak shall be repaired and may be seal welded. When used, seal welding shall not be the sole means of repair.

**FIGURE S1.2.4**
SEAL WELDED STAYBOLTS



## S1.2.5 WELDED INSTALLATION OF STAYBOLTS

a) The installation of unthreaded staybolts using full penetration welds is permissible.

b) All staybolts shorter than 8 in. (200 mm) in length shall have telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (32 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred. Ball socket-type flexible staybolts may have telltale holes that extend from the welded end of the bolt into the bolt head for a distance of one-third the spherical bolt head diameter.

c) Where necessary for boiler expansion, ball socket-type flexible staybolts shall be positioned in such a manner as to not interfere with boiler expansion. Where individual bolts are replaced, care should be taken to ensure that the stress load of the new bolt is compatible to the loading of adjacent bolts.

**Note:** Some locomotive boiler designs positioned the bolts by backing the bolt head away from the sleeve socket bottom a certain amount.

d) Installation of different diameter staybolts shall be considered a repair.

## S1.2.6 DIAGONAL BRACES, GUSSET BRACES, AND THROAT SHEET/TUBESHEET BRACES

a) Loose or damaged braces shall be repaired or replaced.

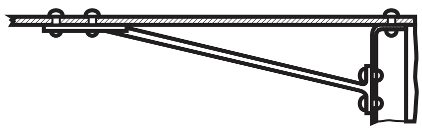
b) Only steel braces may be repaired by welding. All such welds shall be full penetration. Wrought iron braces shall not be repaired by welding. When repairs or alterations are completed, the tightness and condition of the braces and their staybolts, rivets, clevises, eyes, and pins shall be verified.

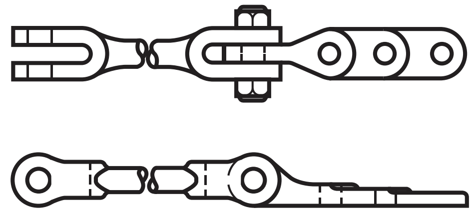
c) For pins that are fitted with nuts, the pin length shall be sized so that all threads of the nut are engaged upon completion of installation.

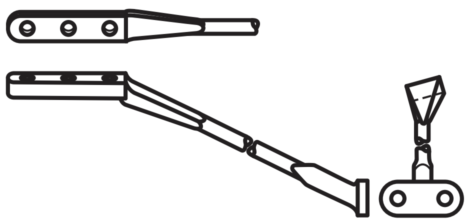
d) Replacement of diagonal stays having loop-type ends shall be considered a repair.

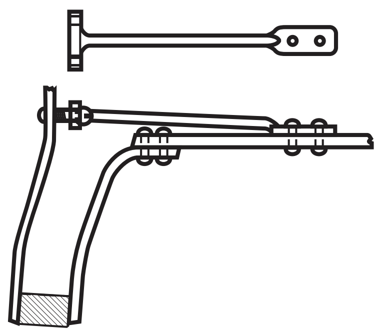
**FIGURE S1.2.6-a**

DIAGONAL BRACES, GUSSET BRACES, AND THROAT SHEET/TUBESHEET BRACES


diagonal brace


pin-type diagonal brace


solid-type brace


throat sheet/tubesheet brace

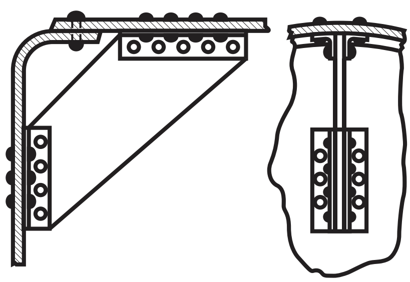
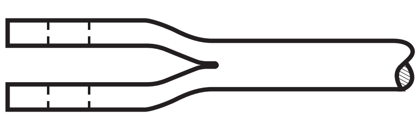
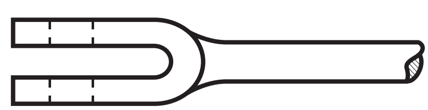

gusset brace

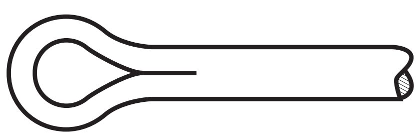
**FIGURE S1.2.6-b**

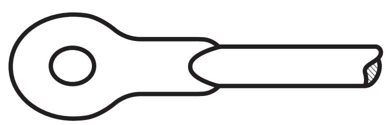
DIAGONAL BRACE ENDS

**Diagonal Brace Ends**






Loop-Type End


One-Piece End

### S1.2.6.1 GIRDER STAYS AND CROWN BARS

a) When repairs or alterations are completed, the installation and condition of the crown bars or girder stays and all associated fittings, including stays, rivets, pins, washers, nuts, thimbles, spacers and retainers, shall be verified.

b) Crown bars, girder stays and associated parts shall have the correct fit, alignment and bearing to the firebox and boiler sheets.

c) Wrought iron crown bars and girder stays, and all associated fittings, shall not be repaired by welding or application of riveted or bolted patches.

d) Steel crown bars, steel girder stays and associated steel brackets may be repaired or fabricated by welding. Welded repairs and components shall be made and examined in accordance with the ASME Boiler and Pressure Vessel Code, Section I.

e) Steel crown bars, steel girder stays and associated steel brackets, wasted or worn to less than 60% of original thickness, shall not be repaired by weld buildup.

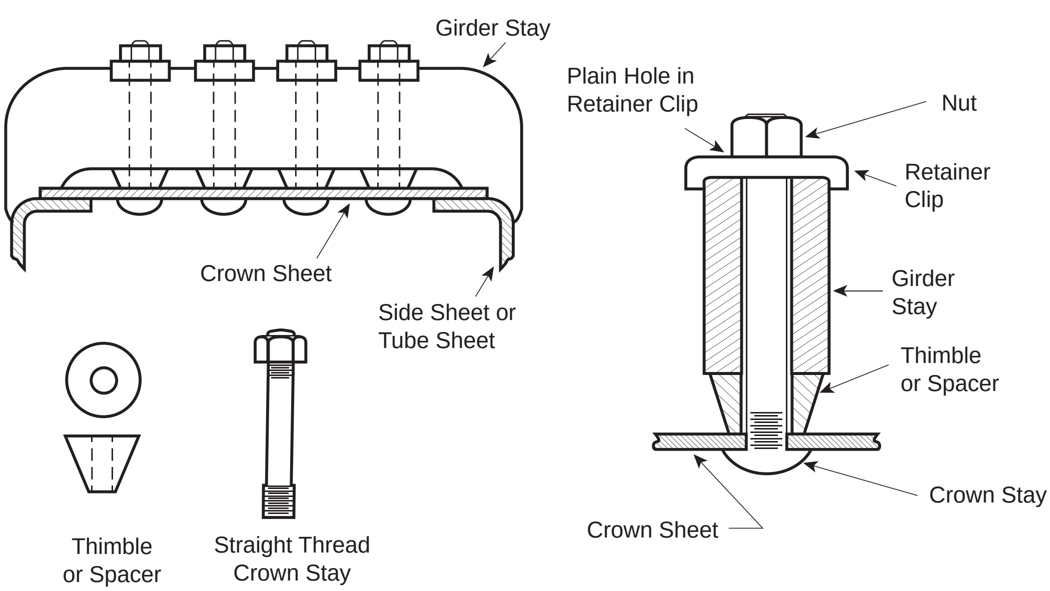
f) On stays and pins that are fitted with nuts, the stay or pin length shall be sized so that all threads of the nut are engaged upon completion of installation.

g) When driving crown bolts, the opposite bolt end shall be bucked or braced to prevent damaging the bolt threads in the firebox sheet. Bracing can be done several ways such as using a pneumatic holder-on or heavy steel bucking bar. The crown bolt head is to be driven in such a manner as to expand radially the crown bolt body and threads into the sheet prior to forming the head. Merely driving over the head is not acceptable.

h) Telltale holes shall be reopened after driving.

i) Crown bolts shall have either 11- or 12- thread pitch in the firebox sheets. Stay threads shall have good close fit in the firebox sheet. Changing the thread pitch from 11 to 12, or the reverse, shall be considered a repair.

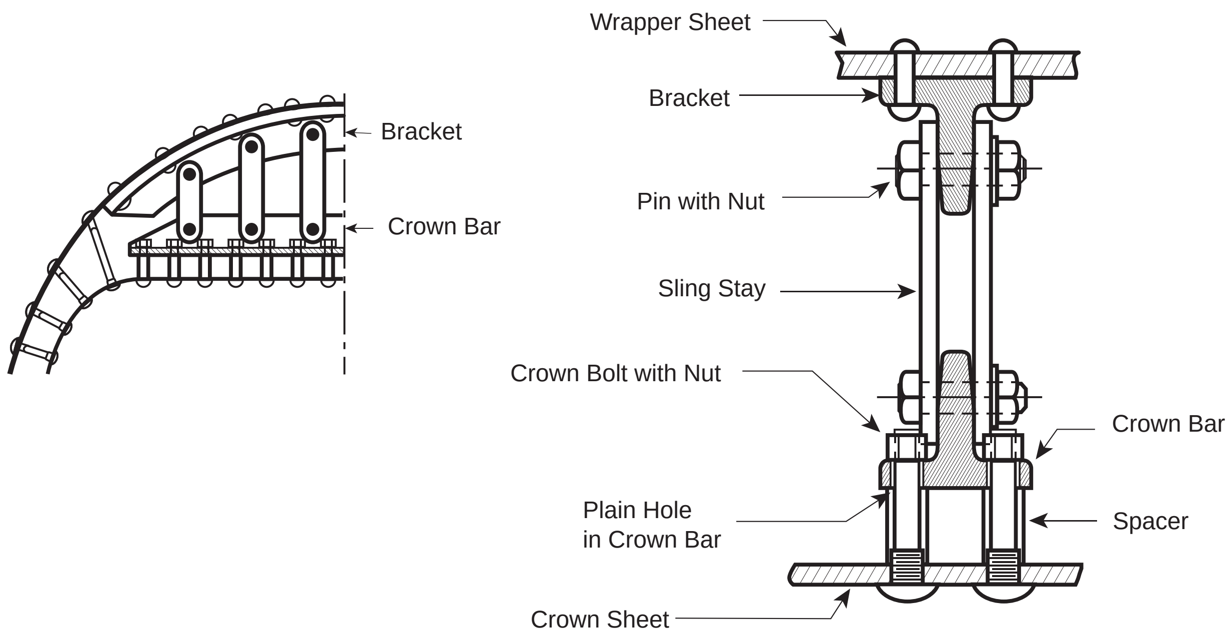
**FIGURE S1.2.6.1-a**
GRINDER STAY






SUPPL. 1

**FIGURE S1.2.6.1-b**
CROWN BAR WITH SLING STAYS








### S1.2.6.2 SLING STAYS

a) When repairs or alterations are completed, the installation and condition of the sling stays and all associated fittings, including brackets, rivets, pins, washers, nuts, thimbles and spacers, shall be verified.

b) Sling stays and the associated parts shall have the correct fit, alignment, and bearing to the crown bars, girder stays, firebox sheets and boiler sheets.

c) On pins that are fitted with nuts the pin length shall be sized so that all threads of the nut are engaged upon completion of installation.

d) Sling stays fabricated or repaired by welding shall be welded and examined in accordance with the ASME Boiler and Pressure Vessel Code Section I.

e) Holes and slots in sling stays should have all edges rounded off.

f) When driving sling-stay eye brackets, the opposite bracket end shall be bucked or braced to prevent damaging the threads. Bracing can be done several ways such as using a pneumatic holder-on or heavy steel bucking bar. The head of the sling stay eye bracket is to be driven in such a manner as to expand radially the body and threads into the sheet prior to forming the head. Merely driving over the head is not acceptable.

g) All sling stays, nuts, and pins shall be retained mechanically or have mechanical retainers installed when renewed or replaced.

**FIGURE S1.2.6.2-a**
EYE-TYPE SLING STAY

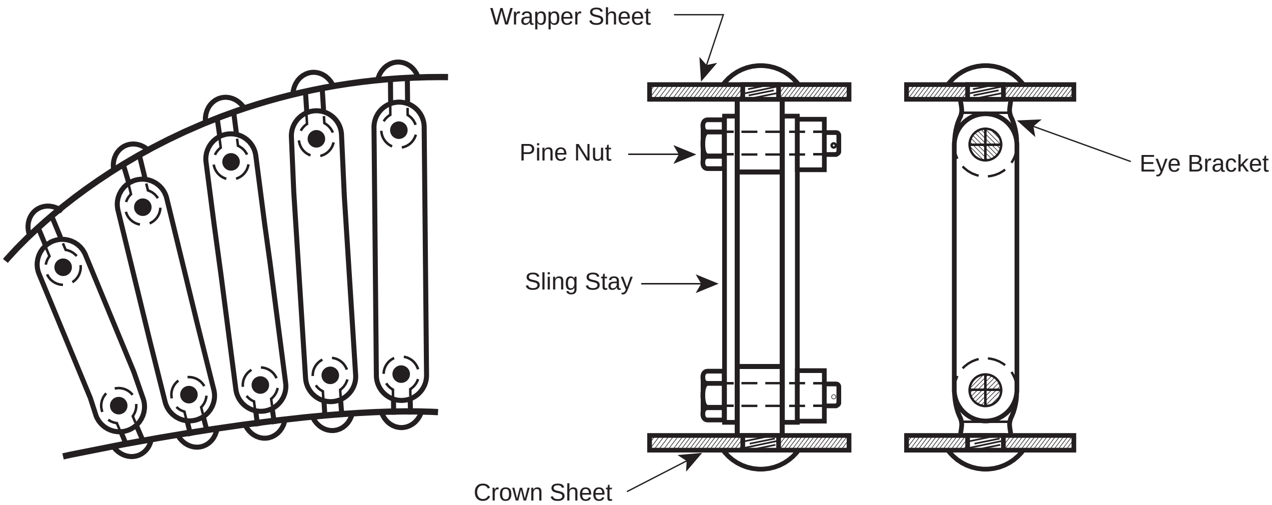
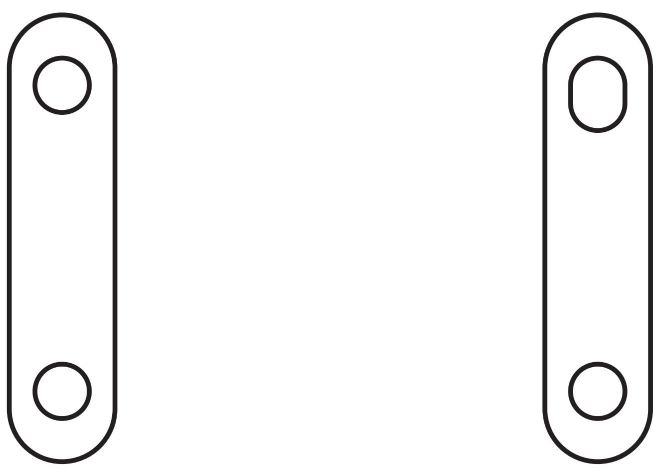



**FIGURE S1.2.6.2-b**



Sling Stay With
Round Pin Holes

Sling Stay With
Expansion Slot For Pin

## S1.2.6.3 EXPANSION STAYS

a) When repairs or alterations are completed, the installation and condition of the expansion stays and all associated fittings, including brackets, rivets, pins, washers, nuts, thimbles and spacers, shall be verified.

b) Wrought iron expansion stay brackets shall not be repaired by welding.

c) Expansion stays shall not be repaired by welding.

d) Worn pin holes and expansion slots of steel expansion stay brackets may be repaired by welding.

e) On stays and pins that are fitted with nuts, the stay or pin length shall be sized so that all threads of the nut are engaged upon completion of installation.

f) Stay length shall be sized so the length of the stay projecting through the sheet is not less than 1/8 in. (3.2 mm) and is sufficient to produce a full head after driving.

g) Stays shall have either 11 or 12 thread pitch. Stay threads shall have good close fit in the sheet. Changing the thread pitch from 11 to 12 or the reverse, shall be considered a repair.

h) Installation of expansion stays that have a different diameter in the firebox sheet shall be considered a repair.

i) Installation of expansion stays that have a different diameter in the bracket shall be considered a repair, provided the changes are within the stress limits of the original code of construction.

j) When driving expansion stay heads, the opposite end shall be bucked or braced to prevent damaging the threads. Bracing can be done several ways, such as using a pneumatic holder-on or heavy steel bucking bar. The stay head is to be driven in such a manner as to expand radially the stay body and threads into the sheet prior to forming the head. Merely driving over the head is not acceptable.

k) Telltale holes shall be reopened after driving.

**FIGURE S1.2.6.3-a**
EXPANSION STAY

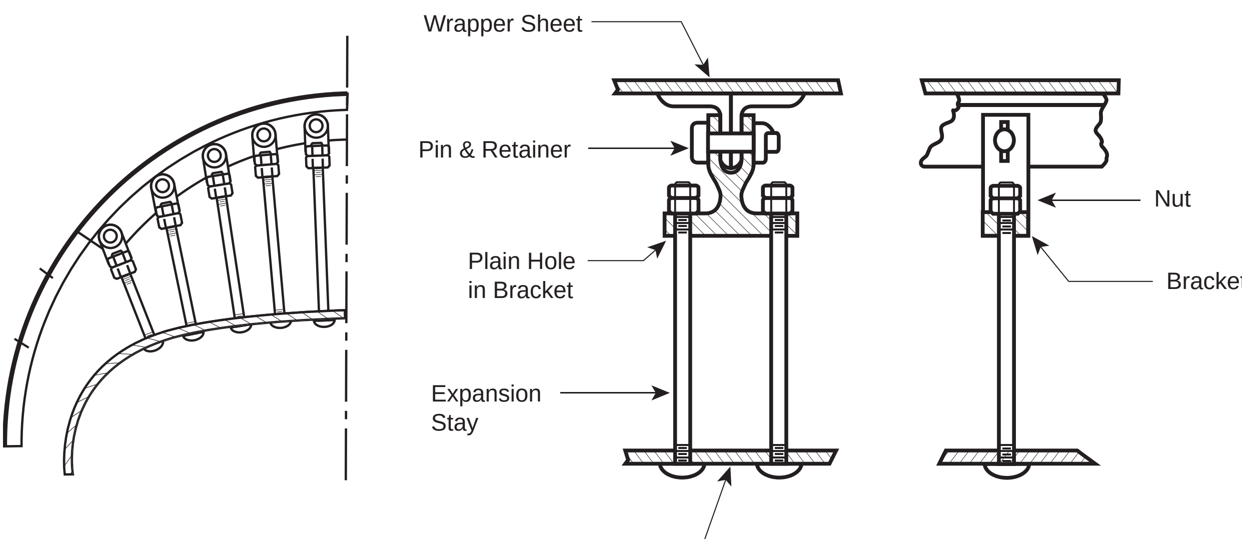
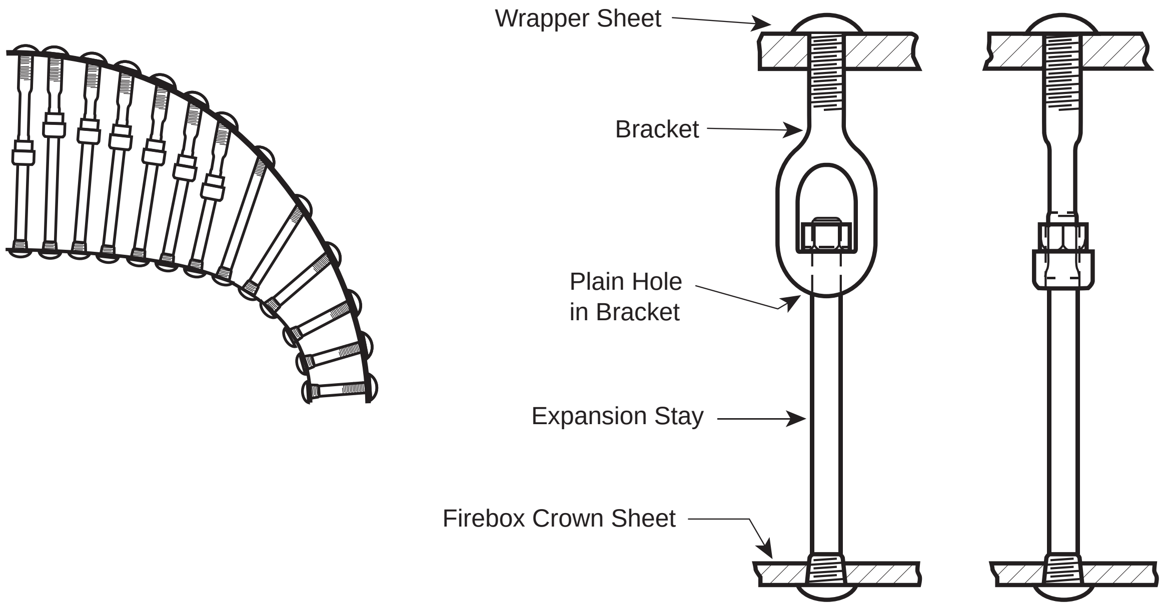


**FIGURE S1.2.6.3-b**
BALDWIN-TYPE EXPANSION STAY




## S1.2.7 THREADED STUDS

Studs threaded into the boiler or firebox sheets shall not be seal welded.

## S1.2.8 PATCH BOLTS

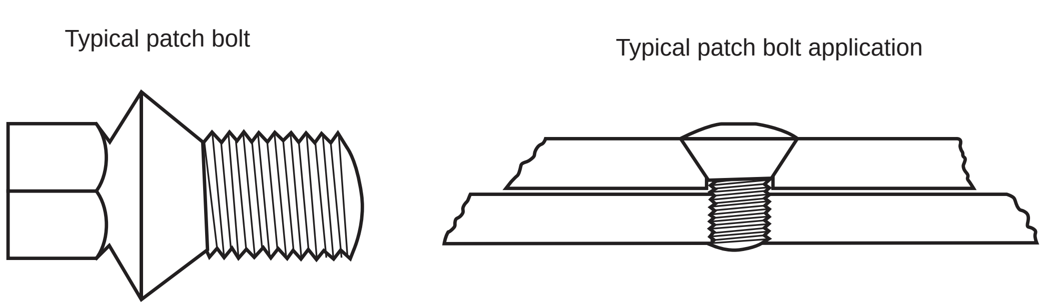
a) Patch bolts may be replaced in kind.

b) Seal welding of bolts is permitted.

c) Patch bolts shall have either 11 or 12 thread pitch. Patch bolt threads shall be fit to support the structure to which the bolt is applied. Changing the patch bolt thread from 11 to 12, or the reverse, shall be considered a repair.

d) A patch bolt applied in place of a rivet shall be considered an alteration.

**FIGURE S1.2.8**
PATCH BOLTS



## S1.2.9 FLUES, ARCH TUBES, CIRCULATORS, THERMIC SYPHONS

### TABLE S1.2.9.1

MAXIMUM ALLOWABLE WORKING PRESSURES FOR STEEL TUBES OR FLUES FOR FIRETUBE BOILERS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPEC. SA-178, SA-192, SA-209, OR SA-210*

| Outside diameter of tube, inches D | Minimum gage, Birmingham Wire Gage (BWG), inches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 13 t = 0.095 | 12 t = 0.109 | 11 t = 0.120 | 10 t = 0.134 | 9 t = 0.148 | 8 t = 0.165 | 7 t = 0.180 | 6 t = 0.203 | 5 t = 0.220 | 4 t = 0.238 |
| 1 | 470 | 690 | — | — | — | — | — | — | — | — |
| 1-1/2 | 320 | 460 | 570 | 720 | 860 | — | — | — | — | — |
| 1-3/4 | 270 | 400 | 490 | 620 | 740 | 890 | — | — | — | — |
| 2 | 240 | 350 | 430 | 540 | 650 | 780 | 900 | — | — | — |
| 2-1/4 | 210 | 310 | 380 | 480 | 580 | 690 | 800 | 960 | — | — |
| 2-1/2 | 190 | 280 | 350 | 430 | 520 | 620 | 720 | 860 | 970 | 1,080 |
| 3 | 160 | 230 | 290 | 360 | 430 | 520 | 600 | 720 | 810 | 900 |
| 3-1/4 | — | 210 | 270 | 330 | 400 | 480 | 550 | 660 | 740 | 830 |
| 3-1/2 | — | 200 | 250 | 310 | 370 | 450 | 510 | 620 | 690 | 770 |
| 4 | — | 180 | 220 | 270 | 330 | 390 | 450 | 540 | 610 | 680 |
| 4-1/2 | — | 160 | 190 | 240 | 290 | 350 | 400 | 480 | 540 | 600 |
| 5 | — | — | 180 | 220 | 260 | 310 | 360 | 430 | 490 | 540 |
| 5-3/8 | — | — | 160 | 200 | 240 | 290 | 340 | 400 | 450 | 500 |
| 5-1/2 | — | — | — | 200 | 240 | 290 | 330 | 390 | 440 | 490 |
| 6 | — | — | — | 180 | 220 | 260 | 300 | 360 | 410 | 450 |

$P = \{(t-0.65)/D\} \times 15550$ where P = maximum allowable working pressure, pounds per square inch,
t = minimum wall thickness, inches,
D = outside diameter of tubes, inches.

For pressures below those given in the table, the gage thickness shall be not less than the minimum given in the table.
* Calculated values of pressure have been rounded to the next higher unit of 10 psi.

SUPPL. 1

## TABLE S1.2.9.1M

MAXIMUM ALLOWABLE WORKING PRESSURES FOR STEEL TUBES OR FLUES FOR FIRETUBE BOILERS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPEC. SA-178, SA-192, SA-209, OR SA-210*

| Outside diameter of tube, mm D | Minimum gage, Birmingham Wire Gage (BWG), to mm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 13 t = 2.4 | 12 t = 2.8 | 11 t = 3.0 | 10 t = 3.4 | 9 t = 3.8 | 8 t = 4.2 | 7 t = 4.6 | 6 t = 5.2 | 5 t = 5.6 | 4 t = 6.0 |
| 25 | 3,250 | 4,950 | — | — | — | — | — | — | — | — |
| 40 | 2,150 | 3,250 | 3,850 | 4,950 | 6,100 | — | — | — | — | — |
| 45 | 1,850 | 2,800 | 3,300 | 4,300 | 5,250 | 6,250 | — | — | — | — |
| 50 | 1,650 | 2,450 | 2,850 | 3,700 | 4,550 | 5,350 | 6,200 | — | — | — |
| 60 | 1,450 | 2,200 | 2,550 | 3,300 | 4,050 | 4,800 | 5,550 | 6,700 | — | — |
| 65 | 1,300 | 1,950 | 2,300 | 2,950 | 3,600 | 4,300 | 4,950 | 5,950 | 6,650 | 7,300 |
| 75 | 1,100 | 1,650 | 1,950 | 2,500 | 3,050 | 3,600 | 4,200 | 5,000 | 5,600 | 6,150 |
| 85 | — | 1,500 | 1,750 | 2,300 | 2,800 | 3,300 | 3,850 | 4,600 | 5,100 | 5,650 |
| 90 | — | 1,400 | 1,650 | 2,150 | 2,600 | 3,100 | 3,550 | 4,300 | 4,750 | 5,250 |
| 100 | — | 1,250 | 1,450 | 1,850 | 2,300 | 2,700 | 3,100 | 3,750 | 4,150 | 5,600 |
| 115 | — | 1,100 | 1,300 | 1,650 | 2,050 | 2,400 | 2,800 | 3,300 | 3,750 | 4,100 |
| 125 | — | — | 1,150 | 1,500 | 1,850 | 2,200 | 2,500 | 3,000 | 3,350 | 3,700 |
| 135 | — | — | 1,100 | 1,400 | 1,700 | 2,000 | 2,350 | 2,800 | 3,100 | 3,400 |
| 140 | — | — | — | 1,350 | 1,650 | 2,000 | 2,300 | 2,750 | 3,050 | 3,350 |
| 150 | — | — | — | 1,250 | 1,550 | 1,800 | 2,100 | 2,500 | 2,800 | 3,100 |

P = {(t–1.65)/D} x 107000 where P = maximum allowable working pressure, kilopascals (kPa),
t = minimum wall thickness, mm,
D = outside diameter of tubes, mm.

For pressures below those given in the table, the gage thickness shall be not less than the minimum given in the table.

* Calculated values of pressure have been rounded to the next higher unit of 50 kPa.

### S1.2.9.1 FLUE AND TUBE RE-ENDING

a) Each boiler tube or flue that is repaired by welding is limited to not more than three circumferential welded joints.

b) Re-ending is permitted provided, the thickness of the tube or flue to be re-ended is not less than 90% of that required by NBIC Part 3, Table S1.2.9.1.

c) Re-end pieces shall be new material and meet the thickness requirements of NBIC Part 3, Table S1.2.9.1.

### S1.2.9.2 ARCH TUBES

a) Arch tubes that are damaged or reduced to less than minimum required wall thickness shall be replaced in entirety by new one-piece arch tubes. Welded repairs or partial replacement is not permitted. Damage includes defects such as bulging, burns, and cracks.

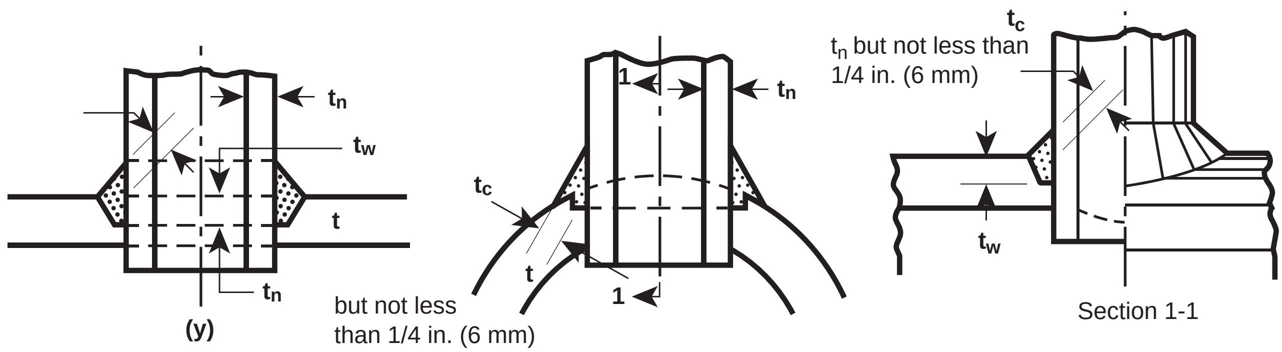
b) When arch tubes are installed by rolling, the tube end shall project through the firebox sheet not less than 1/4 in. (6 mm) nor more than 3/4 in. (19 mm) before flaring. At a minimum, the tube shall be expanded and flared at least 1/8 in. (3 mm) greater than the diameter of the tube hole. Additionally, the tube may be beaded and/or seal welded provided the throat of the seal weld is not more than 3/8 in. (10 mm), and the tube is finished rolled after welding.

c) An arch tube installed by welding shall be considered a welded nozzle. Some acceptable weld joints are shown in NBIC Part 3, Figure S1.2.9.2-a (Ref. ASME Section I, Part PW 16.1).

d) A change in tube attachment from rolled-to-welded or welded-to-rolled shall be considered an alteration.

**FIGURE S1.2.9.2-a**

WELDED INSTALLATION OF ARCH TUBE




$t$ = thickness of vessel shell or head, in.

$t_n$ = thickness of nozzle wall, in.

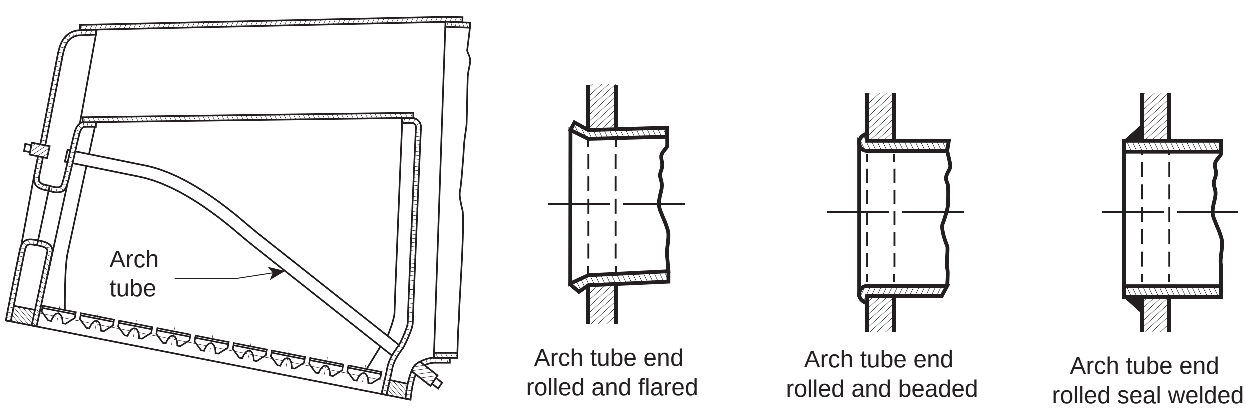
$t_w$ = dimension of partial penetration attachment welds (fillet, single bevel, or single J), measured as shown in ASME Section I, Figure PW-16.1, in.

$t_c$ = not less than the smaller of 1/4 in. (6 mm) or 0.7 $t_{min}$ (inside corner welds may be further limited by a lesser length of projection of the nozzle wall beyond the inside face of the vessel wall)

$t_{min}$ = the smaller of 3/4 in. (19 mm) or the thickness of either of the weld parts joined by a fillet, single bevel, or single J-weld, in.

**FIGURE S1.2.9.2-b**

EXAMPLE OF ARCH TUBE INSTALLATION




Arch tube end rolled and flared

Arch tube end rolled and beaded

Arch tube end rolled seal welded



SUPPL. 1

## S1.2.9.3 TUBE WALL THICKNESS FOR ARCH TUBES

The minimum wall thickness of replacement arch tubes shall be as shown in Table S1.2.9.3.

### TABLE S1.2.9.3

| Size | Wall Thickness |
|---|---|
| Up to 3 in. (75 mm) OD | 8 Birmingham wire gage (BWG) |
| More than 3 in. (75 mm) OD to 4 in. (100 mm) OD | 7 Birmingham wire gage (BWG) |

## S1.2.9.4 THERMIC SYPHONS

a) For repairs to syphon knuckles see *Repair of Firebox and Tubesheet Knuckles*, and NBIC Part 3, Figures S1.2.11.5-a and S1.2.11.5-b.

b) All weld repairs to the unstayed sections of the syphon neck and body shall be radiographically examined.

### FIGURE S1.2.9.4-a

LOCOMOTIVE FIREBOX THERMIC SYPHON INSTALLATION

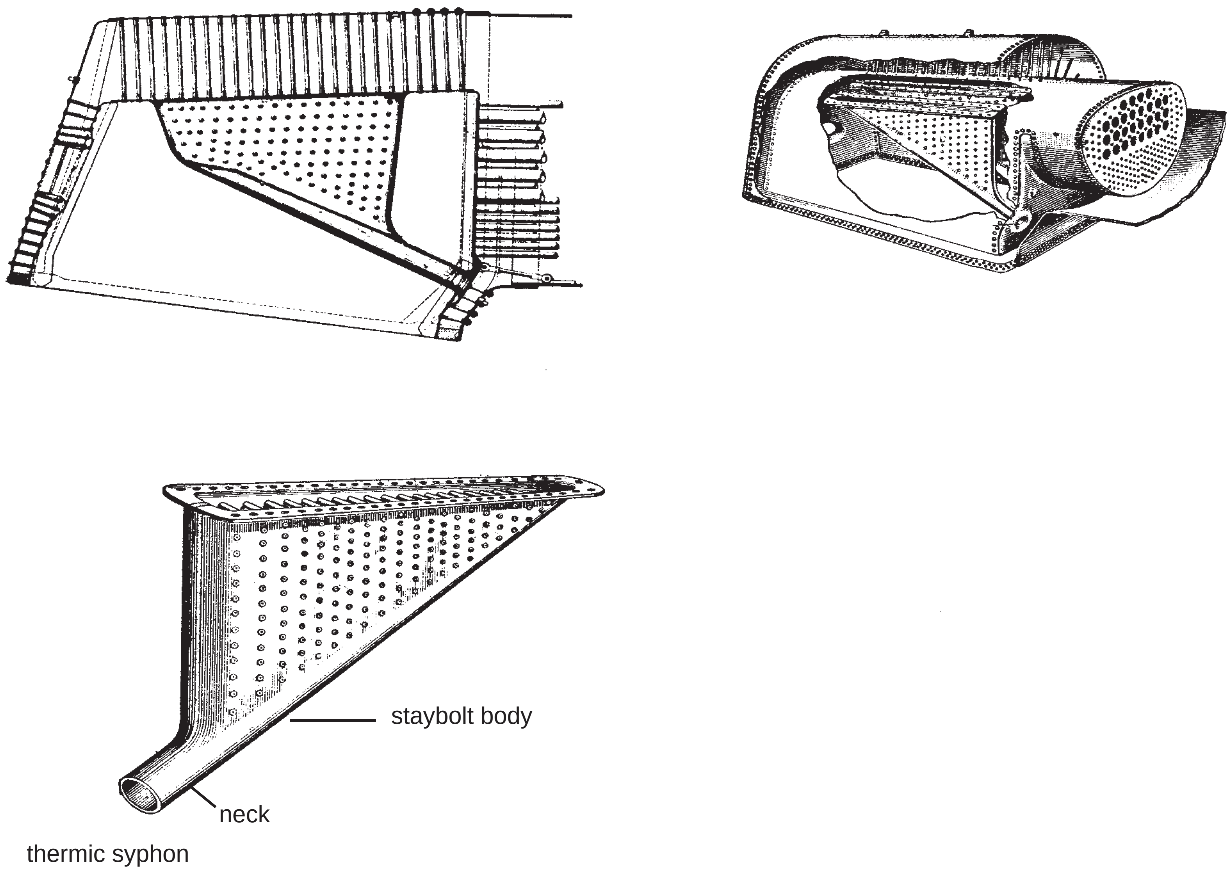
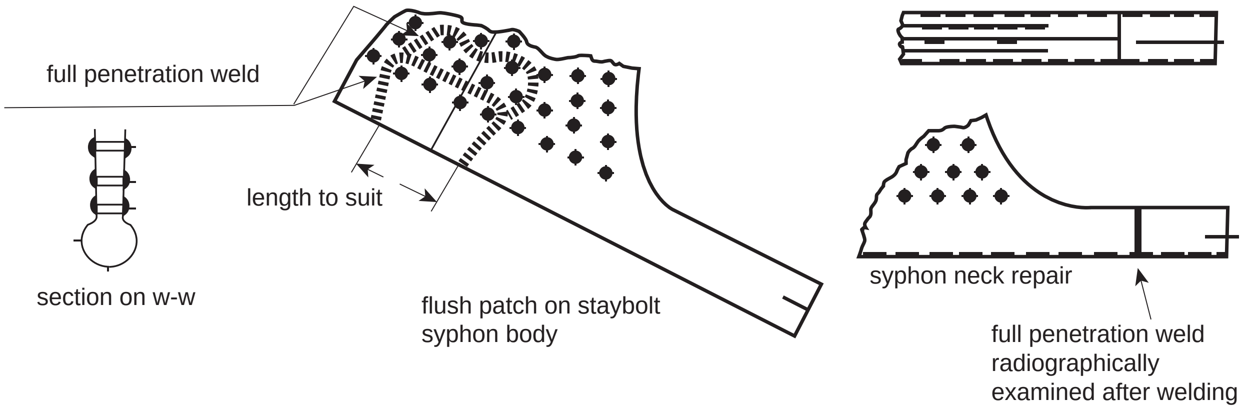


**FIGURE S1.2.9.4-b**
THERMIC SYPHON REPAIR




### S1.2.9.5 CIRCULATORS

a) All buttwelds on circulators shall be radiographically examined.

b) Welds applied to the circulator/firebox sheet joint shall be in accordance with the weld requirements for arch tubes. (See NBIC Part 3, Figure S1.2.9.2-a).

### S1.2.9.6 RE-ROLLING OF FLUE-TUBES AFTER SEAL WELDING

All flues and tubes that are installed by rolling and seal welding shall be re-rolled after seal welding is complete.

### S1.2.9.7 FERRULES

a) Ferrous or non-ferrous ferrules may be used on either or both ends of flues and arch tubes.

b) If ferrules are recessed, the recess depth shall not exceed 1/16 in. (1.6 mm) measured from the flue sheet fireside edge.

c) Protrusion of the ferrule beyond the edges of either flue sheet is permitted provided the ferrule does not interfere with any further attachment procedures.

d) For steel ferrules, if the flue is installed by expanding it straight and seal welding it to the flue sheet, the seal weld shall be arranged to contact the flue sheet and the flue. Seal welding the flue to the ferrule only is prohibited.

e) The applications of ferrules where none were used before shall be considered a repair.

f) The application with ferrules, where none were used before shall be considered a repair.

### S1.2.9.8 FLUES SMALLER THAN 3 INCHES

All flues smaller than 3 in. (76 mm) OD shall be rolled and beaded or rolled and seal welded on the firebox end, and at least one in ten at the front flue sheet end. All flues 3 in. (76 mm) OD and larger shall be rolled and beaded or rolled and seal welded at both ends and all adjacent flues smaller than 3 in. (76 mm) OD that are within the large flue pack shall be rolled and beaded or rolled and seal welded at both ends.

At least one in ten of the remaining flues smaller than 3 in. (76 mm) OD shall be beaded or seal welded on the front flue sheet, in addition to rolling. Where less than all flues are seal welded or beaded on the front flue sheet, those seal welded or beaded shall be distributed as evenly as practicable throughout the flue pack. This shall be considered a repair.

## S1.2.10 REPAIRS AND ALTERATIONS TO BOILER BARREL UNSTAYED AREAS

a) Except as provided in NBIC Part 3, 3.4.4.8, a repair of a defect in a welded joint or base material shall not be made until the defect is removed. A suitable nondestructive examination (NDE) method such as magnetic particle (MT) or liquid penetrant (PT) may be necessary to ensure complete removal of the defect. If the defect penetrates the full thickness of the material, the repair shall be made with a full penetration weld such as a double buttweld or a single buttweld with or without backing. Where circumstances indicate that the defect is likely to recur, consideration should be given to removing the defective area and installing a flush patch or taking other corrective measures acceptable to the Inspector, and when required by the Jurisdiction.

b) Weld buildup shall not be used if the affected section of plate has wasted below 60% of the minimum required thickness.

c) If the cracked section of plate is retained and is to be repaired by installation of a riveted patch, the crack may be stopped by drilling stop holes at each end or removed by a method such as grinding, cutting, or machining. Results of stop drilling or crack removal shall be verified by NDE.

d) Welded repairs at or near riveted seams requiring preheating or postweld heat treatment shall be carefully made in order to prevent loosening in the riveted seams, especially when localized heating is used. Where necessary to control expansion or to gain access for welding, rivets at the defective section and to each side of it may be removed. Reuse of rivets and staybolts is prohibited.

e) All welded repairs to boiler barrel unstayed areas shall be radiographically examined in accordance with ASME Code, Section I when the size of the repaired area is greater than the maximum size of an unreinforced opening as calculated in accordance with the latest edition of ASME Code, Section I.

f) Riveted patches may be any shape or size provided the lowest patch efficiency is equal to or greater than the lowest equivalent seam efficiency of the boiler course to which it is applied. Ref: ASME Code, Section I.

g) The factor of safety of all riveted patches shall not be less than four for locomotives operating under Federal Railroad Administration regulations.

## S1.2.11 REPAIRS AND ALTERATIONS TO BOILER BARREL STAYED AREA

### S1.2.11.1 FIREBOX SHEET REPAIR

a) Cracks in all stayed firebox sheets may be repaired by welding or the installation of a flush patch.

b) If the crack extends into a staybolt or rivet hole, the staybolt or rivet shall be removed prior to making the repair.

c) Fire cracks or thermal fatigue cracks in riveted seams located in the firebox that run from the edge of the plate into the rivet holes may be left in place provided they do not leak and there is no indication that the seam or rivets are loose. (See NBIC Part 3, Figure S1.2.11.1).

**FIGURE S1.2.11.1**

EXAMPLE OF THERMAL FIRE CRACK

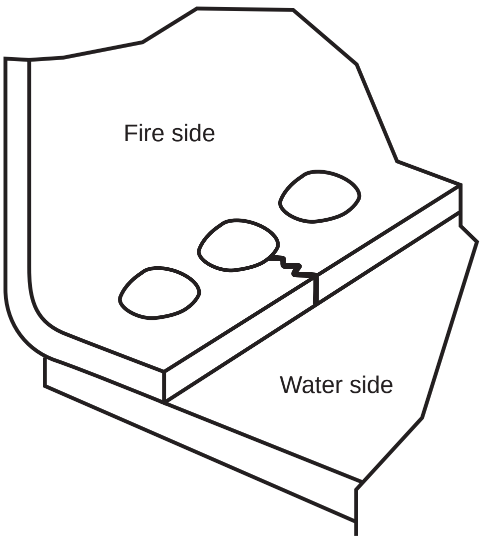
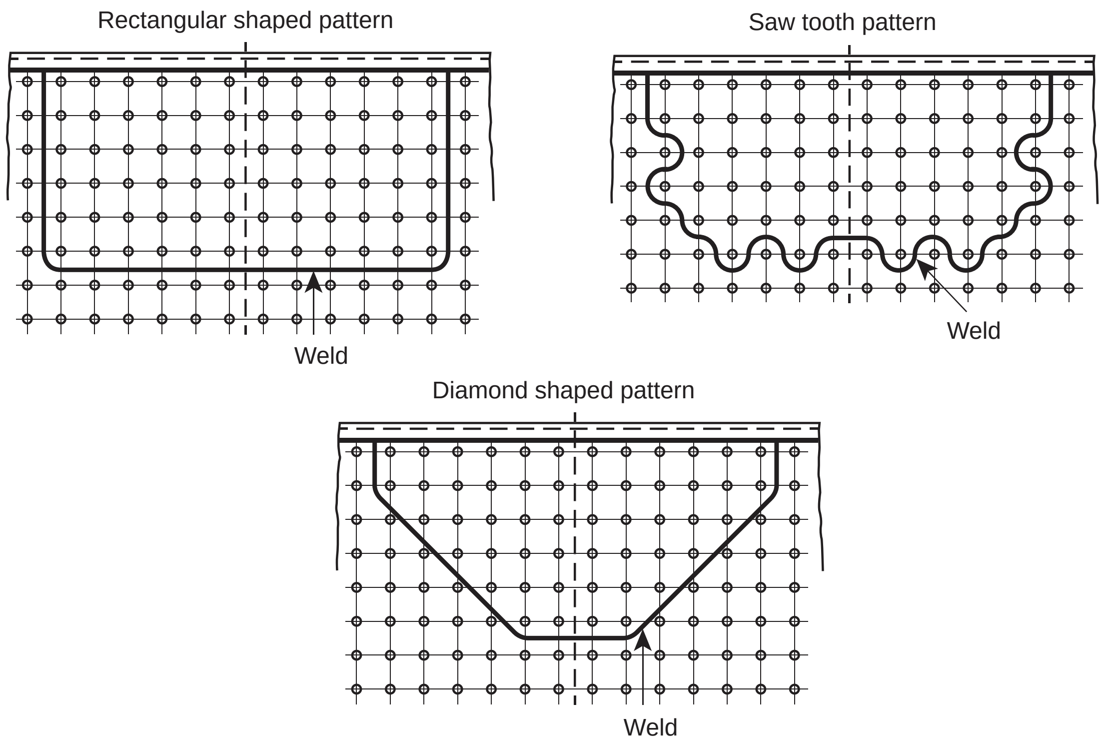



**FIGURE S1.2.11.2**

TYPICAL FIREBOX PATCHES

This figure illustrates what would be considered a saw-tooth patch. Its advantage is that a maximum amount of welding is obtained for securing a given patch and by zig-zagging the weld, the weld is supported by three rows of staybolts instead of two. Its disadvantage is its irregular shape which causes greater difficulty in fitting and applying. Rectangular and diamond shaped patches are illustrated for comparison.






SUPPL. 1

### S1.2.11.2 FIREBOXES AND OTHER STAYED AREA PATCHES

a) Patches may be any shape provided they are adequately supported by staybolts, rivets, tubes, or other forms of construction. Patches on stayed surfaces should be designed so weld seams pass between staybolt rows. (See NBIC Part 3, Figure S1.2.11.2).

b) Patches are to be flush type, using full penetration welds. If the load on the patch is carried by other forms of construction, such as staybolts, rivets, or tubes, radiographic examination and postweld heat treatment of the welds are not required.

c) If the patch includes an existing riveted seam, the patch shall be riveted at that seam. Changing a riveted seam to a welded seam is considered an alteration.

d) All rectangular or angled patches shall have adequate radius at all corners. Minimum radius to be not less than three times plate thickness.

e) Patches shall fit flush on the waterside of the sheet. Misalignment shall not exceed one-quarter plate thickness on edge alignment with the sheet water side.

f) Staybolts and rivets should be installed after welding of patch is completed. Reuse of staybolts and rivets is prohibited.

g) Weld seams parallel to a knuckle shall be located no closer to the knuckle than the point of tangency of the knuckle unless the weld is radiographically examined. Weld seams not located in the knuckle are preferred. (See NBIC Part 3, Figure S1.2.11.5-b).

h) Patches shall be made from material that is at least equal in quality and thickness to the original material.

### S1.2.11.3 REPAIR OF STAYED FIREBOX SHEETS GROOVED OR WASTED AT THE MUDRING

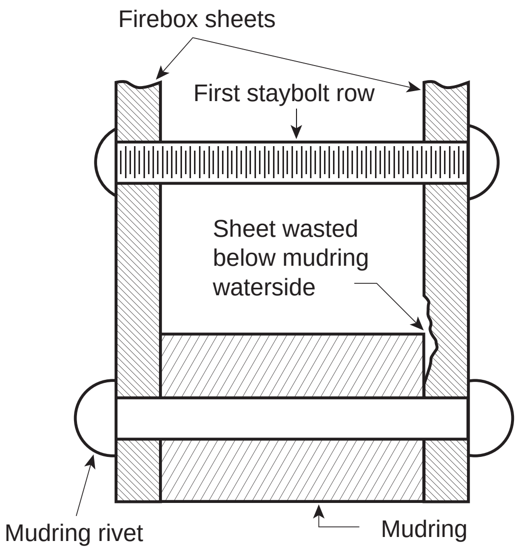
a) Grooved or wasted firebox sheets having greater than 60% of the minimum required thickness remaining may be repaired by weld buildup provided the wastage does not extend below the waterside surface of the mudring and the strength of the structure will not be impaired. If extensive welding is required, the affected area shall be removed and replaced with a flush patch.

b) If the sheet thickness has been reduced to less than 60% of the minimum required thickness, the affected section shall be removed and replaced with a flush patch.

c) If wastage and grooving extends below the mudring waterside surface and if the plate thickness remaining has been reduced to less than the minimum required thickness, the affected section shall be removed and replaced with a flush patch.

d) Flush patches shall be arranged to include the mudring rivets and at least the first row of staybolts above the mudring.

**FIGURE S1.2.11.3**
STAYED FIREBOX SHEET GROOVED OR WASTED AT MUDRING

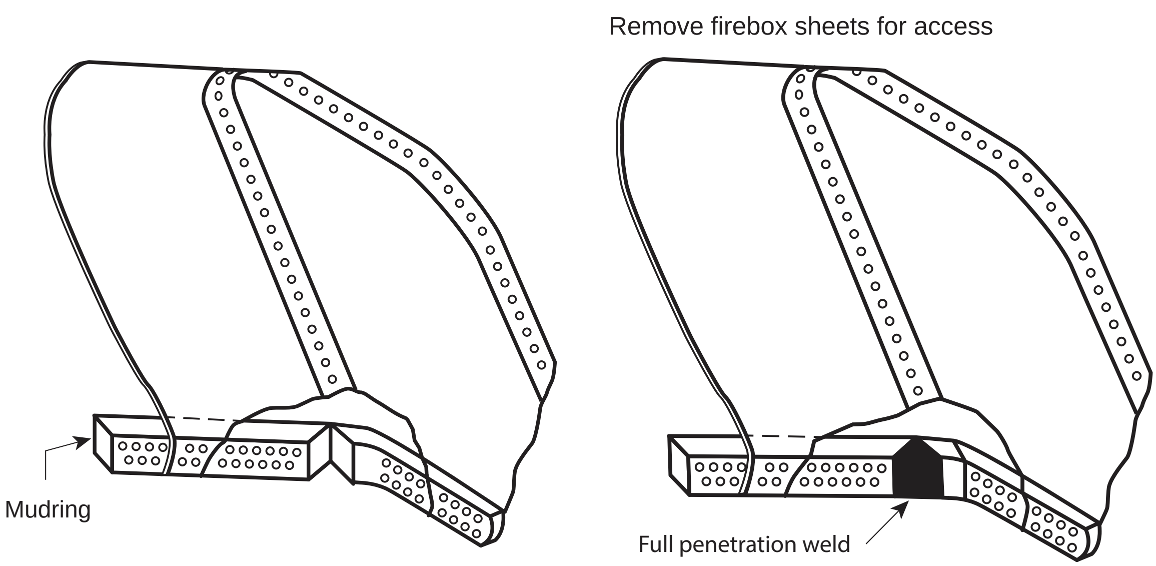



### S1.2.11.4 MUDRING REPAIRS

a) Pitted and wasted sections of mudrings may be built up by welding provided the strength of the mudring will not be impaired. Where extensive weld buildup is employed, the Inspector may require an appropriate method of NDE for the repair.

b) Cracked or broken mudrings may be repaired by welding or installation of flush patches using full penetration welds. Patches shall be made from material that is at least equal in quality and thickness to the original material. Patches shall fit flush on waterside surfaces. Where necessary, firebox sheets on both sides of the defect may be removed to provide access for inspection and welding.

**FIGURE S1.2.11.4**
MUDRING REPAIRS






SUPPL. 1

### S1.2.11.5 REPAIR OF FIREBOX AND TUBESHEET KNUCKLES

a) Welds within the points of tangency of a knuckle are permitted. Welds with angles of less than 45 degrees to the longitudinal axis of the knuckle shall be radiographically examined. (See NBIC Part 3, Figures S1.2.11.5-a through S1.2.11.5-g).

b) Any patch not supported by means other than the weld, such as rivets, staybolts, tubes, or other forms of construction, shall have all weld seams radiographically examined.

c) Patches shall be formed to proper shape and curvature.

d) Wasted sections of knuckles that have not wasted below 60% of the minimum required thickness may be repaired by weld buildup provided the strength of the structure will not be impaired. Where weld buildup is employed, the Inspector may require an appropriate method of NDE for the repair.

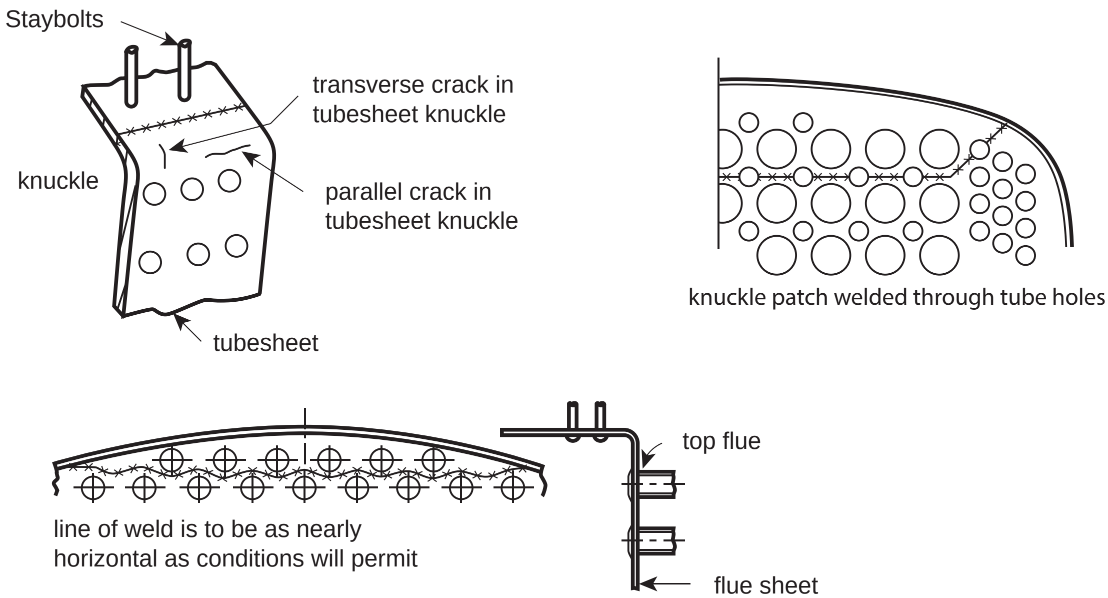
e) Wasted sections of knuckles that have wasted below 60% of the minimum required thickness shall be replaced.

f) Flanges shall be made so as to avoid stress intensifiers such as abrupt ridges and grooves.

g) Flanges shall be made smooth and free of ridges, valleys and grooves.

h) Flanges may be welded in accordance with this section and all applicable sections of this code.

**FIGURE S1.2.11.5-a**
FIREBOX TUBESHEET KNUCKLE REPAIR




knuckle patch welded around tube holes



**FIGURE S1.2.11.5-b**
REPAIR OF FIREBOX AND TUBESHEET KNUCKLES

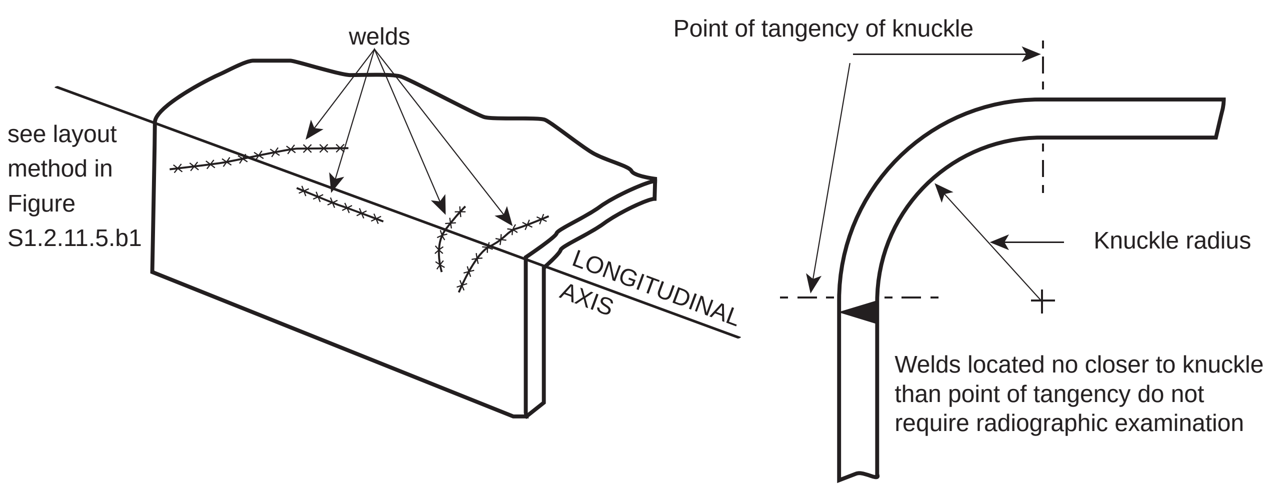
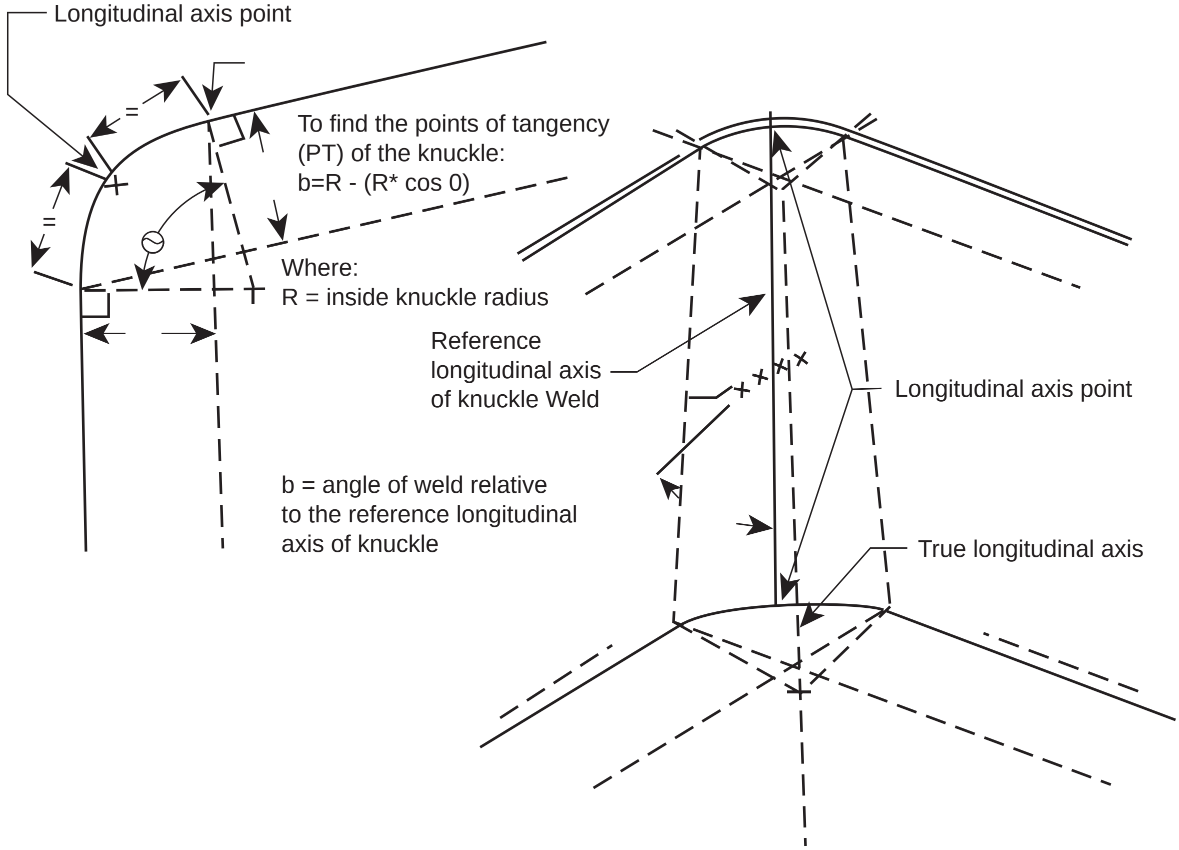


**FIGURE S1.2.11.5-b1**

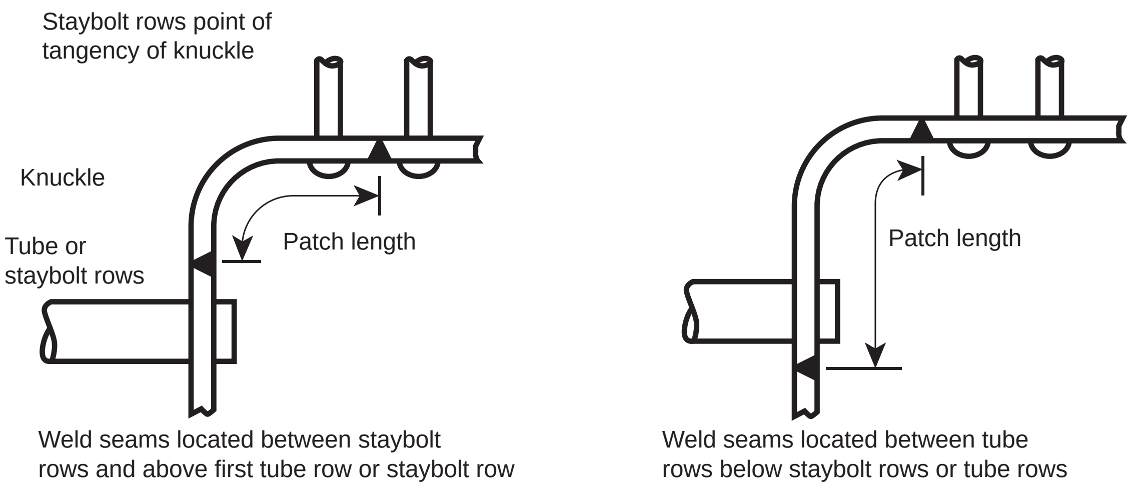
LAYOUT METHOD OF DETERMINING KNUCKLE WELD ANGLE



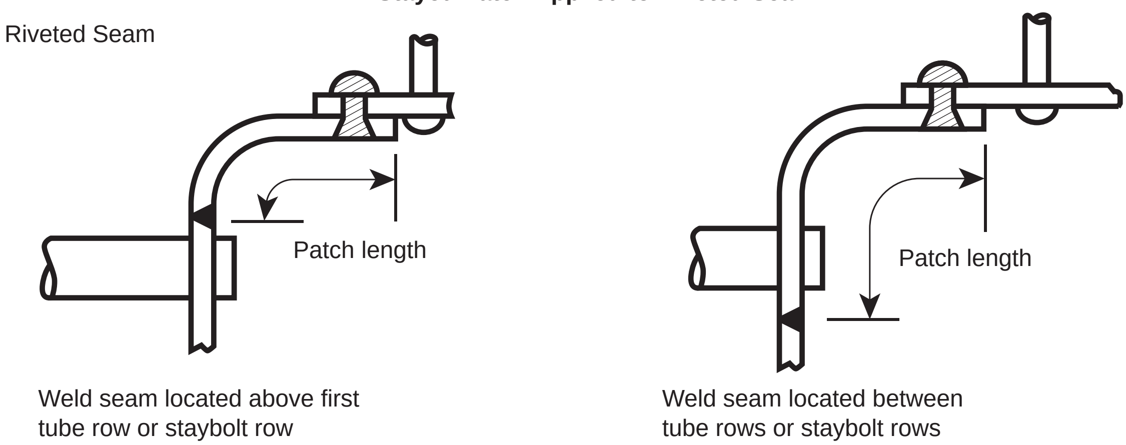

Illustrations are of inside surface of knuckle

**FIGURE S1.2.11.5-c**
REPAIR OF FIREBOX AND TUBESHEET KNUCKLES

**Stayed Patch Applied to Buttwelded Seam**




**Stayed Patch Applied to Riveted Seam**




**Repairs Requiring Radiographic Examination of Weld Seams**

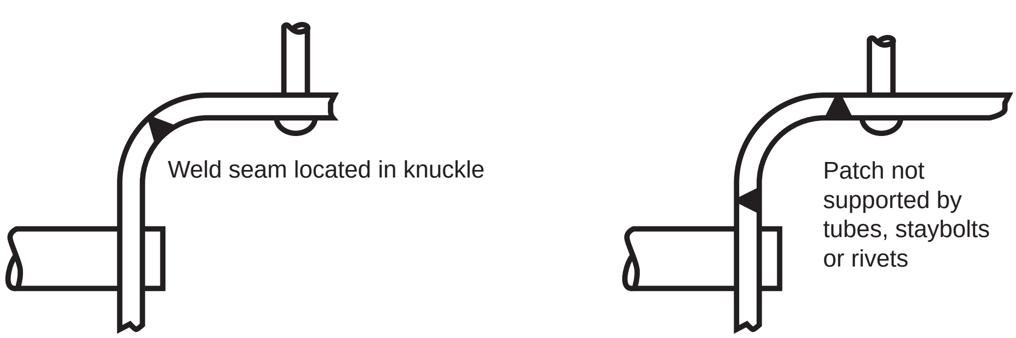


**FIGURE S1.2.11.5-d**
FIREBOX THROAT SHEET KNUCKLE

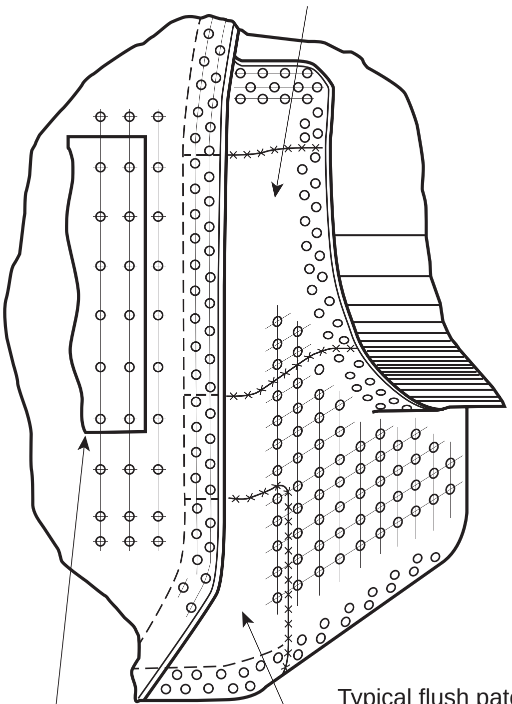



**FIGURE S1.2.11.5-e**
BACKHEAD KNUCKLE REPAIRS

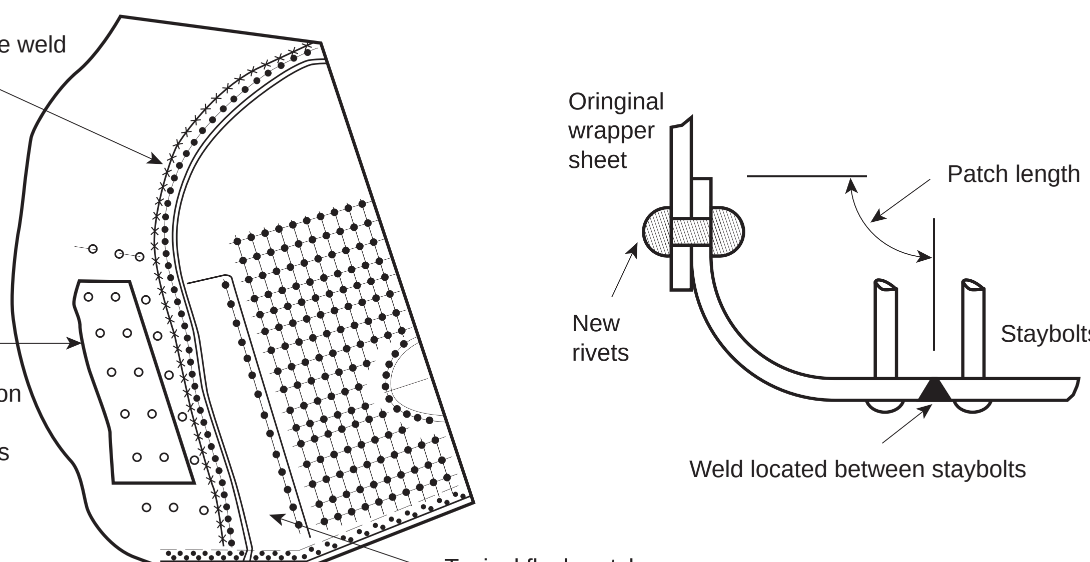


**FIGURE S1.2.11.5-f**
FIRE DOOR OPENING REPAIR

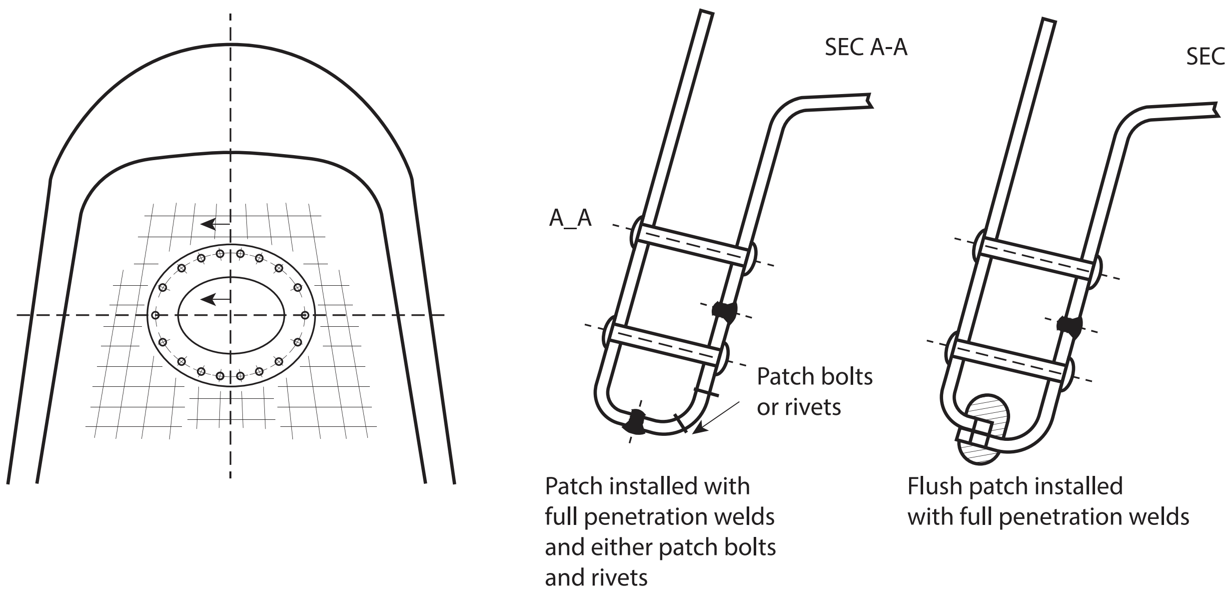
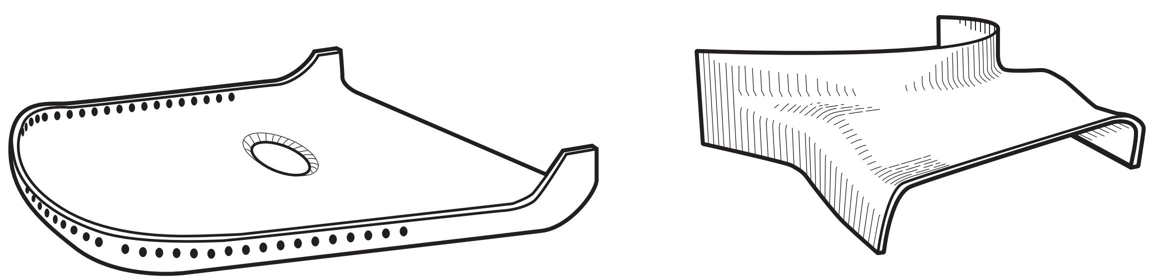



**FIGURE S1.2.11.5-g**
TYPICAL FLANGED SHEETS



Typical Flanged Sheets

1. Flanges shall be made smooth and free of ridges, valleys and grooves
2. Flanges may be welded in accordance with this sectionand all applicable sections of this code.

### S1.2.11.6 TUBESHEET REPAIRS

a) Cracked tubesheet ligaments may be repaired by welding using full penetration welds.

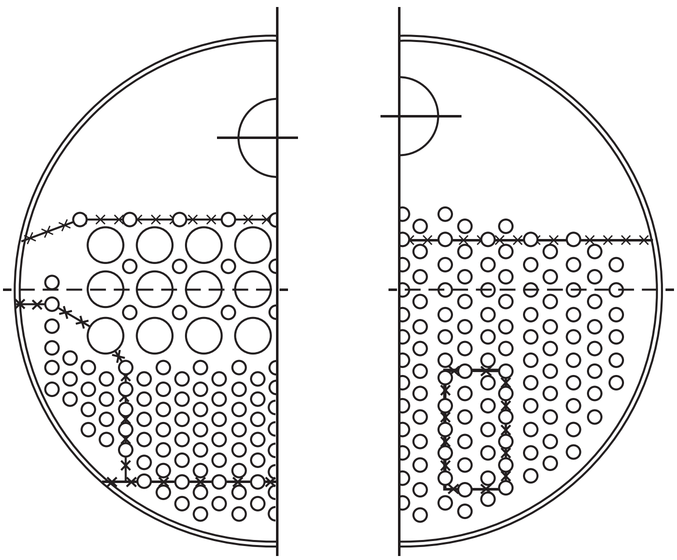
b) Damaged tubesheet holes may be repaired by welding.

c) Sections of tubesheets damaged or wasted to less than 60% minimum required thickness shall be repaired by installing a flush patch using full penetration welds.

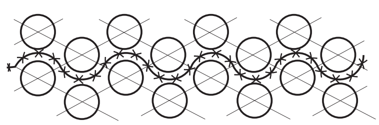
d) Sections of tubesheets that have not wasted below 60% minimum required thickness may be repaired by weld buildup, provided the strength of the structure will not be impaired. Where weld buildup is employed, the Inspector may require an appropriate method of NDE for the repair.

e) Maximum diameter of flue holes shall be 1/4 in. (6.3 mm) greater than the diameter of the flue. Holes shall be made round if they equal or exceed 1/8 in. (3.2 mm) out of the round. See NBIC Part 3, S1.2.9.7.

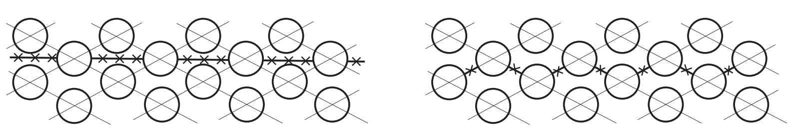
**FIGURE S1.2.11.6**
TUBESHEET REPAIRS



Typical tubesheet flush patches



Tubesheet welded around tube holes



Tubesheet welded through ligaments and tube holes

## S1.2.12 SEAMS AND JOINTS

### S1.2.12.1 CAULKING RIVETED SEAMS AND RIVET HEADS

a) Replacement rivets shall have heads of sufficient size to conform to NBIC Part 2, S1.4.2.1 l). Changing the rivet head style at either end shall be considered a repair, changing the rivet body diameter or changing the rivet hole diameter shall be an alteration.

b) Rivet heads shall completely cover the perimeter of the hole. in the plate or entirely fill the countersink.

c) During driving of rivets, where the factory head moves away from the sheet because of insufficient bucking, such rivets shall be removed and discarded.

d) Rivets shall be heated sufficiently to be driven completely with the equipment being used.

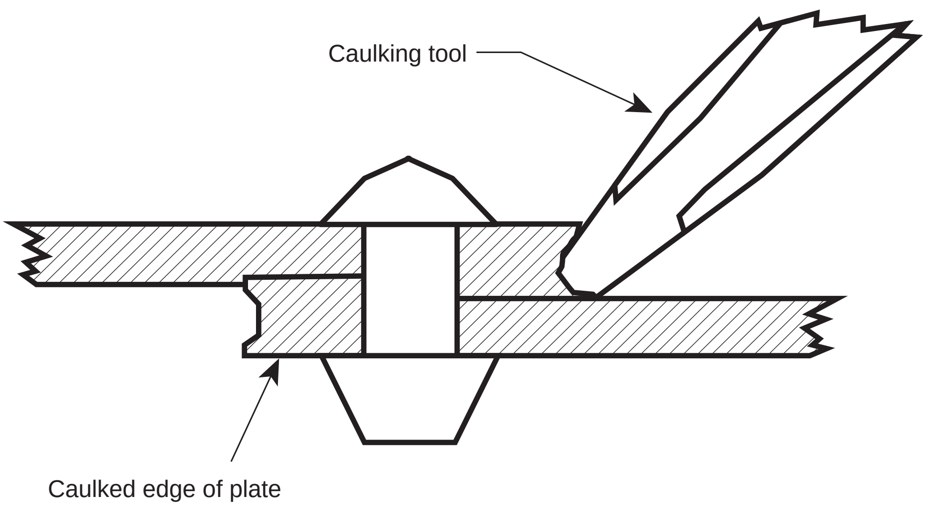
e) Reheating of rivets above 600ºF (316ºC) after the original installation is prohibited. When seal welding rivet heads, inter or post-pass head temperature shall be kept below 600ºF (316ºC).

f) Each rivet head shall contact the plate over the entire circumference upon completion of the installation. Rivets on which either head does not have contact with the plate over the entire area of the driven head, not including any excess washer (excess material at the base of the rivet head), shall be replaced. Repair is prohibited.

g) Caulking refers to the sealing of plate seams and rivet heads by driving the edge of one surface onto the other by using an impact tool.

h) Caulked rivet seams and rivet heads shall be in accordance with ASME Code Section I, Part PR,1971 Edition.[16]

**FIGURE S1.2.12.1**




## S1.2.12.2 THREADED OPENINGS IN VESSEL WALLS, BUSHINGS, AND WELDED NOZZLES (WASHOUT PLUG HOLES AND OTHER CONNECTIONS)

a) Threaded openings in vessel walls and welded nozzles with damaged threads that cannot be repaired by retapping or rethreading should be repaired by welding a nozzle in the sheet. The nozzle shall be of such a size as to not interfere with proper washout and inspection.

b) Threaded bushings and nozzles found to be defective shall be replaced. Seal welding is not permitted.

c) New threaded bushings equipped with shoulders may be seal welded at the shoulder.

d) New threaded bushings without shoulders that are seal welded after installation shall have the threads removed from the weld zone of the bushing prior to welding.

e) Threaded holes with damaged threads may be repaired by weld buildup and re-tapping. The threads shall be removed prior to welding.

16 This code is available from the National Board.

## S1.2.13 FITTINGS AND GAGES

### S1.2.13.1 WATER GAGE CONNECTION

a) Water gage glasses shall be applied so that the lowest water reading in the water gage glass of a horizontal firetube boiler on level track shall be at least 3 in. (75 mm) above the highest point of the tubes, flues, or crownsheet.

b) The bottom mounting for water gage glass (and for water column if used) must not extend less than 1-1/2 in. (38 mm) inside the boiler and beyond any obstacle immediately above it. The passage must be straight and approximately horizontal. Connections must be applied without pockets, traps, sags, or syphons. Tubular water gage glasses must be equipped with a protection shield.

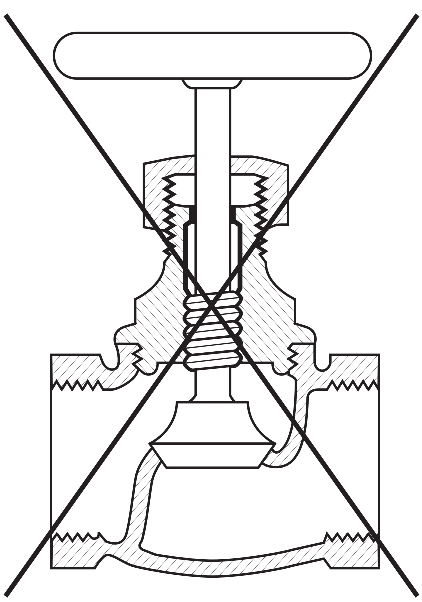
c) Locomotive water gage glasses shall be provided with one top and one bottom shutoff cock and a means to illuminate each glass. Each top and bottom shutoff cock or valve shall be of such through flow construction as to prevent stoppage by deposits of sediments. Straight run globe valve of the ordinary type shall not be used on such connections. (See NBIC Part 3, Figure S1.2.13.1). The water gage glass connection and pipe connection shall be fitted with a drain cock or valve having an unrestricted opening of not less than 3/8 in. (10 mm) in diameter to facilitate cleaning.

d) The top and bottom water gage glass fittings are to be aligned, supported, and secured so as to maintain the alignment of the water gage glass.

e) The lower edge of the steam connection to a water column or water gage glass in the boiler shall not be below the highest visible water level in the water gage glass. There shall be no pockets, traps, sags, or syphons in the piping that will permit the accumulation of sediments.

f) The upper edge of the water connection to a water gage glass and the boiler shall not be above the lowest visible water level in the water gage glass. There shall be no pockets, traps, sags, or syphons in the connection.

**FIGURE S1.2.13.1**
STRAIGHT RUN GLOBE VALVE NOT PERMITTED





SUPPL. 1

# SUPPLEMENT 2
# HISTORICAL BOILERS

## S2.1 SCOPE

a) This supplement is provided as a guide to repair and alteration of historical steam boilers of riveted and/or welded construction not falling under the scope of Supplement 1. These historical steam boilers would include: steam tractors, traction engines, hobby steam boilers, portable steam boilers, and other such boilers that are being preserved, restored and maintained for demonstration, viewing, or educational purposes.

**Note:** This supplement is not to be used for steam locomotive boilers falling under the requirements of the Federal Railroad Administration (FRA). FRA rules for steam locomotive boilers are published in 49 CFR 230. Specific rules and special requirements for inspection, repairs, alterations, and storage of steam locomotive boilers are identified in NBIC Parts 2 and 3, Supplement 1.

b) The rules specified in this supplement shall be used in conjunction with the applicable rules in this Code. References specified or contained in this supplement may provide additional information to assist the user when applying the requirements of this supplement.

## S2.2 INTRODUCTION

a) The following repair and alteration rules are minimum requirements for safe and satisfactory operation of historical boilers. Users of this supplement are cautioned that where complete details are not provided, the user is advised to seek technical guidance to provide good sound engineering evaluations and practices.

b) Where adopted by a Jurisdiction, these requirements are mandatory. Where a Jurisdiction establishes different requirements for historical boilers or where a conflict exists, the rules of the Jurisdiction prevail.

## S2.3 RESPONSIBILITIES

The owner, user and/or operator are responsible for ensuring that the boiler meets all the requirements of the Jurisdiction where the boiler is operated, including inspections, repairs, licensing, operating certificates, permits, and operator training.

**Note:** It should be recognized that safety of these boilers is dependent upon the knowledge and training of the operator in proper use, repair, maintenance, and safe operation of each specific boiler proposed to be operated (See NBIC Part 2, Supplement 2).

## S2.4 REPAIRS AND ALTERATIONS

Repairs and alterations to boilers of historical nature should be performed with consideration towards preserving the authenticity of original design, while at the same time ensuring that the boiler is safe to operate at the pressure allowed by NBIC Part 2, Supplement 2.

## S2.5 CONSTRUCTION STANDARDS

Repairs and alterations shall conform to the requirements of the original construction standard insofar as possible. If the original construction standard is unknown or unavailable, the boiler shall be considered a boiler of locomotive design and subject to the construction standard most applicable. The construction standard selected for the repair or alteration must meet the approval of the Jurisdiction.

## S2.6 ACCREDITATION

a) Organizations performing welded repairs shall be accredited as described in NBIC Part 3, 1.6.

b) Organizations and/or individuals performing non-welded repairs do not need to have an “R” stamp unless required by the Jurisdiction. However, they must be competent in the type of repair they are performing.

## S2.7 MATERIALS

a) Materials used in making repairs shall conform to the original construction standard, if known, or to a construction standard acceptable to the Jurisdiction. Carbon or alloy steels having carbon content greater than 0.35% shall not be welded. The repair organization is responsible for verifying identification of existing and replacement materials.

b) The older steels used in historical boiler construction could have been supplied as either rimmed steel, flange or firebox quality steel. Rimmed steel may be higher in carbon, sulfur, phosphorus and hydrogen contents that will adversely affect weldability.

c) If welding is to be used to repair a pressure-retaining item where the existing material cannot be verified (unknown), the requirements of NBIC Part 3, 3.2.1 shall be met. Specific quantities of carbon, manganese, sulfur, phosphorus, and aluminum shall be identified and included in the analysis. The result of the analysis shall be acceptable to the Inspector and, when required, the Jurisdiction.

### S2.7.1 MATERIAL LIST FOR HISTORICAL BOILERS REPAIRS

Table S2.7.1 is intended as a basic guideline only and covers just the basic carbon steel and some alloy steel material specifications. Other alloy materials may be available for these applications if necessary.

**Note:** See ASME Section II for Other Acceptable Section I Materials.

**TABLE S2.7.1**
MATERIALS LIST FOR HISTORIC BOILERS

| Application | Specification |
|---|---|
| Boiler Tubes & Flues | SA-178 Grade A, SA-192, SA-210 |
| Boiler & Firebox Plate | SA-285 Grade C, SA-515, SA-516 |
| Staybolts | SA-675, SA-36, ASTM A-31 |
| Boiler Braces | SA-675, SA-36 |
| Rivets | SA-675,SA-31 |
| Forged Parts & Fittings | SA-105, SA-217 |
| Hollow Cylindrical Pressure Retaining Parts | SA-105 Forgings SA-675 Bar Stock, |
| Pipe Flanges | SA-181, SA-105 |
| Bronze Castings & Washout Plugs | SB-61, SB-62 |

a) SA-516 steel is recommended for firebox repairs. It is a fine grain steel that accepts flanging and bending with less tendency to crack than course grain steels such as SA-515 or SA-285 Grade C. Coarse grain steels have, on occasion, been found to crack or split after complicated flanging, bending, and forming.

b) SA-36 is not to be used to make any pressure-retaining part such as shells.

c) When rivets are made from SA-675, the finished rivets must meet the physical and test requirements of the original ASME rivet specification ASTM A-31 Grade A or B.

d) When staybolt material tensile strength is greater than that of the firebox sheets, the firebox sheets deflect instead of the staybolts, which can result in the sheets developing cracks and leaking staybolts. In addition, high tensile strength steels are difficult to drive.

### S2.7.2 REPLACEMENT PARTS

Replacement pressure parts formed by casting, forging, or die forming, and on which no welding has been performed shall be supplied as material. Such parts shall be marked with the material identification required by the construction standard used for the repair. Replacement pressure parts fabricated by welding shall be manufactured by an organization certified as required by the construction standard used for the repair. When it is not possible or practical for a manufacturer to supply replacement parts fabricated by welding, an organization accredited as described in NBIC Part 3, 1.6 may fabricate the part with the approval of the Jurisdiction.

### S2.8 WELDED REPAIR INSPECTION

Prior to commencing any welded repairs to the pressure boundaries of historical boilers, the repair organization shall obtain an Inspector's approval of the proposed repair. The Inspector shall be an employee of either a Jurisdiction, as defined in NBIC Part 3, Section 9, *Glossary*, or of the Authorized Inspection Agency contracted by the repair organization. The Inspector shall ensure the repairs are performed in accordance with the approved construction standard, and shall verify any nondestructive examinations or witness pressure testing of the completed repair.

### S2.9 WELDING

Welding shall be performed in accordance with the requirements of the approved construction standard in consultation with the Inspector. A repair organization accredited as described in NBIC Part 3, 1.6 may use the Standard Welding Procedure Specifications shown in 2.3, as applicable. Welders shall be qualified for the welding processes used. Qualification shall be in accordance with the approved construction standard, or ASME Section IX.

### S2.10 HEAT TREATMENT

a) Preheat and postweld heat treatment may be used to assist in completion of the welded joint. Consideration should be given to the percentage of carbon content and to the thickness of the boiler materials to be welded. Required preheat and PWHT temperatures shall be specified on the qualified Welding Procedure Specification being used.

b) Postweld heat treatment shall be performed as required by the accepted construction standard, in accordance with written procedures acceptable to the Inspector.

c) Alternative postweld heat treatment methods may be used with the Inspector's approval. Welding methods that may be used as alternatives to postweld heat treatment when PWHT cannot be performed are limited to increased preheat temperatures and controlled temper bead methods. (See NBIC Part 3, 2.5.3)

## S2.11 NONDESTRUCTIVE EXAMINATION

The Inspector may require nondestructive examination (RT, PT, MT, UT, and VT) as necessary to ensure satisfactory welded repairs have been accomplished.

## S2.12 DOCUMENTATION

Organizations performing repairs to historic boilers shall document the repair or alteration on Form R-1 or R-2, as applicable. Permanent documentation detailing repairs or alterations should be retained by the owner in permanent boiler records such as an operator log book.

## S2.13 REPAIR METHODS

a) Before performing any welding activity, consideration shall be given to ensure the weldability of historical boiler materials. Materials used for patches shall be made from material that is at least equal in quality and strength to the original material.

b) Before a repair is made to a defect in a welded joint or base metal, care should be taken to investigate its cause and to determine its extent and likelihood of recurrence.

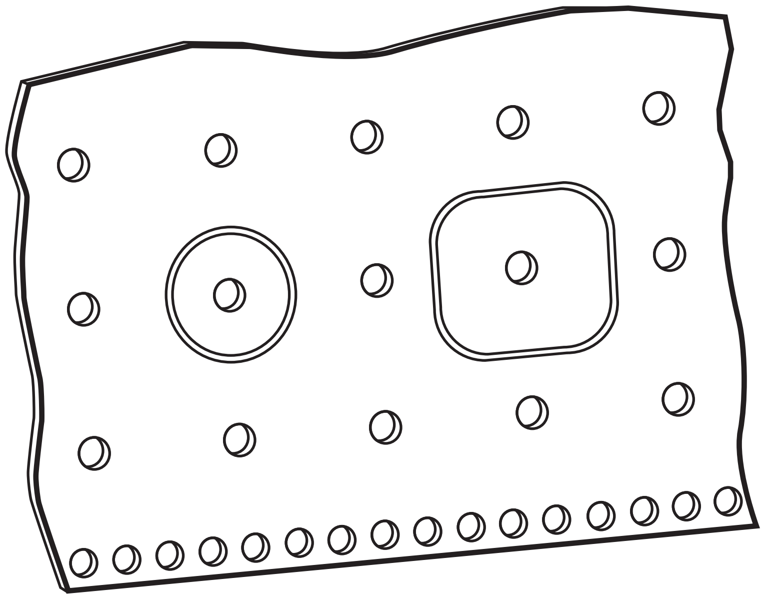
c) A repair of a defect, such as a crack in a welded joint or base material, shall not be made until the defect has been removed. A suitable nondestructive examination method such as magnetic particle (MT) or liquid penetrant (PT) may be necessary to assure complete removal of the defect. If the defect penetrates the full thickness of the material, the repair shall be made with a complete penetration weld such as a double buttweld or a single buttweld with or without backing. Where circumstances indicate that the defect is likely to recur, consideration should be given to removing the defective area and installing a flush patch or taking other acceptable, corrective measures. A repair of a bulge or blister shall be made if a bulge or blister will affect the pressure retaining capability of the plate or tube or when evidence of leakage is noted. Defects such as cracks, grooving, and wastage may be repaired by weld buildup, welded repair, a welded flush patch, or a riveted patch as appropriate.

d) Welded repairs at or near riveted seams requiring preheating or postweld heat treatment shall be carefully made to prevent loosening in the riveted seams, especially when localized heating is used. Where necessary to control expansion or to gain access for welding, rivets at the defective section and to each side of it may be removed. Reuse of rivets is prohibited.

### S2.13.1 REPAIR OF THREADED STAYBOLT HOLES

Staybolt holes may be repaired by welding, reaming, re-tapping to a larger size, or by installing a flush patch. (See NBIC Part 3, Figure S2.13.1). If the staybolt hole was threaded and is to be repaired by welding, the threads shall be removed prior to welding.

**FIGURE S2.13.1**
SINGLE STAYBOLT FLUSH PATCH



### S2.13.2 INSTALLATION OF THREADED STAYBOLTS

a) Threaded staybolts shall have either 11 or 12 thread pitch. Staybolt threads shall have a close fit in sheets. Changing the staybolt thread pitch from 11 to 12 or the reverse shall be considered a repair.

b) When staybolts 8 in. (200 mm) or less in length are replaced, they shall be replaced with staybolts that have a telltale hole 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter their entire length or with ones that have a 3/16 in. (5 mm) to 7/32 in. (5.5 mm) diameter hole in each end, drilled a minimum of 1-1/4 in. (31 mm) deep. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. (See NBIC Part 3, Figure S2.13.2).

c) Telltale holes shall be reopened after driving.

d) Staybolt length shall be sized so the length of bolt projecting through the sheet is not less than 1/8 in. (3 mm) and is sufficient to produce a full head after driving.

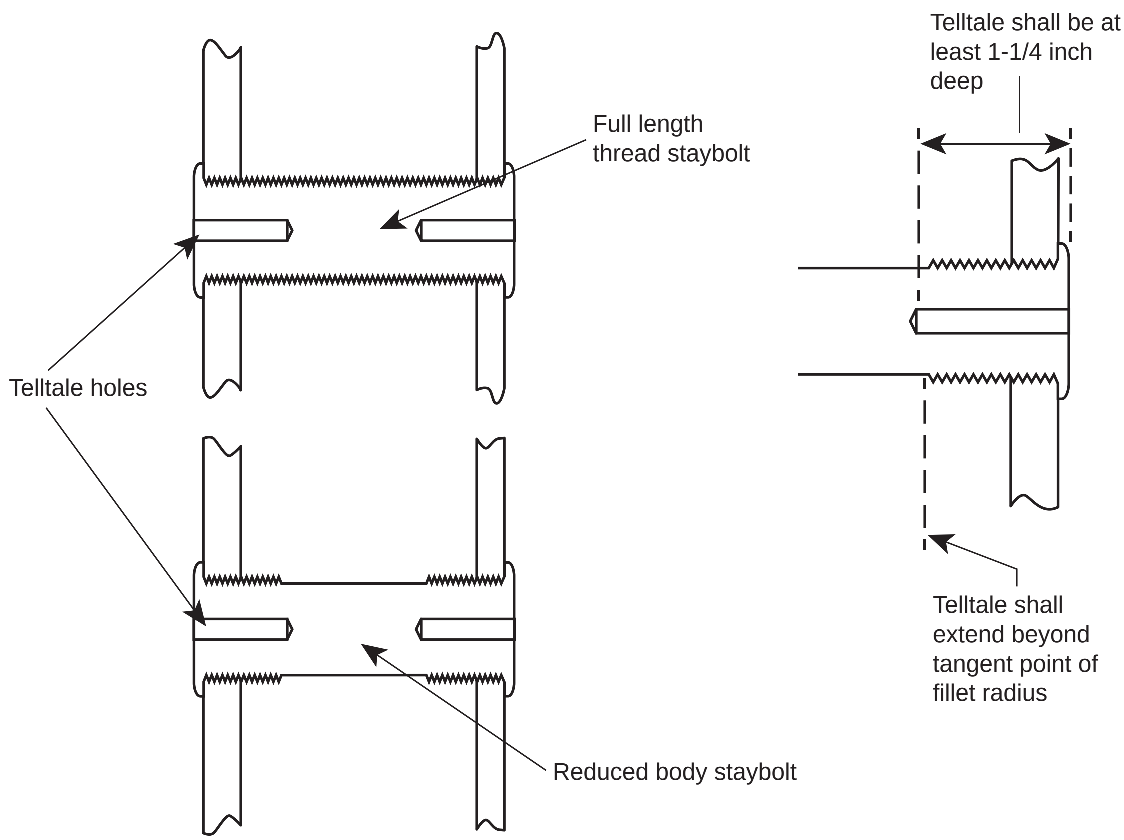
e) The thread lead of both bolt ends and both firebox sheets shall be synchronized to permit the bolt to be installed without stripping the threads.

f) When driving staybolt heads, the bolt's opposite end shall be bucked or braced to prevent damaging the bolt's threads. Bracing can be done several ways, such as using a pneumatic holder or a heavy steel bucking bar. Driving the heads on both ends of the staybolt simultaneously using two pneumatic rivet hammers (double gunning), is acceptable. Bolts are to be driven in such a manner as to expand radially the bolt body and threads into the sheet prior to forming the head. Merely driving over the head is not acceptable.

g) Reuse of threaded staybolts is prohibited.

h) Installation of different diameter staybolts shall be considered a non-welded (mechanical) repair.

**FIGURE S2.13.2**
THREADED STAYBOLT

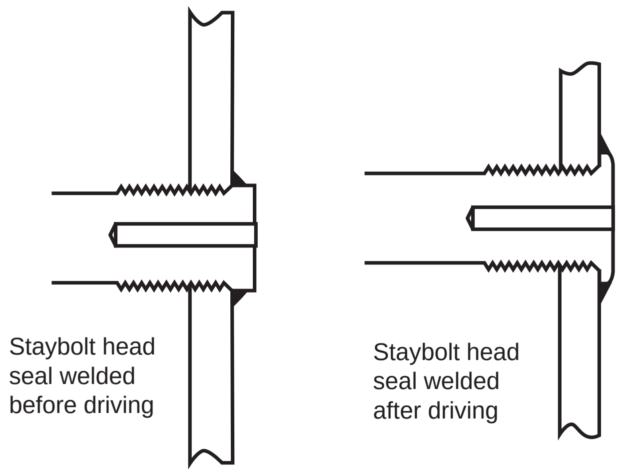



## S2.13.3 SEAL WELDING OF THREADED STAYBOLTS

a) Replacement threaded staybolts may be seal welded before or after driving. (See NBIC Part 3, Figure S2.13.3).

b) Existing threaded staybolts that leak shall be repaired and may be seal welded. When used, seal welding shall not be the sole means of repair. Inspection must be done to ensure the material adjacent to the staybolt has not been materially weakened by deterioration or wasting away before welding can be performed.

**FIGURE S2.13.3**
SEAL WELDING STAYBOLTS




### S2.13.4 INSTALLATION OF WELDED STAYBOLTS

a) The installation of unthreaded staybolts using full penetration welds is permissible. (See NBIC Part 3, Figure S2.13.4).

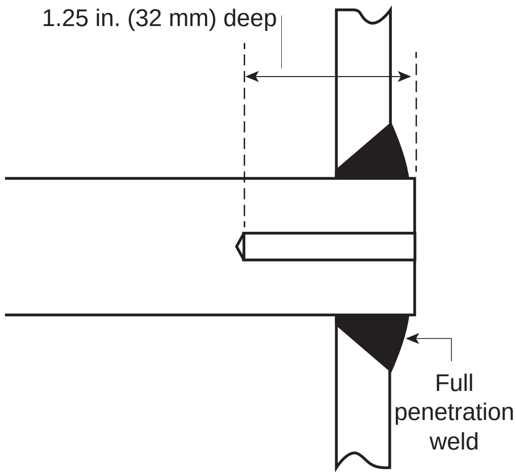
b) Threaded stays may be replaced by welded-in stays provided that, in the judgement of the Inspector, the material adjacent to the staybolt has not been materially weakened by deterioration or wasting away. If staybolt hole is threaded, the threads shall be removed prior to welding.

c) Staybolts shorter than 8 in. (200 mm) in length shall have telltale holes. Telltale hole diameter shall be 3/16 in. (5 mm) to 7/32 in. (5.5 mm) in diameter and at least 1-1/4 in. (31 mm) deep in the outer end. On reduced body staybolts, the telltale hole shall extend beyond the fillet and into the reduced section of the staybolt. Staybolts should have through telltale holes, which are preferred.

d) Reuse of welded staybolts is prohibited.

e) Installation of different diameter staybolts shall be considered a repair.

**FIGURE S2.13.4**
WELDED STAYBOLTS

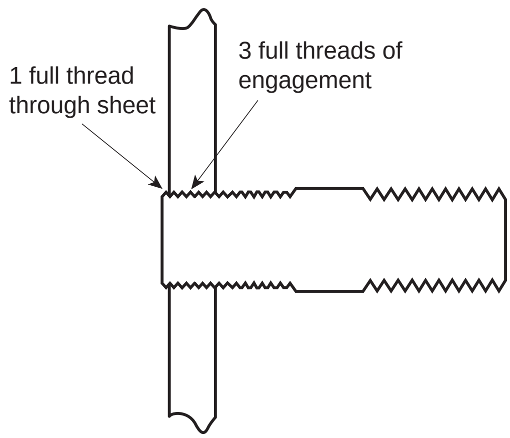



## S2.13.5 THREADED STUDS

a) Studs threaded into the boiler or firebox sheets shall not be seal welded (See NBIC Part 3, Figure S2.13.5).

b) When studs are replaced, they shall extend at least one full thread through the sheet on the opposite side of installation. Replacement studs shall have a minimum of three threads of engagement.

**FIGURE S2.13.5**
THREADED STUDS

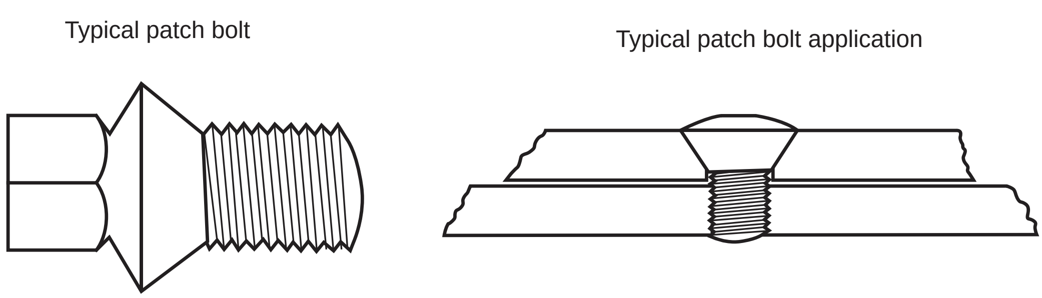



## S2.13.6 PATCH BOLTS

a) Patch bolts may be replaced in kind. (See NBIC Part 3, NBIC Part 3, Figure S2.13.6).

b) Seal welding of patch bolts is permitted.

**FIGURE S2.13.6**
PATCH BOLTS




## S2.13.7 FLUE AND TUBE RE-ENDING

a) Each boiler tube or flue that is repaired by welding is limited to not more than three circumferential welded joints.

b) Re-ending is permitted provided the thickness of the tube or flue to be re-ended is not less than 90% of that required by NBIC Part 3, Table S2.13.7. Re-end pieces shall be new material and meet the thickness requirements of NBIC Part 3, Table S2.13.7.

## TABLE S2.13.7

MAXIMUM ALLOWABLE WORKING PRESSURES FOR STEEL TUBES OR FLUES FOR FIRETUBE BOILERS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES CONFORMING TO THE REQUIREMENTS OF SPEC. SA-176, SA-192, SA-209, OR SA 210

| Outside diameter of tube, inches D | Minimum gage, Birmingham Wire Gage (BWG), inches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 13<br>t = 0.095 | 12<br>t = 0.109 | 11<br>t = 0.120 | 10<br>t = 0.134 | 9<br>t = 0.148 | 8<br>t = 0.165 | 7<br>t = 0.180 | 6<br>t = 0.203 | 5<br>t = 0.220 | 4<br>t = 0.238 |
| 1 | 470 | 690 | — | — | — | — | — | — | — | — |
| 1-1/2 | 320 | 460 | 570 | 720 | 860 | — | — | — | — | — |
| 1-3/4 | 270 | 400 | 490 | 620 | 740 | 890 | — | — | — | — |
| 2 | 240 | 350 | 430 | 540 | 650 | 780 | 900 | — | — | — |
| 2-1/4 | 210 | 310 | 380 | 480 | 580 | 690 | 800 | 960 | — | — |
| 2-1/2 | 190 | 280 | 350 | 430 | 520 | 620 | 720 | 860 | 970 | 1,080 |
| 3 | 160 | 230 | 290 | 360 | 430 | 520 | 600 | 720 | 810 | 900 |
| 3-1/4 | — | 210 | 270 | 330 | 400 | 480 | 550 | 660 | 740 | 830 |
| 3-1/2 | — | 200 | 250 | 310 | 370 | 450 | 510 | 620 | 690 | 770 |
| 4 | — | 180 | 220 | 270 | 330 | 390 | 450 | 540 | 610 | 680 |
| 4-1/2 | — | 160 | 190 | 240 | 290 | 350 | 400 | 480 | 540 | 600 |
| 5 | — | — | 180 | 220 | 260 | 310 | 360 | 430 | 490 | 540 |
| 5-3/8 | — | — | 160 | 200 | 240 | 290 | 340 | 400 | 450 | 500 |
| 5-1/2 | — | — | — | 200 | 240 | 290 | 330 | 390 | 440 | 490 |
| 6 | — | — | — | 180 | 220 | 260 | 300 | 360 | 410 | 450 |

$P = \{(t–0.65)/D\} \times 15550$ where P = maximum allowable working pressure, pounds per square inch,
t = minimum wall thickness, inches,
D = outside diameter of tubes, inches.

For pressures below those given in the table, the gage thickness shall be not less than the minimum given in the table.
Calculated values of pressure have been rounded to the next higher unit of 10 psi.

## TABLE S2.13.7M

MAXIMUM ALLOWABLE WORKING PRESSURES FOR STEEL TUBES OR FLUES FOR FIRETUBE BOILERS FOR DIFFERENT DIAMETERS AND GAGES OF TUBES TO THE REQUIREMENTS OF SPEC. SA-176, SA-192, OR SA 210

| Outside diameter of tube, mm D | Minimum gage, Birmingham Wire Gage (BWG), to mm | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 13 t = 2.4 | 12 t = 2.8 | 11 t = 3.0 | 10 t = 3.4 | 9 t = 3.8 | 8 t = 4.2 | 7 t = 4.6 | 6 t = 5.2 | 5 t = 5.6 | 4 t = 6.0 |
| 25 | 3,250 | 4,950 | — | — | — | — | — | — | — | — |
| 40 | 2,150 | 3,250 | 3,850 | 4,950 | 6,100 | — | — | — | — | — |
| 45 | 1,850 | 2,800 | 3,300 | 4,300 | 5,250 | 6,250 | — | — | — | — |
| 50 | 1,650 | 2,450 | 2,850 | 3,700 | 4,550 | 5,350 | 6,200 | — | — | — |
| 60 | 1,450 | 2,200 | 2,550 | 3,300 | 4,050 | 4,800 | 5,550 | 6,700 | — | — |
| 65 | 1,300 | 1,950 | 2,300 | 2,950 | 3,600 | 4,300 | 4,950 | 5,950 | 6,650 | 7,300 |
| 75 | 1,100 | 1,650 | 1,950 | 2,500 | 3,050 | 3,600 | 4,200 | 5,000 | 5,600 | 6,150 |
| 85 | — | 1,500 | 1,750 | 2,300 | 2,800 | 3,300 | 3,850 | 4,600 | 5,100 | 5,650 |
| 90 | — | 1,400 | 1,650 | 2,150 | 2,600 | 3,100 | 3,550 | 4,300 | 4,750 | 5,250 |
| 100 | — | 1,250 | 1,450 | 1,850 | 2,300 | 2,700 | 3,100 | 3,750 | 4,150 | 5,600 |
| 115 | — | 1,100 | 1,300 | 1,650 | 2,050 | 2,400 | 2,800 | 3,300 | 3,750 | 4,100 |
| 125 | — | — | 1,150 | 1,500 | 1,850 | 2,200 | 2,500 | 3,000 | 3,350 | 3,700 |
| 135 | — | — | 1,100 | 1,400 | 1,700 | 2,000 | 2,350 | 2,800 | 3,100 | 3,400 |
| 140 | — | — | — | 1,350 | 1,650 | 2,000 | 2,300 | 2,750 | 3,050 | 3,350 |
| 150 | — | — | — | 1,250 | 1,550 | 1,800 | 2,100 | 2,500 | 2,800 | 3,100 |

$P = \{(t-1.65)/D\} \times 107000$ where P = maximum allowable working pressure, kilopascals (kPa),
t = minimum wall thickness, mm,
D = outside diameter of tubes, mm.

For pressures below those given in the table, the gage thickness shall be not less than the minimum given in the table.
Calculated values of pressure have been rounded to the next higher unit of 50 kPa.

## S2.13.8 FLUE AND TUBE INSTALLATION

a) When boiler tubes and flues are replaced, the MAWP of the boiler must not exceed the MAWP of the tube or flue per Table S2.13.7.

b) The boiler shall have the ends of the tubes firmly rolled and beaded, or rolled and welded around the edge of the tube. (See NBIC Part 3, Figure S2.13.8). Tube ends attached by rolling and welding are subject to the following provisions:

   1) The tube sheet hole may be beveled or recessed to a depth at least equal to the thickness of the tubes. Where the hole is beveled or recessed, the projection of the tube beyond the tube sheet shall not exceed a distance equal to the tube thickness. The depth of any bevel or recess shall not be less than the tube thickness or 1/8 in. (3 mm), whichever is greater, nor more than one-third of the tube sheet thickness. (See NBIC Part 3, Figure S2.13.8 f) and g)).

   2) Where no bevel or recess is employed, the tube shall extend beyond the tube sheet not less than a distance equal to the tube thickness, nor more than twice the tube thickness. (See NBIC Part 3, Figure S2.13.8 e)).

3) On welded attachments, the tubes shall be rolled before welding and again rolled lightly after the welding procedure.

c) Expanding of tubes by the Prosser method (see NBIC Part 3, Figure S2.13.8 b) in lieu of rolling may be employed in combination with any beaded or welded attachment method.

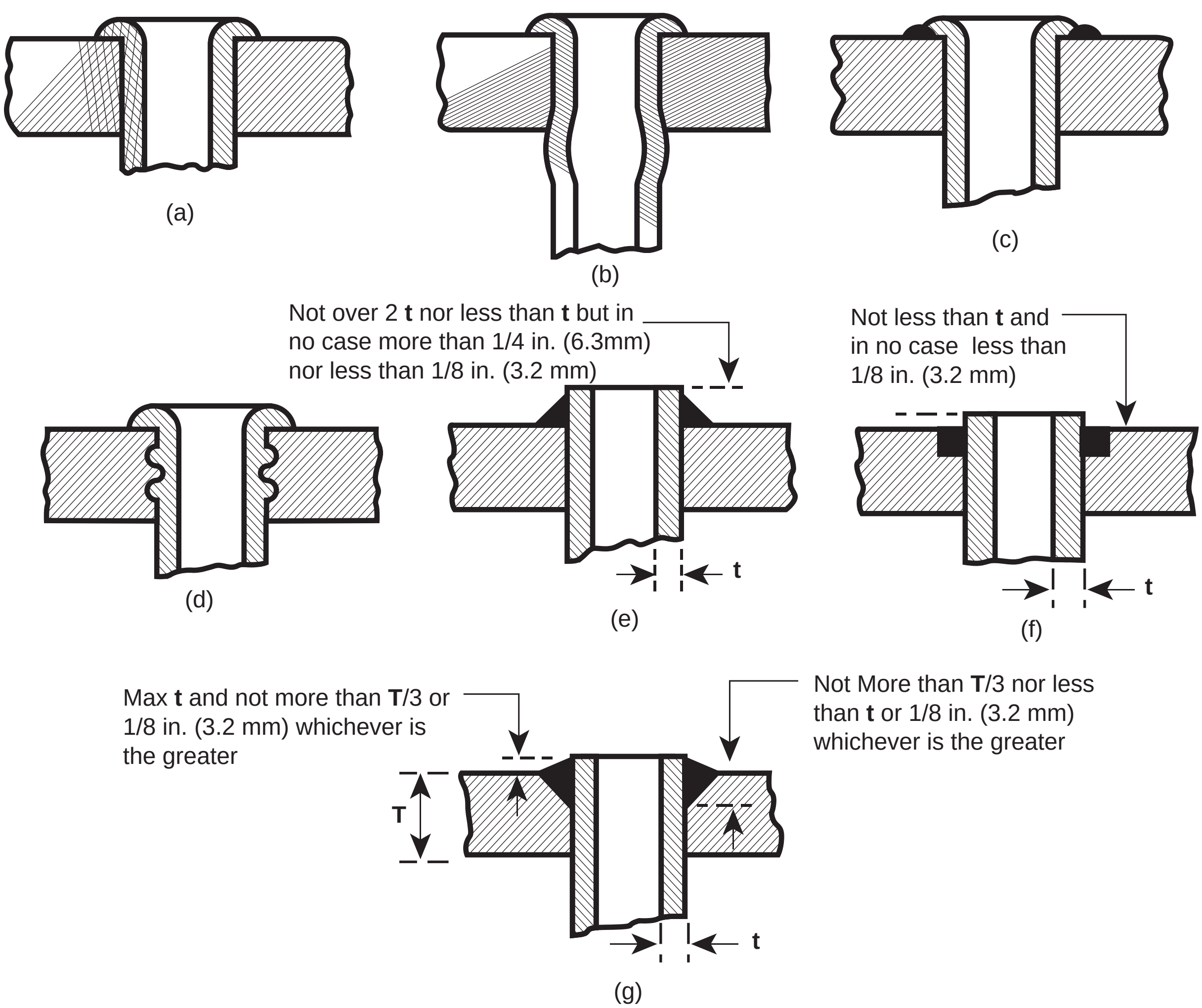
d) Seal welding is permissible on any type of beaded attachment. Where seal welding is employed, a single hydrostatic test of the boiler after seal welding shall be performed.

e) The inner surface of the tube hole in any form of attachment may be grooved or chamfered.

f) The sharp edges of tube holes shall be taken off on both sides of the plate with a file or other tool.

**FIGURE S2.13.8**

ACCEPTABLE FORMS OF TUBE ATTACHMENTS



## S2.13.9 REPAIRS AND ALTERATIONS TO UNSTAYED AREAS

### S2.13.9.1 WELD BUILDUP OF WASTAGE AND GROOVING IN UNSTAYED AREAS

a) Weld buildup shall not be used if the affected section of plate has wasted below 60% of the minimum required thickness per NBIC Part 2, Supplement 2 in an area exceeding 3 sq. inches (1,950 sq. mm.). (See NBIC Part 3, Figure S2.13.9.1).

b) Wasted sections that have wasted below 60% of the minimum required thickness and have an area exceeding 3 sq. in (1,950 sq. mm) shall be repaired by installing a flush patch using full penetration welds.

c) Weld buildup of wasted areas shall not exceed 100 sq. in. (65,000 sq. mm).

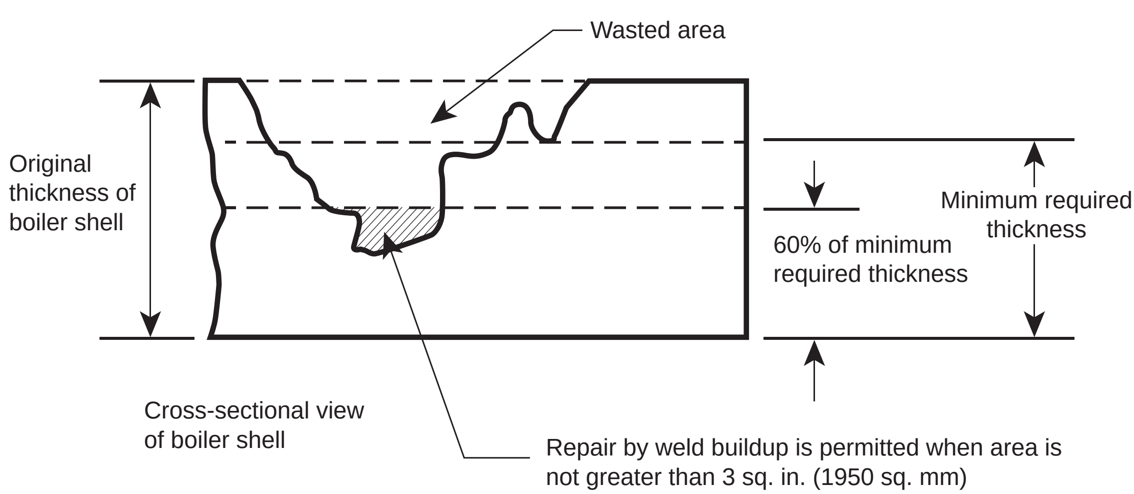
d) Weld buildup is to replace material that has been lost due to wastage and grooving, and is not to replace thickness on the opposite side of the sheet. Weld buildup must be applied to the side of the sheet that is wasted or grooved.

e) Prior to welding, the rivets in the wasted area should be removed.

f) Rivets holes should be reamed after welding.

g) Welding shall not cover rivet heads.

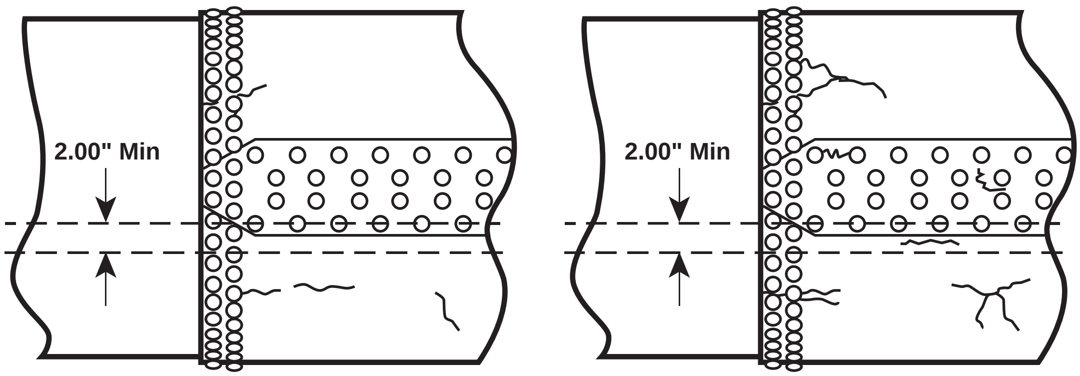
**FIGURE S2.13.9.1**
WELD BUILDUP






SUPPL. 2

**FIGURE S2.13.9.2**
UNSTAYED AREA CRACK




Cracks acceptable to repair by welding

Cracks not acceptable to repair by welding

## S2.13.9.2 WELDED REPAIR OF CRACKS IN UNSTAYED AREAS

a) Prior to repairing cracks, the plate shall be NDE examined for other defects. All affected sections shall be repaired.

b) Cracks in unstayed areas may be repaired by welding. Before cracks are repaired, however, the inner surface of the plate should be examined for possible excessive corrosion or grooving.

c) Cracks in unstayed areas may be repaired by welding, providing the cracks do not extend between rivet holes in a longitudinal seam or parallel to a longitudinal seam within 2 in. (50 mm) from the center line of the outer most row of rivets. Minimum 175ºF (79ºC) preheat shall be used. The completed repair must be radiographed and stress relieved. Alternative methods in lieu of postweld heat treatment identified in NBIC Part 3, 2.5.3 may be used. (See NBIC Part 3, Figure S2.13.9.2).

d) Cracks radiating from a common point (star cracking) shall not be repaired; installation of a flush patch is required. Cracks radiating from a rivet hole in a circumferential seam may be repaired if the plate is not seriously damaged. (See NBIC Part 3, Figure S2.13.9.2).

e) Prior to welding, the rivets into which cracks extend and the rivets on each side of them shall be removed.

f) In riveted joints, tack bolts should be placed in alternating holes to hold the plate laps firmly.

g) Rivets holes should be reamed after welding.

h) Welding shall not cover rivet heads.

## S2.13.9.3 WELDED FLUSH PATCHES IN UNSTAYED AREAS

a) Welded repairs to boiler unstayed areas shall be radiographically examined in accordance with the approved code of construction or ASME Section I, when the size of the repaired area is greater than 3 in. (75 mm) in diameter. The completed repair must be stress relieved. Alternative Methods without Postweld Heat Treatment identified in NBIC Part 3, 2.5.3 may be used.

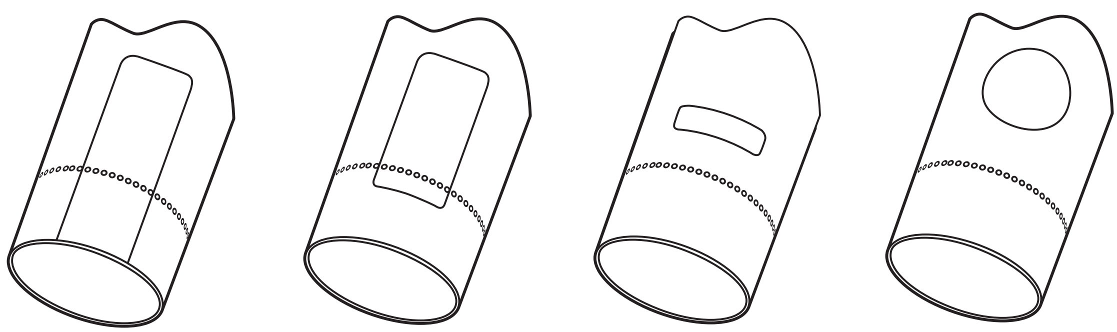
b) The weld around a flush patch shall be a full penetration weld and the accessible surfaces shall be ground flush. Examples of flush welded patches are shown in Figure NBIC Part 3, S2.13.9.3.

c) Before installing a flush patch, the defective material should be removed until sound material is reached.

d) The patch should be rolled or pressed to the proper shape or curvature. The edges of the patch should align with original material without overlap. Patches shall fit flush on the waterside of the sheet. If the patch includes an existing riveted seam, the patch shall be riveted at that seam. Changing a riveted seam to a welded seam is considered an alteration. Patches may be of any shape or size. If the patch is square or rectangular, an adequate radius, of at least three times the material thickness should be provided at the corners. Square corners shall be avoided.

e) Material thickness of patches shall be at least equal to, but not greater than, 1/8 in. (3 mm) thicker than original construction thickness.

**FIGURE S2.13.9.3**
UNSTAYED AREA FLUSH PATCH



### S2.13.9.4 REPAIR OF CRACKS, GROOVING, AND WASTAGE USING A RIVETED PATCH IN UNSTAYED AREAS

a) If the cracked section of plate is retained and is to be repaired by installation of a riveted patch, the crack may be stopped by drilling stop holes at each end or removed by a method such as grinding, cutting, or machining. Results of stop drilling or crack removal shall be verified by NDE. (See NBIC Part 3, Figure S2.13.9.4).

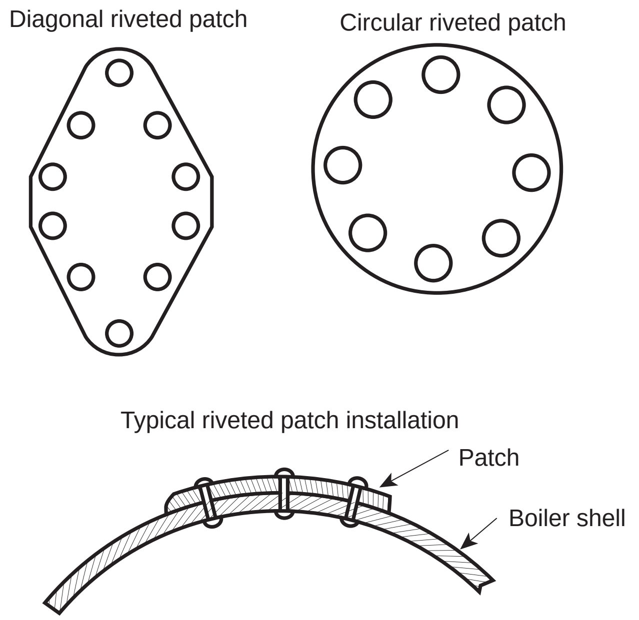
b) Riveted patches may be installed on the boiler shell interior or exterior.

c) Installation of a riveted patch shall be considered an alteration.

d) Riveted patches may be any shape or size provided the lowest patch efficiency is equal to or greater than the lowest equivalent seam efficiency of the boiler course to which it is applied.

e) The design margin of all riveted patches shall not be less than four.

**FIGURE S2.13.9.4**
RIVETED BOILER SHELL PATCH




## S2.13.9.5 BARREL REPLACEMENT (15)

An entire course of a barrel may be replaced as a repair provided that:

a) The replacement material is code-accepted material (see NBIC Part 3, S2.7.1) that has a nominal composition and strength that is equal to or greater than the original, and is suitable for the intended service.

b) The minimum required thickness shall be at least equal to the original material thickness. The original thickness may be determined from the original Manufacturer's Data Report, original drawings, or by measuring the original material thickness in an area unaffected by corrosion.

c) The longitudinal joint efficiency of the new barrel course meets or exceeds the original design/construction;

d) All doubling/reinforcing plates, stays and openings in the original barrel are duplicated or retained on the new barrel and installed in a manner that meets or exceeds the original design/construction;

e) All attachments and connections with other portions of the boiler are attached in the same manner as the original;

f) The boiler will not be re-rated at a MAWP greater than the original design MAWP; and

g) If all of the above requirements are not met, then the replacement will be considered an alteration and must follow the requirements of NBIC Part 3, 3.4 and S2.13.10 repairs and alterations to stayed areas.

## S2.13.10 REPAIRS AND ALTERATIONS TO STAYED AREAS

### S2.13.10.1 WELD BUILDUP OF WASTAGE AND GROOVING IN STAYED AREAS

Requirements specified in NBIC Part 3, S2.13.9.1 shall apply with the following additional requirements identified below:

a) Prior to welding, the rivets and or staybolts in the wasted areas should be removed.

b) Threaded staybolt holes shall be retapped after welding.

c) Welding shall not cover rivet or staybolt heads.

### S2.13.10.2 WELDED REPAIR OF CRACKS IN STAYED AREAS

Requirements specified in NBIC Part 3, S2.13.9.2 shall apply with the following additional requirements identified below:

a) If the crack extends into a staybolt hole, the staybolt shall be removed prior to making the repair.

b) Threaded staybots shall be retapped after welding.

### S2.13.10.3 WELDED FLUSH PATCHES IN STAYED AREAS

The requirements identified in NBIC Part 3, S2.13.9.3 shall apply with the additional requirements specified below:

a) Patches may be any shape provided they are adequately supported by staybolts, rivets, tubes, or other forms of construction. Patches on stayed surfaces should be designed so weld seams pass between staybolt rows. (See NBIC Part 3, Figure S2.13.10.3-a);

b) Patches are to be flush type, using full penetration welds. If the load on the patch is carried by other forms of construction, such as staybolts, rivets, or tubes, radiographic examination of the welds is not required;

c) Staybolts and rivets should be installed after welding of patch is completed. Reuse of staybolts and rivets is prohibited; and

d) Weld seams parallel to a knuckle shall be located no closer to the knuckle than the point of tangency of the knuckle unless the weld is radiographically examined. Weld seams not located in the knuckle are preferred. (See NBIC Part 3, Figure S2.13.10.3-b).

**FIGURE S2.13.10.3-a**
STAYED AREA FLUSH PATCH

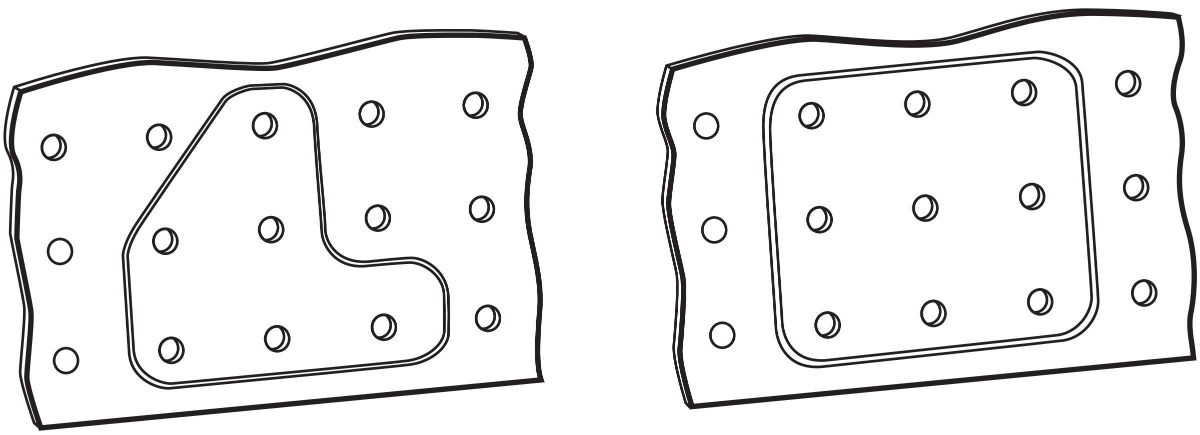
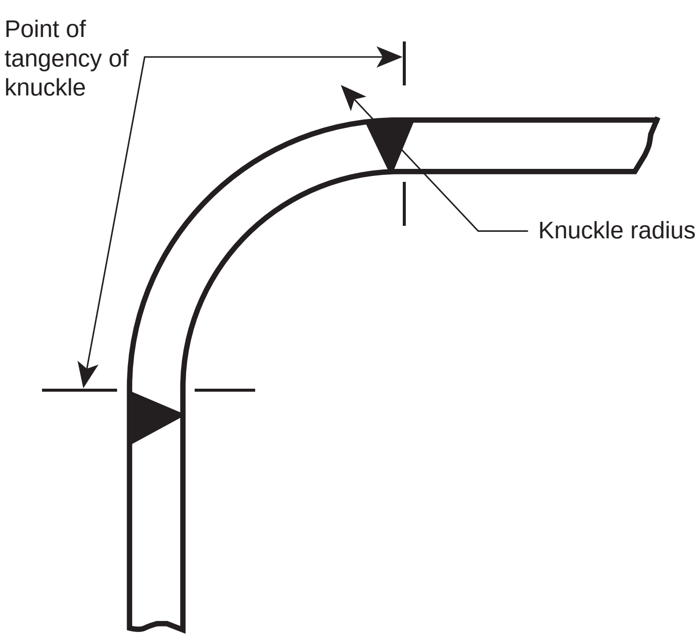


**FIGURE S2.13.10.3-b**
KNUCKLE POINT OF TANGENCY




## S2.13.10.4 REPAIR OF STAYED FIREBOX SHEETS GROOVED OR WASTED AT THE MUDRING

a) Mudrings of the Ogee style (knuckle) shall be repaired in accordance with NBIC Part 3, S2.13.11.

b) For mudrings of the locomotive style (See NBIC Part 3, Figure S2.13.10.4-a), weld buildup shall not be used if the affected section of plate has wasted below 60% of the minimum required thickness per Part 2, Supplement 2 in an area exceeding 3 sq. in. (1,950 sq. mm). (See NBIC Part 3, Figure S2.13.9.1) Repair by weld buildup cannot be used if the wastage extends below the waterside surface of the mudring or if the strength of the structure will be impaired. If extensive welding is required, the affected area shall be removed and replaced with a flush patch.

c) Wasted sections that have wasted below 60% of the minimum required thickness, and have an area exceeding 3 sq. in (1950 sq.mm) shall be repaired by installing a flush patch using a full penetration weld.

d) If wastage and grooving extends below the mudring waterside surface and if the plate thickness remaining has been reduced to less than the minimum required thickness, the affected section shall be removed and replaced with a flush patch (See NBIC Part 3, Figure S2.13.10.4-a).

e) Flush patches shall be arranged to include the mudring rivets and at least the first row of staybolts above the mudring (See NBIC Part 3, Figure S2.13.10.4-b).

f) For mudrings of the locomotive style, pitted and wasted sections of mudrings may be built up by welding provided the strength of the mudring will not be impaired. Where extensive weld buildup is employed, the Inspector may require an appropriate method of NDE for the repair.

g) Cracked or broken mudrings may be repaired by welding or installing flush patches using full penetration welds. Patches shall be made from material that is at least equal in strength and thickness to the original material. Patches shall fit flush on waterside surfaces. Where necessary, firebox sheets on both sides of the defect may be removed to provide access for inspection and welding.

**FIGURE S2.13.10.4-a**
MUDRING WASTAGE REPAIR

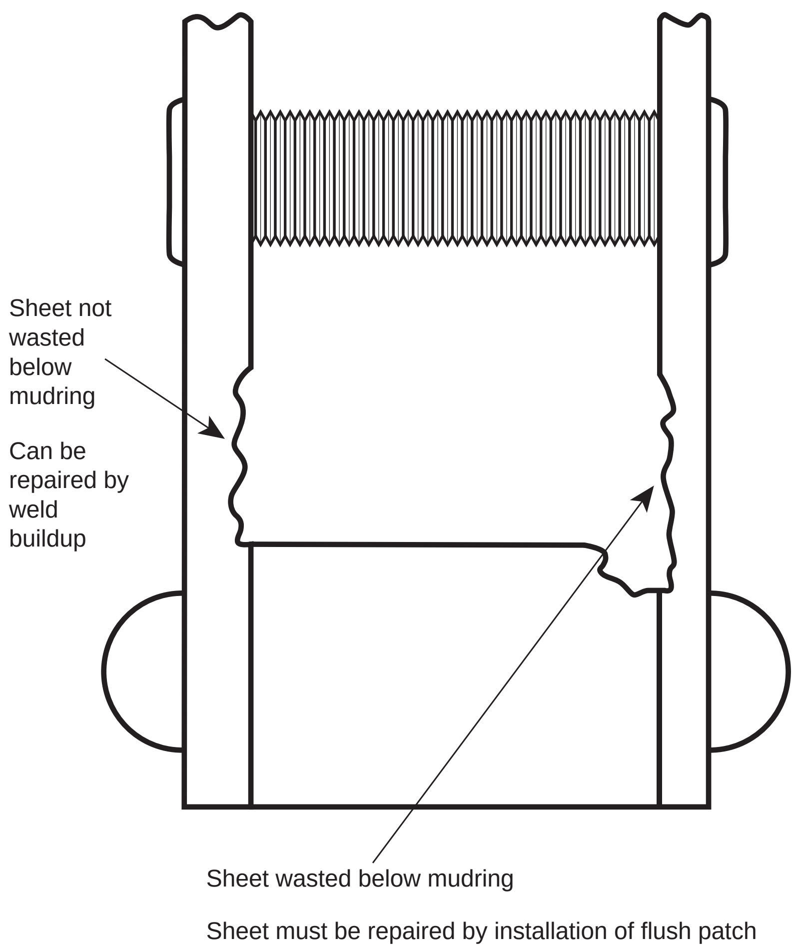
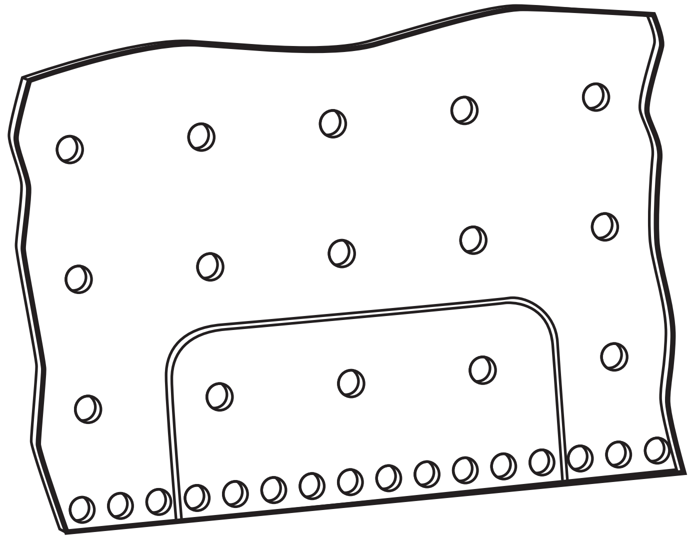


**FIGURE S2.13.10.4-b**
MUDRING FLUSH PATCH



## S2.13.11 REPAIR OF FIREBOX AND TUBESHEET KNUCKLES

### S2.13.11.1 WELD BUILDUP OF WASTAGE AND GROOVING IN FIREBOX AND TUBESHEET KNUCKLES

a) Weld buildup shall not be used if the affected section of plate has wasted below 60% of the minimum required thickness per NBIC Part 2, Supplement 2 (See NBIC Part 3, Figure S2.13.9.1).

b) Wasted sections that have wasted below 60% of the minimum required thickness shall be repaired by installing a flush patch using full penetration welds.

c) Weld buildup of wasted areas shall not exceed 100 sq. in. (65,000 sq. mm).

d) Weld buildup is to replace material that has been lost due to wastage and grooving, and is not to replace thickness on the opposite side of the sheet. Weld buildup must be applied to the side of the sheet that is wasted or grooved.

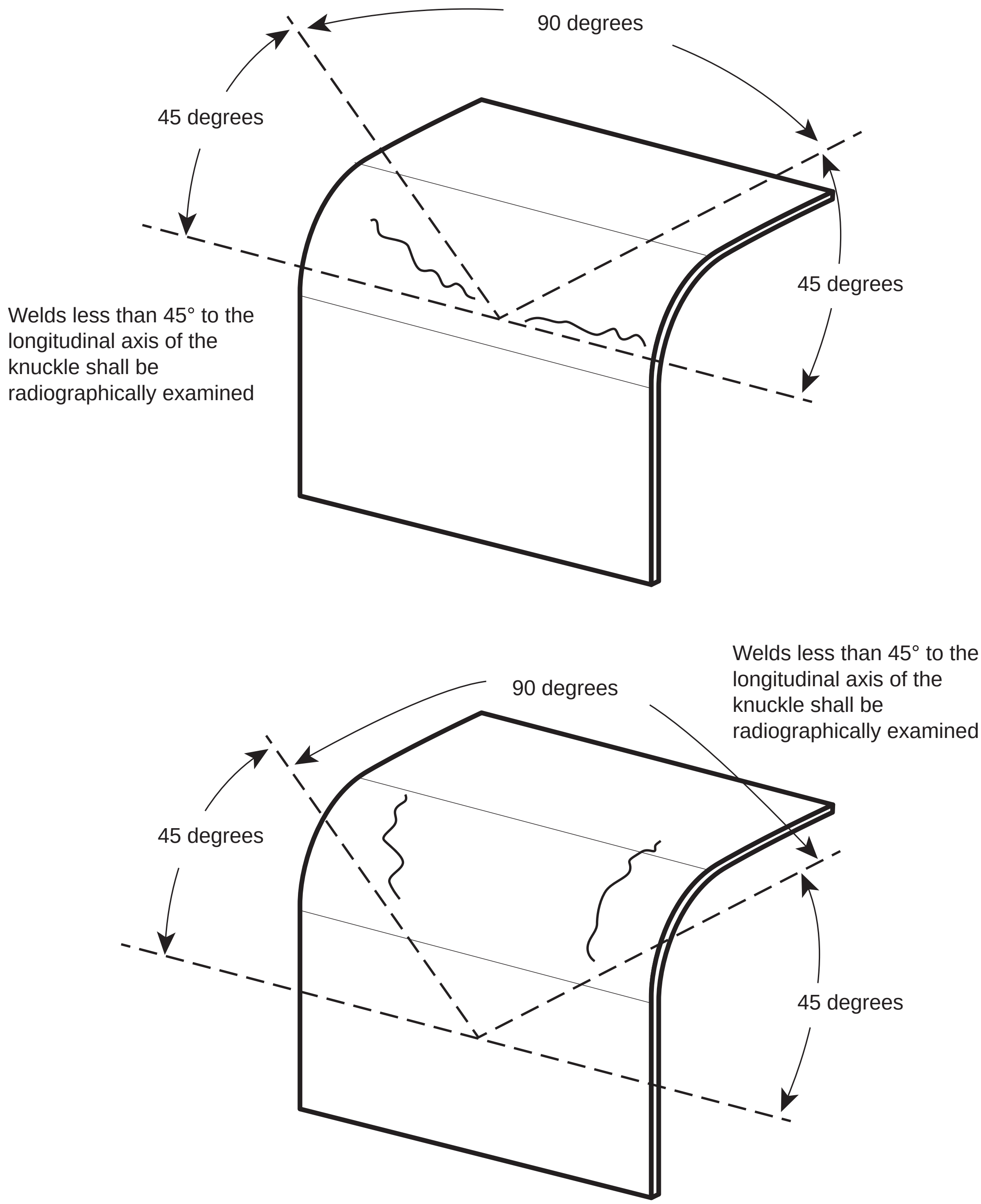
### S2.13.11.2 WELDED REPAIR OF CRACKS IN FIREBOX AND TUBESHEET KNUCKLES

a) Prior to repairing cracks, the plate shall be NDE examined for other defects. All affected sections shall be repaired.

b) Welds within the points of tangency of a knuckle are permitted. Welds with angles of less than 45 degrees to the longitudinal axis of the knuckle shall be radiographically examined (See NBIC Part 3, Figure S2.13.11.2).

c) Cracks radiating from a common point (star cracking) shall not be repaired; installation of a flush patch is required.

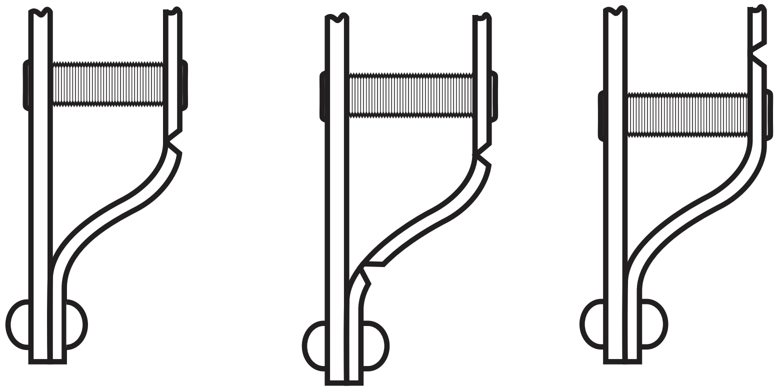
**FIGURE S2.13.11.2**
KNUCKLE WELD ANGLES



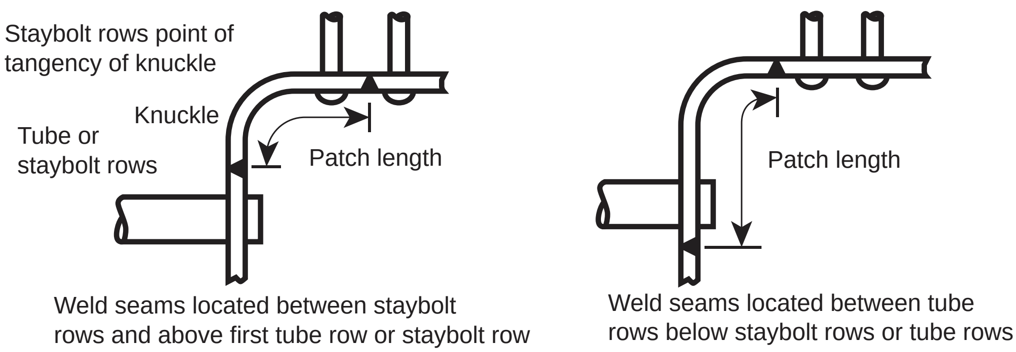

### S2.13.11.3 WELDED FLUSH PATCHES IN FIREBOX AND TUBESHEET KNUCKLES

Any patch not supported by means other than the weld, such as rivets, staybolts, tubes, or other forms of construction, shall have all weld seams radiographically examined. (See NBIC Part 3, Figure S2.13.11.3). All other requirements specified in NBIC Part 3, S2.13.9.3 shall be followed.

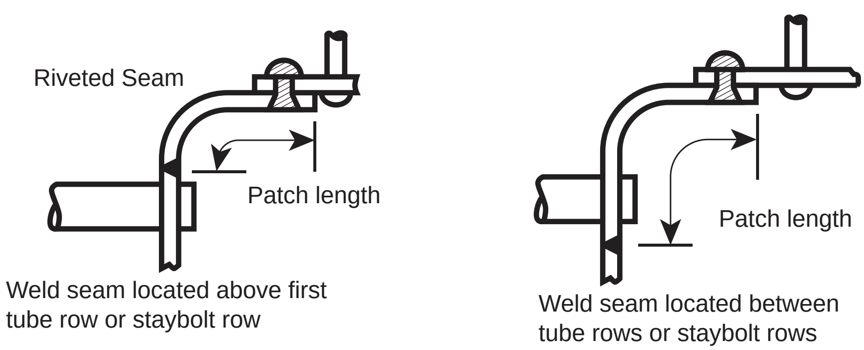
**FIGURE S2.13.11.3**
KNUCKLE FLUSH PATCH



**Stayed Patch Applied to Buttwelded Seam**




**Stayed Patch Applied to Riveted Seam**




**Repairs Requiring Radiographic Examination of Weld Seams**

## S2.13.12 REPAIR OF TUBESHEETS

### S2.13.12.1 WELD BUILDUP OF WASTAGE AND GROOVING IN TUBESHEETS

All requirements of NBIC Part 3, S2.13.9.1 and S2.13.10 shall be followed with the additional requirements listed below:

a) Damaged tubesheet holes may be repaired by welding;

b) Prior to welding, tubes in the wasted area should be removed;

c) Tube holes should be reamed after welding;

d) Welding shall not cover tube ends.

### S2.13.12.2 WELDED REPAIR OF CRACKS IN TUBESHEETS

The same method of repairing cracks in stayed areas identified in NBIC Part 3, Figure S2.13.12.2 shall be followed with the additional requirements identified below:

a) Cracks in a tubesheet and cracks between tubesheet ligaments may be repaired by welding using full penetration welds. Before cracks are repaired, however, the inner surface of the plate should be carefully examined for possible excessive corrosion or grooving;

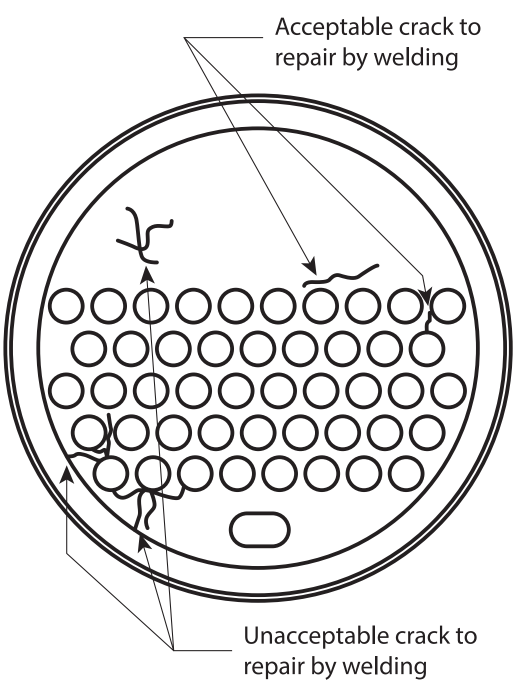
b) If the crack extends into a tube hole, the tube shall be removed prior to making the repair;

c) Tube holes should be reamed after welding; and

d) Welding shall not cover tube ends.

**FIGURE S2.13.12.2**

WELDED REPAIR OF CRACKS IN TUBESHEETS



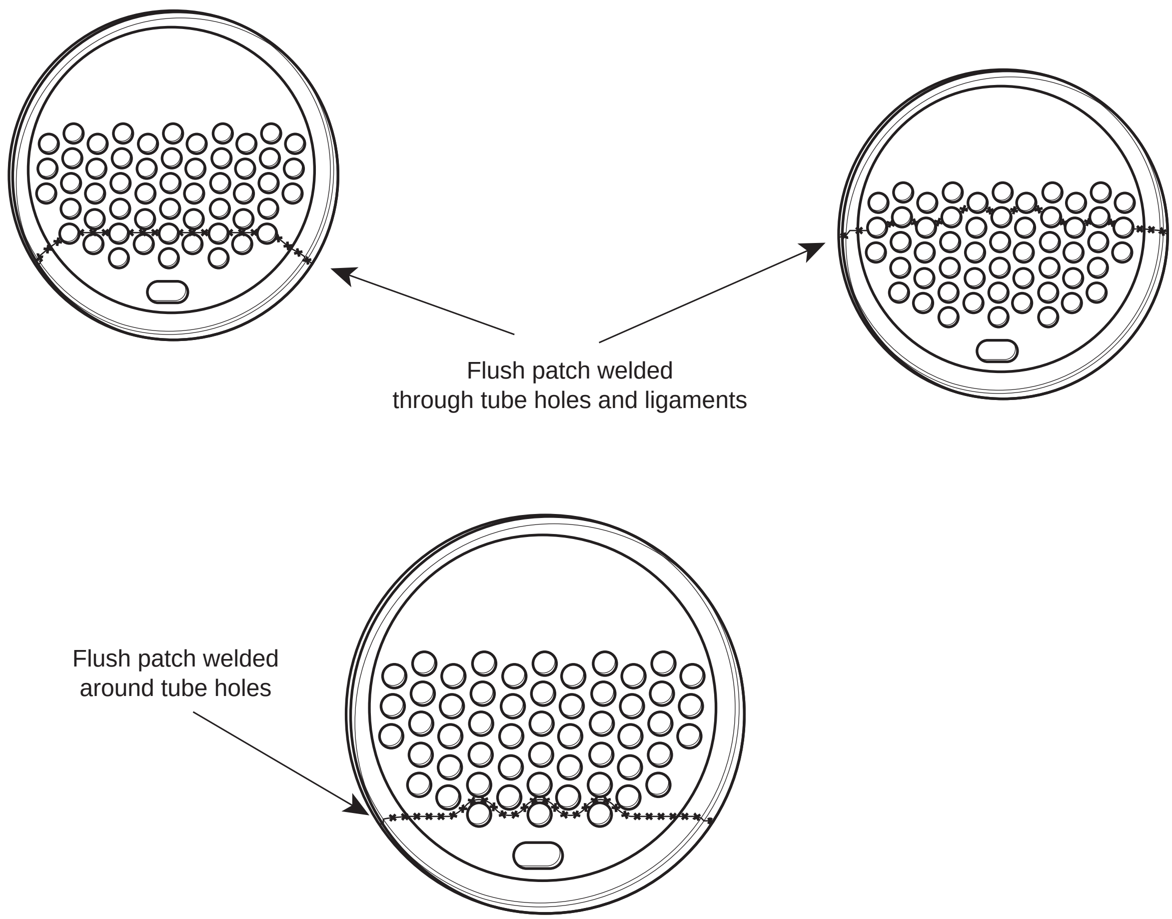
### S2.13.12.3 WELDED FLUSH PATCHES IN TUBESHEETS

a) The method of repair shall follow the same requirements identified in S2.13.10.3 with the following requirement as noted below:

   1) Tubes, staybolts, and rivets should be installed after welding of the patch is completed. (See NBIC Part 3, Figure S2.13.12.3).

**FIGURE S2.13.12.3**

TUBESHEET FLUSH PATCH




### S2.13.13 SEAMS, JOINTS, AND RIVETS

### S2.13.13.1 CAULKING RIVETED SEAMS AND RIVET HEADS

a) Caulking refers to the sealing of plate seams and rivet heads by driving the edge of one surface onto the other by use of a caulking tool.

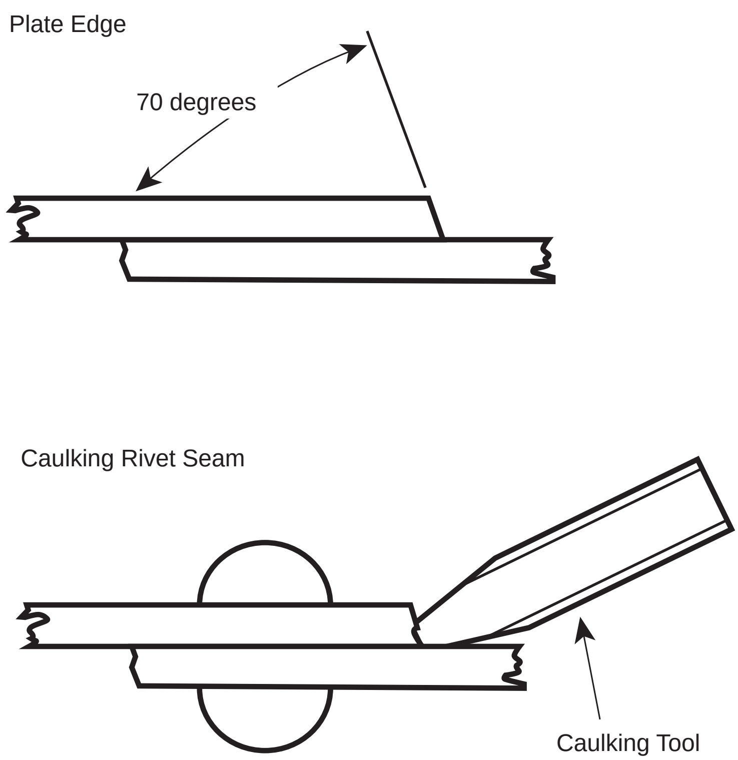
b) The plate edges should be beveled to an angle not sharper than 70 degrees to the plane of the plate and as near thereto as practicable.

c) Caulking shall be done with a tool of such form that there is no danger of scoring or damaging the plate underneath the caulking edge, or splitting the caulked sheet.

d) Riveted seams and rivet heads may be re-caulked after repairs to tighten joint.

**FIGURE S2.13.13.1**

CAULKING RIVET SEAMS




### S2.13.13.2 RIVET HOLES

a) All holes for rivets in plates, buttstraps, heads, stays, and lugs shall be drilled; or they may be punched at least 1/8 in. (3.2 mm) less than full diameter for material not over 5/16 in. (7.9 mm) in thickness and at least 1/4 in. (6.3 mm) less than full diameter for material over 5/16 in. (7.9 mm)

b) Such holes shall not be punched in material more than 5/8 in. (16 mm) in thickness.

c) For final drilling or reaming the hole to full diameter, the parts shall be firmly bolted in position by tack bolts.

d) The finished holes must be true, clean, and concentric.

### S2.13.13.3 ASSEMBLY OF RIVETED JOINTS

After drilling or reaming rivet holes, the plates shall be separated, the burrs and chips removed, and th plates reassembled. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used.

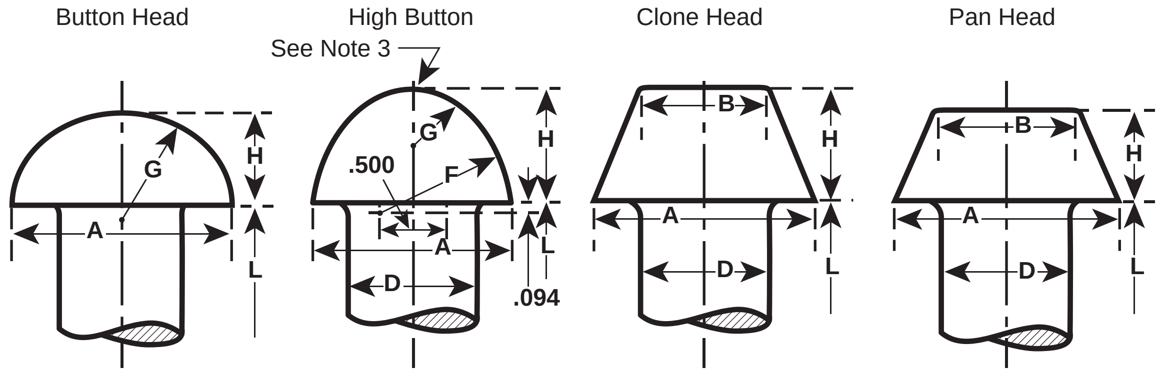
### S2.13.13.4 RIVETING

a) Rivets shall be so driven as to fill the holes preferably by a machine that maintains the pressure until no part of the head shows red in the daylight. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven on each side of each tack bolt before removing the tack bolt.

b) Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal in strength to the bodies of the rivets. Forms of finished rivet heads that will be acceptable are shown in NBIC Part 3, Figure S2.13.13.4-a and S2.13.13.4-b.

### FIGURE S2.13.13.4-a

AMERICAN NATIONAL STANDARD LARGE RIVETS — I (ANSI B18.1.2-1972, R1989)




| Nom. Body Diam. D† | Head Diam. A | | Height H | | Head Diam. A | | Height H | |
|---|---|---|---|---|---|---|---|---|
| | Mfd. Note 1 | Driven Note 2 | Mfd. Note 1 | DrivenNote 2 | Mfd. Note 1 | Driven Note 2 | Mfd.Note 1 | Driven Note 2 |
| | Button Head | | | | High Button Head (Acorn) | | | |
| 1/2 | 0.875 | 0.922 | 0.375 | 0.344 | 0.781 | 0.875 | 0.500 | 0.375 |
| 5/8 | 1.094 | 1.141 | 0.469 | 0.438 | 0.969 | 1.062 | 0.594 | 0.453 |
| 3/4 | 1.312 | 1.375 | 0.562 | 0.516 | 1.156 | 1.250 | 0.688 | 0.531 |
| 7/8 | 1.531 | 1.594 | 0.656 | 0.609 | 1.344 | 1.438 | 0.781 | 0.609 |
| 1 | 1.750 | 1.828 | 0.750 | 0.688 | 1.531 | 1.625 | 0.875 | 0.688 |
| 1-1/8 | 1.969 | 2.062 | 0.844 | 0.781 | 1.719 | 1.812 | 0.969 | 0.766 |
| 1-1/4 | 2.188 | 2.281 | 0.938 | 0.859 | 1.906 | 2.000 | 1.062 | 0.844 |
| 1-3/8 | 2.406 | 2.516 | 1.031 | 0.953 | 2.094 | 2.188 | 1.156 | 0.938 |
| 1-1/2 | 2.625 | 2.734 | 1.125 | 1.031 | 2.281 | 2.375 | 1.250 | 1.000 |
| 1-5/8 | 2.844 | 2.969 | 1.219 | 1.125 | 2.469 | 2.562 | 1.344 | 1.094 |
| 1-3/4 | 3.062 | 3.203 | 1.312 | 1.203 | 2.656 | 2.750 | 1.438 | 1.172 |
| | Cone Head | | | | Pan Head | | | |
| 1/2 | 0.875 | 0.922 | 0.438 | 0.406 | 0.800 | 0.844 | 0.350 | 0.328 |
| 5/8 | 1.094 | 1.141 | 0.547 | 0.516 | 1.000 | 1.047 | 0.438 | 0.406 |
| 3/4 | 1.312 | 1.375 | 0.656 | 0.625 | 1.200 | 1.266 | 0.525 | 0.484 |
| 7/8 | 1.531 | 1.594 | 0.766 | 0.719 | 1.400 | 1.469 | 0.612 | 0.578 |
| 1 | 1.750 | 1.828 | 0.875 | 0.828 | 1.600 | 1.687 | 0.700 | 0.656 |
| 1-1/8 | 1.969 | 2.063 | 0.984 | 0.938 | 1.800 | 1.891 | 0.788 | 0.734 |
| 1-1/4 | 2.188 | 2.281 | 1.094 | 1.031 | 2.000 | 2.094 | 0.875 | 0.812 |
| 1-3/8 | 2.406 | 2.516 | 1.203 | 1.141 | 2.200 | 2.312 | 0.962 | 0.906 |
| 1-1/2 | 2.625 | 2.734 | 1.312 | 1.250 | 2.400 | 2.516 | 1.050 | 0.984 |
| 1-5/8 | 2.844 | 2.969 | 1.422 | 1.344 | 2.600 | 2.734 | 1.138 | 1.062 |
| 1-3/4 | 3.062 | 3.203 | 1.531 | 1.453 | 2.800 | 2.938 | 1.225 | 1.141 |

All dimensions are given in inches.

† Tolerance for diameter of body is plus and minus from nominal and for 1/2-inch size equals +0.020, -0.022; for size 5/8 to 1-inch, incl., equals +0.030, -0.025 for sizes 1-1/8 and 1-1/4-inch equals +0.035. -0.027; for sizes 1-3/8 and 1-1/2-inch equals +0.040, -0.060; for sizes 1-5/8 and 1-3/4-inch equals +0.040, -0.037.

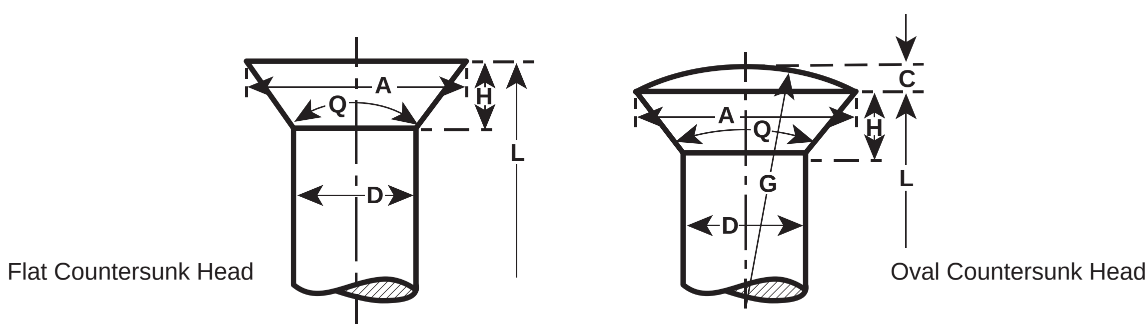
**Note 1:** Basic dimensions of head as manufactured.

**Note 2:** Dimensions of manufactured head after driving and also driven head.

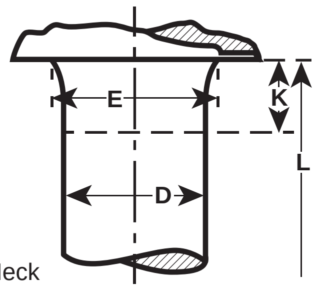
**Note 3:** Slight flat permissible within the specified head-height tolerance.

The following formulas give the basic dimensions for manufactured shapes: Button Head, *A* = 1.750D; *H* = 0.750D; *G* = 0.885*D*. *High Button Head*, *A* = 1.500*D + 0.031; H* = 0.750*D* + 0.125; *F* = 0.750*D* + 0.281; *G* = 0.750D - 0.281. *Cone Head*, *A* = 1.750D; *B* = 0.938D; *H* = 0.875D. *Pan Head*, *A* = 1.600D; *B* = 1.000D; *H* = 0.700D. Length *L* is measured parallel to the rivet axis, from the extreme end to the bearing surface plane for flat bearing surface head-type rivets, or to the intersection of the head top surface with the head diameter for countersunk head-type rivets.

**FIGURE S2.13.13.4-b**
AMERICAN NATIONAL STANDARD LARGE RIVETS — I (ANSI B18.1.2-1972, R1989)




| Flat and Oval Countersunk Head | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Body Diameter, *D* | | | | Head Diameter, *A* | | Head Depth, *H* | Oval Crown Height,* *C* | Oval Crown Radius,* *G* |
| Nominal* | | Max. | Min. | Max.† | Min.± | Ref. | | |
| 1/2 | 0.500 | 0.520 | 0.478 | 0.936 | 0.872 | 0.260 | 0.095 | 1.125 |
| 5/8 | 0.625 | 0.655 | 0.600 | 1.194 | 1.112 | 0.339 | 0.119 | 1.406 |
| 3/4 | 0.750 | 0.780 | 0.725 | 1.421 | 1.322 | 0.400 | 0.142 | 1.688 |
| 7/8 | 0.875 | 0.905 | 0.850 | 1.647 | 1.532 | 0.460 | 0.166 | 1.969 |
| 1 | 1.000 | 1.030 | 0.975 | 1.873 | 1.745 | 0.520 | 0.190 | 2.250 |
| 1-1/8 | 1.125 | 1.160 | 1.098 | 2.114 | 1.973 | 0.589 | 0.214 | 2.531 |
| 1-1/4 | 1.250 | 1.285 | 1.223 | 2.340 | 2.199 | 0.650 | 0.238 | 2.812 |
| 1-3/8 | 1.375 | 1.415 | 1.345 | 2.567 | 2.426 | 0.710 | 0.261 | 3.094 |
| 1-1/2 | 1.500 | 1.540 | 1.470 | 2.793 | 2.652 | 0.771 | 0.285 | 3.375 |
| 1-5/8 | 1.625 | 1.665 | 1.588 | 3.019 | 2.878 | 0.831 | 0.309 | 3.656 |
| 1-3/4 | 1.750 | 1.790 | 1.713 | 3.262 | 3.121 | 0.901 | 0.332 | 3.938 |




Swell Neck

| Swell Neck# | | | | | | |
|---|---|---|---|---|---|---|
| Body Diameter, *D* | | | | Diameter Under Head, *E* | | Neck Length, *K** |
| Nominal* | | Max. | Min. | Max. (Basic) | Min. | |
| 1/2 | 0.500 | 0.520 | 0.478 | 0.563 | 0.543 | 0.250 |
| 5/8 | 0.625 | 0.655 | 0.600 | 0.688 | 0.658 | 0.312 |
| 3/4 | 0.750 | 0.780 | 0.725 | 0.813 | 0.783 | 0.375 |
| 7/8 | 0.875 | 0.905 | 0.850 | 0.938 | 0.908 | 0.438 |
| 1 | 1.000 | 1.030 | 0.975 | 1.063 | 1.033 | 0.500 |
| 1-1/8 | 1.125 | 1.160 | 1.098 | 1.188 | 1.153 | 0.562 |
| 1-1/4 | 1.250 | 1.285 | 1.223 | 1.313 | 1.278 | 0.625 |
| 1-3/8 | 1.375 | 1.415 | 1.345 | 1.438 | 1.398 | 0.688 |
| 1-1/2 | 1.500 | 1.540 | 1.470 | 1.563 | 1.523 | 0.750 |
| 1-5/8 | 1.625 | 1.665 | 1.588 | 1.688 | 1.648 | 0.812 |
| 1-3/4 | 1.750 | 1.790 | 1.713 | 1.813 | 1.773 | 0.875 |

All dimensions are given in inches. * Basic dimension as manufactured.

† Shard-edged head. ± Rounded or flat-edged irregularly shaped head (heads are not machined or trimmed.)

# The swell neck is applicable to all standard forms of large rivets except the flat countersunk and oval countersunk-head types.

The following formulas give the basic dimensions for manufactured shapes: *Flat Countersunk Head*, $A = 1.810D$; $H = 1.192D$ (Max. $A - D$)/2; included angle $Q$ of head = 78 degrees. *Oval Countersunk Head*, $A = 1.810D$; $H = 1.192$ (Max. $A - D$)/2; included angle of head = 78 degrees. *Swell Neck*, $E = D + 0.063$; $K = 0.500D$. Length $L$ is measured parallel to the rivet axis, from the extreme end to the bearing surface plane for flat bearing surface head-type rivets, or to the intersection of the head top surface with the head diameter for countersunk head-type rivets.

**Note:** For more information see ANSI B18.1.2. A copy can be obtained in the machinist handbook.

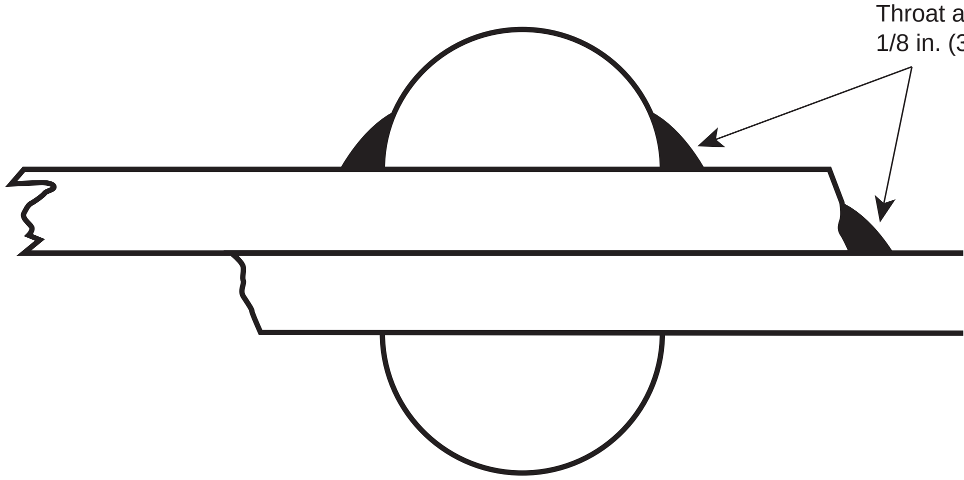
### S2.13.13.5 SEAL WELDING SEAM, JOINTS, AND RIVET HEADS

a) Prior to welding the area should be examined to assure that there are no cracks radiating from the rivet holes. (See NBIC Part 3, Figure S2.13.13.5).

b) Seal welding should not be performed if cracks are present in riveted areas.

c) Seal welding shall not be considered a strength weld.

**FIGURE S2.13.13.5**
SEAL WELDING SEAM AND RIVET HEAD




## S2.13.14 REPAIR OF OPENINGS

### S2.13.14.1 REPAIR OF THREADED OPENINGS

a) Threaded holes with damaged threads may be repaired by weld buildup and re-tapping. The threads shall be removed prior to welding.

b) Threaded openings with damaged threads that cannot be repaired by re-tapping or re-threading should be repaired by welding a flush patch or a connection in the sheet.

c) The connection shall be of such a size as to not interfere with proper operation, washout and inspection.

d) Patches are to be flush type, using full penetration welds. If the load on the patch is carried by other forms of construction, such as staybolts, rivets, or tubes, radiographic examination of the welds is not required.

e) Threaded bushings and piping found to be defective shall be replaced. Seal welding is not permitted.

### S2.13.14.2 REPAIR OF HANDHOLE OPENINGS

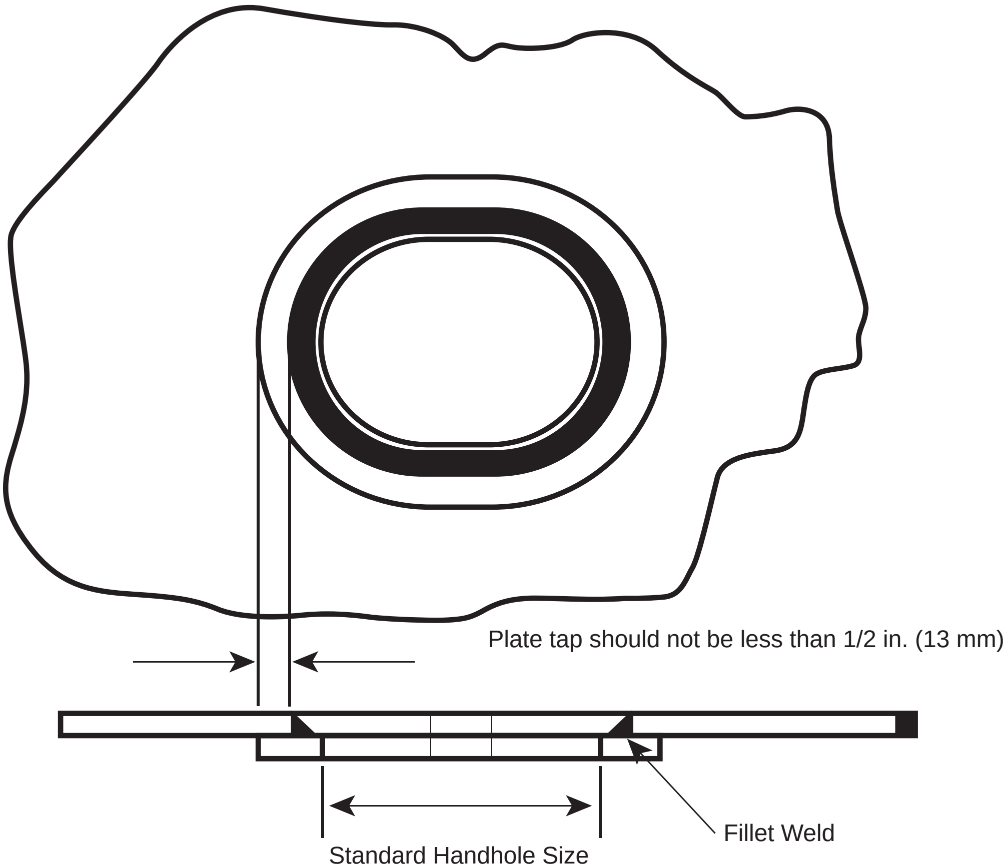
a) Weld buildup shall not be used if the affected section of plate has wasted below 60% of the original thickness per NBIC Part 3, Supplement 2 in an area exceeding 3 sq. in (1950 sq. mm). (See NBIC Part 3, Figure S2.13.9.1).

b) Weld buildup is to replace material that has been lost due to wastage and grooving, and is not to replace thickness on the opposite side of the sheet. Weld buildup must be applied to the side of the sheet that is wasted or grooved.

c) Wasted sections that have wasted below 60% of the minimum required thickness and have an area exceeding 3 sq. in. (1950 sq. mm.) shall be repaired by installing a flush patch using full penetration welds.

d) Weld buildup of wasted areas shall not exceed 100 sq. in. (65,000 sq. mm).

**FIGURE S2.13.14.2**
REPAIR OF HANDHOLE OPENING




## S2.13.14.3 REPAIR OF FUSIBLE PLUG OPENING

a) Threaded holes with damaged threads may be repaired by re-tapping or weld buildup and rethreading the threads shall be removed prior to welding.

b) Threaded opening with damaged threads that can not be repaired by re-tapping or re-threading should be repaired by welding a flush patch or half coupling connection to the sheet.

c) The half coupling connection shall be such a size as to not interfere with proper operation of the fusible plug. The half coupling shall be welded flush to the fire side using a full penetration weld. The half coupling must not project higher than ½ inch (13 mm) from the water side (See Figure NBIC Part 3, S2.13.14.3-a).

d) Flush patch type repairs are to be installed in accordance with S2.13.9.3 and S2.13.10.3 (See Figure S2.13.14.3-b).

**FIGURE S2.13.14.3-a**
FUSIBLE PLUG REPAIR USING FLUSH PATCH

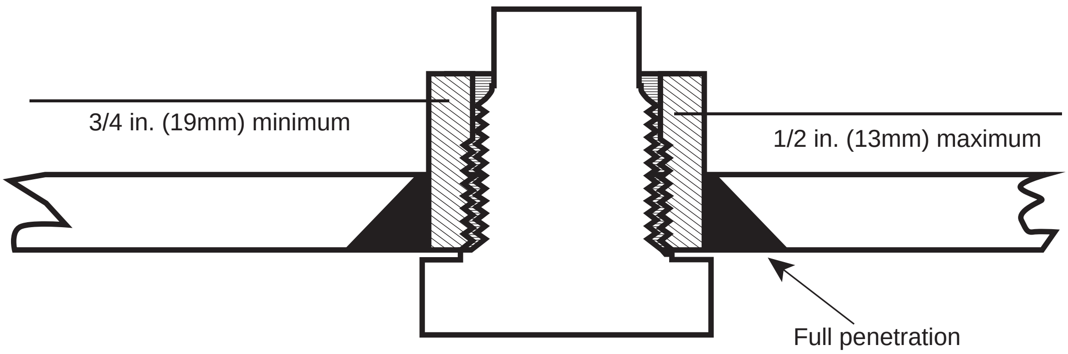
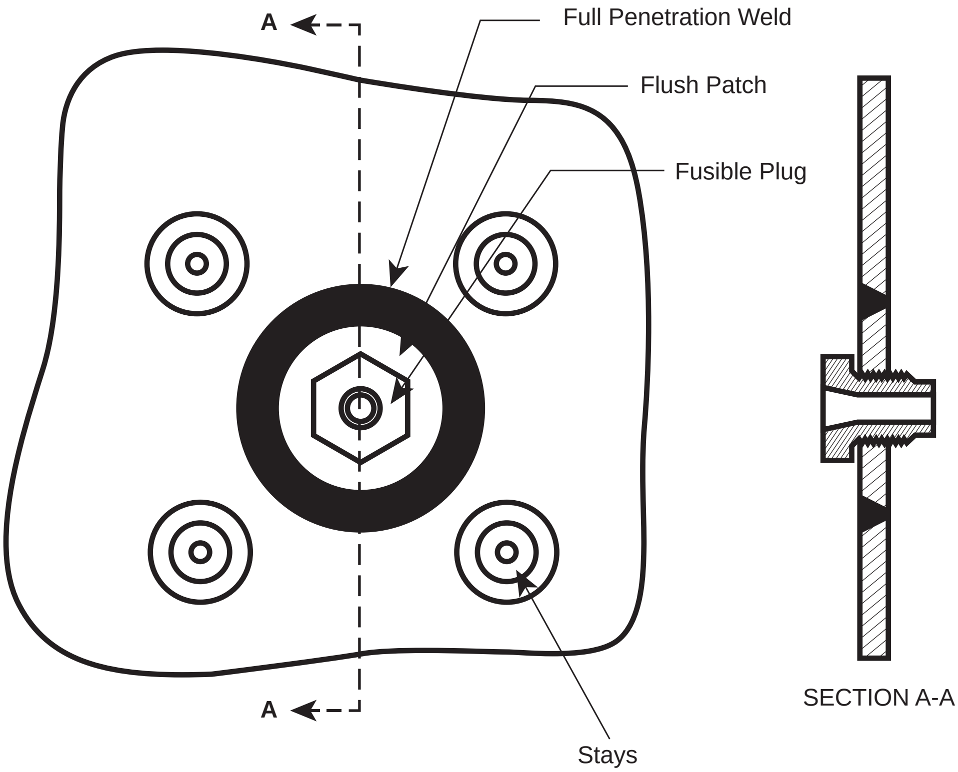



**FIGURE S2.13.14.3-b**
FUSIBLE PLUG REPAIR USING HALF COUPLING




### S2.13.14.4 REPAIR OF HANDHOLE DOORS

Handhole doors, studs, nuts, yokes, and clamps which are worn, cracked or otherwise damaged shall be replaced and not repaired. Replacements shall be of new manufacture, rated for the pressure and temperature

## SUPPLEMENT 3
## REPAIR AND ALTERATION OF GRAPHITE PRESSURE EQUIPMENT

### S3.1 SCOPE

Repairs to graphite pressure equipment require the use of certified impregnated graphite and cement. The determining factor in establishing the desired material properties is the resin impregnation cycle. If the resin impregnation cycle is not controlled, it is not possible to meet the minimum design values.

### S3.2 REPAIRS

The requirements provided in this supplement shall apply, insofar as they are applicable to graphite pressure equipment. Graphite specific requirements include:

a) Organizations performing repairs shall be accredited as described in NBIC Part 3, 1.6 as appropriate for the scope of work to be performed.

b) When the standard governing the original construction is not the ASME Code, repairs or alterations shall conform to the edition of the original construction standard or specification most applicable to the work. Where the original code of construction is unknown, the edition and addenda of the ASME Code most appropriate for the work shall be used, provided the "R" Certificate Holder has the concurrence of the Inspector and the Jurisdiction where the pressure-retaining item is installed.

c) The materials used in making repairs or alterations shall conform to the requirements of the original code of construction except as provided in NBIC Part 3, S3.2 j). The "R" Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the materials to be installed.

d) When ASME is the original code of construction, replacement parts subject to internal or external pressure, which require shop inspection by an Authorized Inspector, shall be fabricated by an organization having an appropriate ASME *Certificate of Authorization*. The item shall be inspected and stamped as required by the applicable section of the ASME Code. A completed ASME *Manufacturer's Partial Data Report* shall be supplied by the manufacturer. Further, all impregnated graphite material subject to internal or external pressure shall be fabricated by an organization having the appropriate ASME *Certificate of Authorization*. The impregnated graphite material shall be inspected and stamped as required by the applicable section of the ASME Code. A completed ASME *Manufacturer's Partial Data Report* with supplementary U1B shall be supplied by the impregnated graphite material manufacturer.

e) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction as required by the original code of construction or equivalent shall be supplied with the item. When this is not possible or practicable, the organization fabricating the part may have a National Board *Certificate of Authorization*; replacement parts shall be documented on Form R-3 and the "R" Symbol Stamp applied as described in NBIC Part 3, Section 5.

f) Organizations performing repairs under an "R" stamp program shall register such repairs with the National Board.

g) Before signing the appropriate NBIC Form, the Inspector shall review the drawings, witness any required pressure test, ensure that the required nondestructive examinations have been performed satisfactorily, and that the other functions necessary to ensure compliance with the requirement of this code have been performed.

h) Pressure-retaining items repaired in accordance with the NBIC shall be marked as required by NBIC Part 3, Section 5. The letter “G” shall be applied to the nameplate under the “R” stamp when graphite repairs are made. The alternate procedure defined in NBIC Part 3, 5.10 may be used in lieu of the stamping and nameplate attachment requirements of NBIC Part 3, Section 5.

i) Legible copies of the completed Form R-1, together with attachments, shall be distributed to the owner or user, the Inspector, the Jurisdiction if required, and the Authorized Inspection Agency responsible for inservice inspection. Form R-1 shall be registered with the National Board. Distribution of Form R-1 and attachments shall be the responsibility of the organization performing the repair.

j) Graphite parts that have previously been in service in one pressure vessel should not be used in a second vessel without prior approval of the owner. Consideration should be given to the service condition of the previous process and possible contamination of the subsequent process.

k) Blind cracks and delaminations may not be repaired by cement injection only.

l) Cracks and porosity in tubes may not be repaired. Cracked and porous sections may be removed so that the remainder of the tube may be used. Individual tube sections shall not be less than 24 in. (610 mm) in length, and the number of segments in a tube shall not exceed the quantity listed in NBIC Part 3, Table S3.2.

**TABLE S3.2**

PERMITTED QUANTITY OF TUBE SEGMENTS

| Total Tube Length, ft. (m) | Number of Tube Segments | Number of Joints |
|---|---|---|
| 6 (1.8) | 1 | 0 |
| 9 (2.7) | 2 | 1 |
| 12 (3.7) | 3 | 2 |
| 14 (4.3) | 3 | 2 |
| 16 (4.9) | 4 | 3 |
| 18 (5.5) | 4 | 3 |
| 20 (6.1) | 4 | 3 |
| 22 (6.7) | 4 | 3 |
| 24 (7.3) | 5 | 4 |
| 27 (8.2) | 5 | 4 |

m) Cementing procedure specifications shall be qualified by the repair organization. The specifications shall be qualified as required by the code of construction. Cementing procedure qualification shall be verified by the Inspector.

n) Cementing technicians shall be qualified by the repair organization. The technicians shall be qualified as required by the code of construction. A cementing technician is any individual who is responsible for proper joint preparation, cleaning parts to be joined, mixing cement, applying cement, securing the joint during the curing process, and controlling the curing process.

o) All records shall be made available to the Inspector.

p) Completed repairs shall be subjected to a pressure test. The test pressure shall not be less than the maximum allowable working pressure or twice the operating pressure, whichever is lower. The test pressure shall be maintained for 30 minutes.

q) Reimpregnation may be used to reduce porosity in an existing graphite component, which will improve the existing graphite component's performance and expected life. Reimpregnation of graphite shall not be considered a means to restore original strength, nor shall it be considered a means to restore the original depth of impregnation.

## S3.3 REPAIRS OF A ROUTINE NATURE

a) The following repairs shall be considered routine, and shall comply with NBIC Part 3, 3.3.2.

   1) Machining — routine repair shall not include the machining of pressure-retaining parts with the exception of minor machining for cleaning and joint preparation not to exceed 1/32 in. (0.8 mm) of material thickness.

   2) Repair of Gasket Surfaces — re-machining of gasket surfaces, re-serrating, or flattening is permitted if the design thickness is maintained.

   3) Replacing Individual Tubes — drilling out and replacing tubes with new tubes or repaired tubes. Only certified materials shall be used for this repair.

   4) Nozzle Replacement — replacement of nozzles by removing the old nozzle and cementing a new nozzle in place. This is applicable for nozzles with inside diameters not exceeding 18 in. (460 mm).

   5) Plugging Tubes — plugging individual tubes using accepted procedures.

   6) Surface Repair — surface repair by installation of plugs or inlay material shall not exceed 1 cu. in. (16 cu. cm) of total volume.

   7) Replacement or Addition of Non-Load Bearing Attachments to Pressure-Retaining Item — For attachment of non-load bearing attachments to pressure-retaining items, the cementing procedure specification need only be qualified for the pressure part and cement to be used.

b) Complete records of these routine repairs shall be kept for review by the Inspector. The records shall include the number of tubes replaced or plugged and their location within the tube bundle.

## S3.4 ALTERATIONS

a) The requirements provided in this section shall apply, insofar as they are applicable to the materials discussed herein. Completed alterations shall be subjected to a pressure test not less than that required by the code of construction. The test pressure shall be maintained for a minimum of 30 minutes. The pressure shall be reduced to MAWP and maintained for inspection.

b) The nameplate shall be applied in accordance with Section 5 of this part. The letter "G" shall be applied to the nameplate under the "R" stamp when graphite alterations are made. The alternate procedure defined in 5.10 may be used in lieu of the stamping and nameplate attachment requirements of NBIC Part 3, Section 5 .

c) Organizations performing alterations under an "R" stamp program shall register such alterations with the National Board.

## S3.5 REPAIR GUIDE FOR IMPERVIOUS GRAPHITE

### S3.5.1 INTRODUCTION

a) This section is intended to provide suggested process and technique details for repairs. This section should be used as a guide by the repair organization in developing specific repair procedures.

b) Damage to domes (heads), tubesheets, or nozzles is invariably a sign of improper installation, operation, or maintenance. Because such damage is random in nature, each case must be analyzed separately to determine the appropriate repair procedure, and the economics of repair versus replacement.

c) Impervious graphite is a machinable material. Parts can be modified or repaired in the field, or in a repair shop.

d) Machining operations may be handled with high-speed steel tools. Extensive machining requires tungsten carbide or diamond tooling. No cooling or flushing fluid is required, nor should either be used.

e) Cleanliness is important. Dusty, dirty, and chemically contaminated surfaces prevent proper cement adhesion. Poor cement adhesion will result in a low strength joint or a joint which leaks. All surfaces should be neutralized to a pH of 7. Graphite parts should be cleaned and washed with acetone to remove all moisture.

f) All damage should be examined and evaluated to determine the cause. Identification and elimination of the cause is essential in helping to prevent a recurrence.

g) A hydrophilic solvent wash on the surface of the damaged part is useful in identifying the full extent of the cracks. The hydrophilic solvent will quickly evaporate from the surface, leaving the cracks damp and clearly visible.

**FIGURE S3.5.1-a**
TYPICAL TUBE-TUBESHEET JOINTS

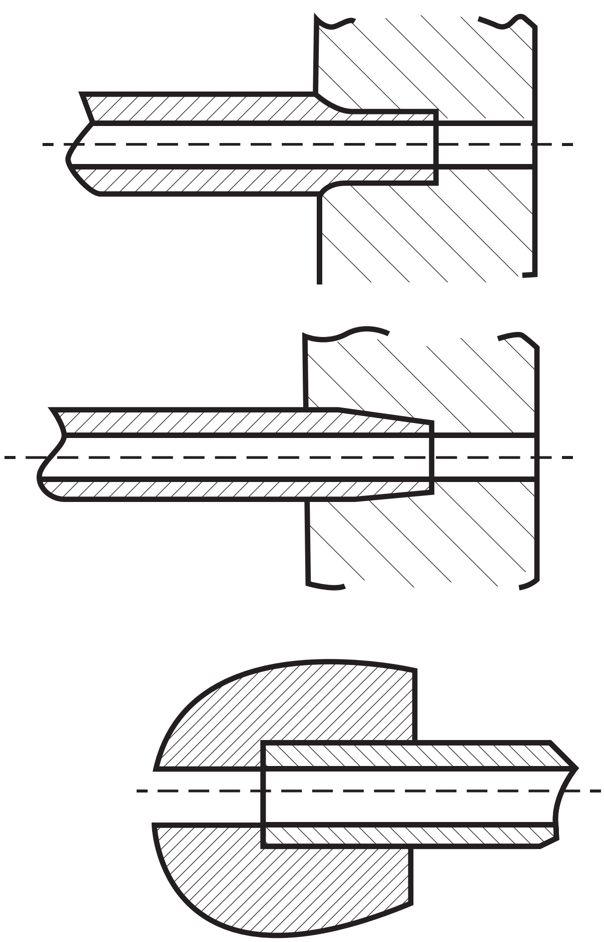


**FIGURE S3.5.1-b**

TYPICAL TUBE REPLACEMENT USING SLEEVE AND INSERT AT TUBESHEET JOINT

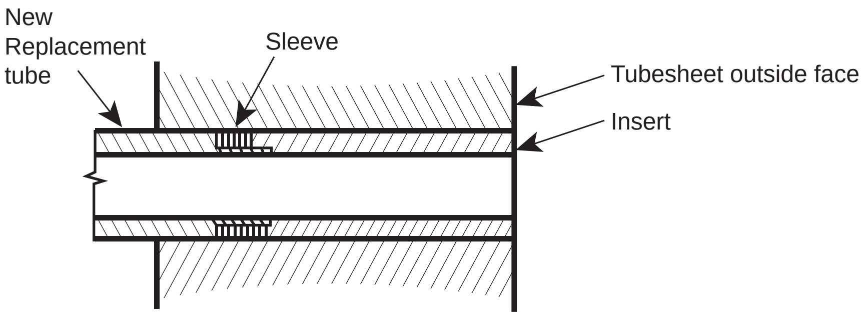



**FIGURE S3.5.1-c**

TYPICAL TUBE REPLACEMENT USING SLEEVE AT TUBESHEET JOINT

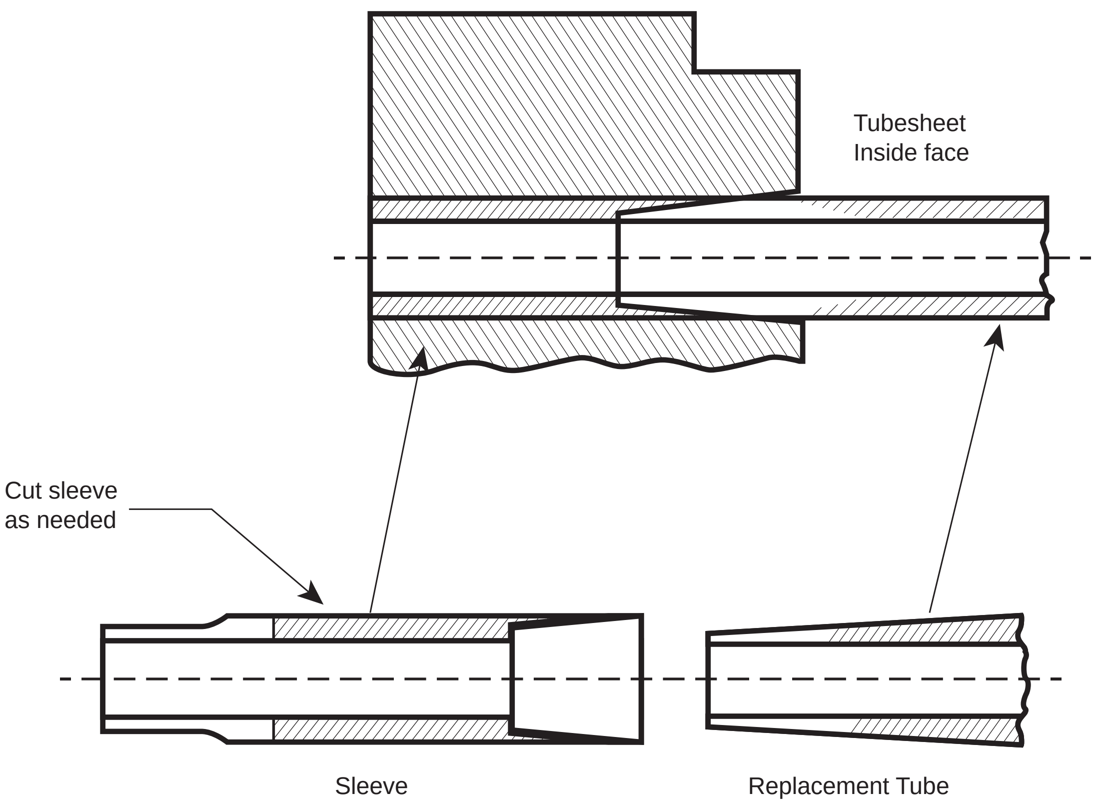


**FIGURE S3.5.1-d**
TYPICAL TUBE-TUBE JOINT

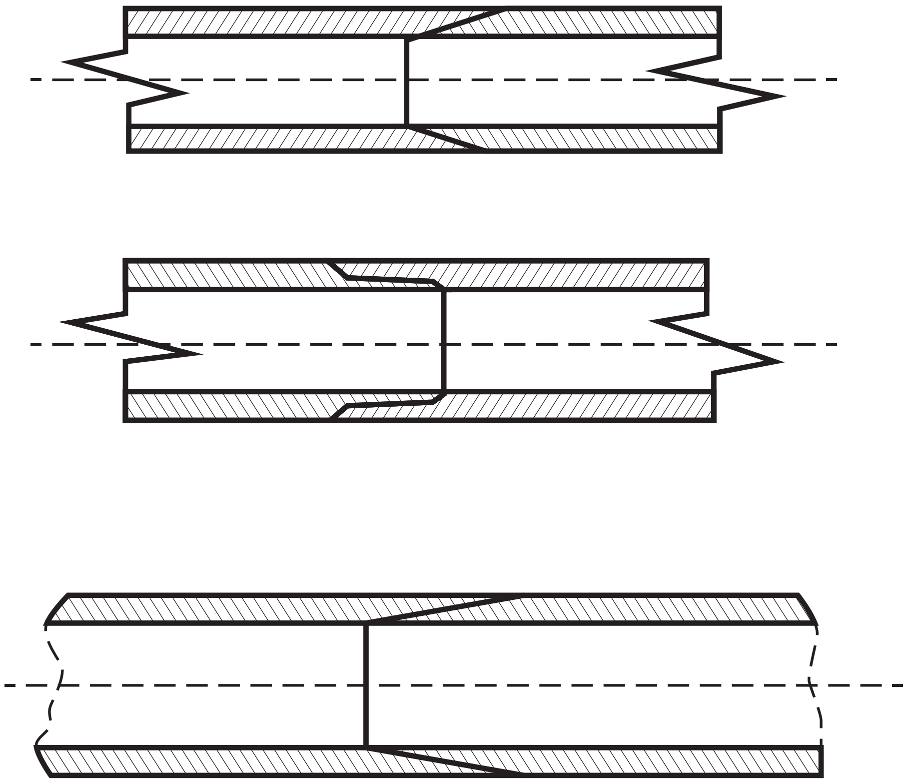


**FIGURE S3.5.1-e**
TYPICAL EDGE REPAIR MATERIAL INLAY

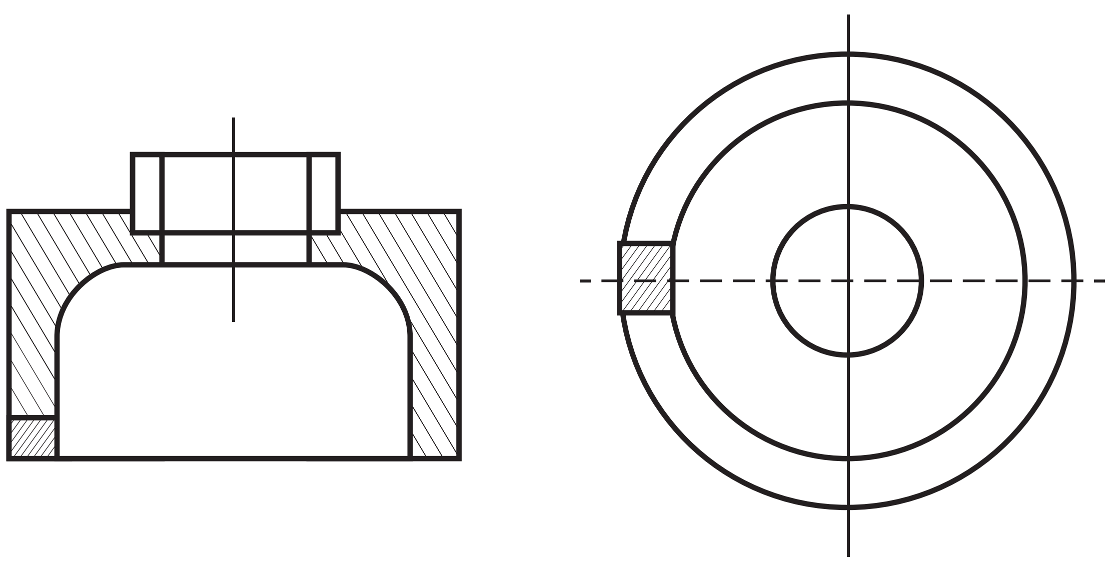
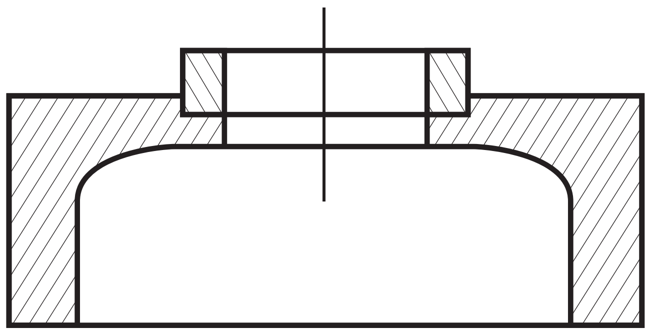


**FIGURE S3.5.1-f**
TYPICAL NOZZLE CONNECTION

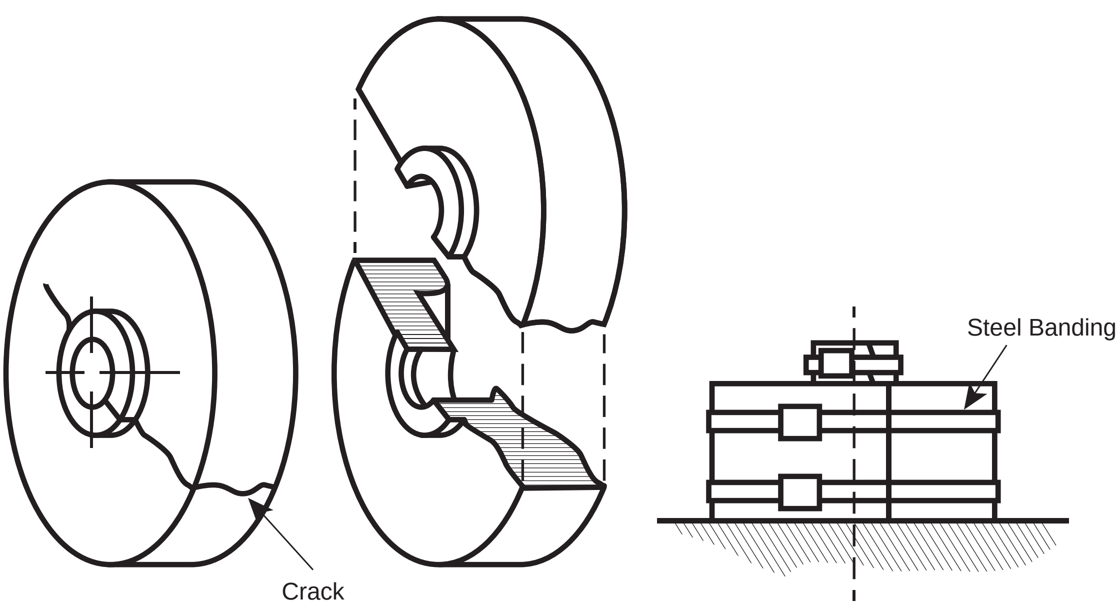


## S3.5.2 TYPICAL GRAPHITE FRACTURES

### S3.5.2.1 MAJOR FRACTURE

An extensive fracture, such as shown in NBIC Part 3, Figure S3.5.2.1, is best repaired by completing the break and re-cementing the two pieces. Temporary steel banding around the circumference is a method of clamping the repair until the cement is cured.

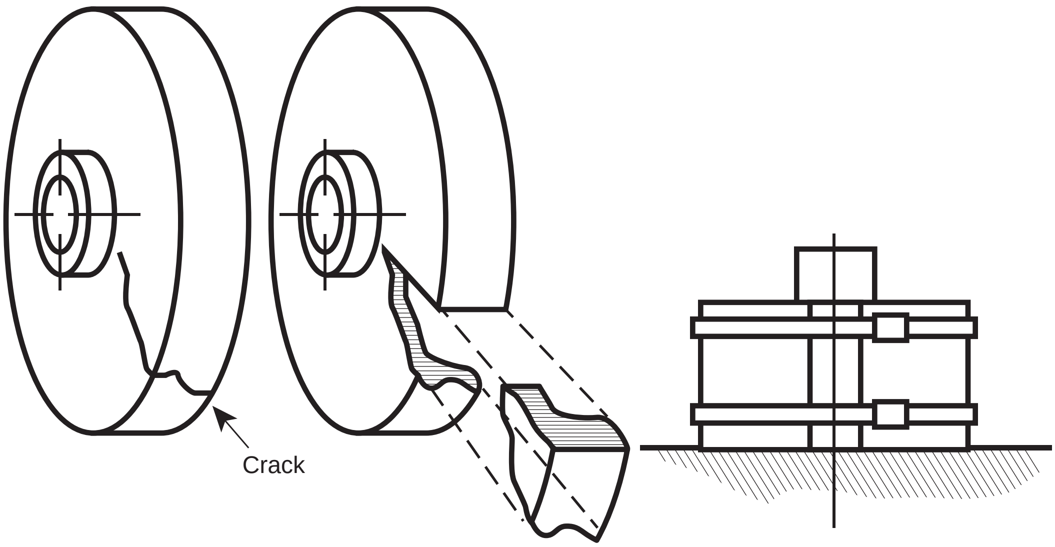
**FIGURE S3.5.2.1**
EXAMPLE OF EXTENSIVE FRACTURE REPAIR




### S3.5.2.2 INTERMEDIATE FRACTURE

If the break is too minor to warrant completing the fracture, a pie-shaped cut may be made and the segment re-cemented in place. (See NBIC Part 3, Figure S3.5.2.2).

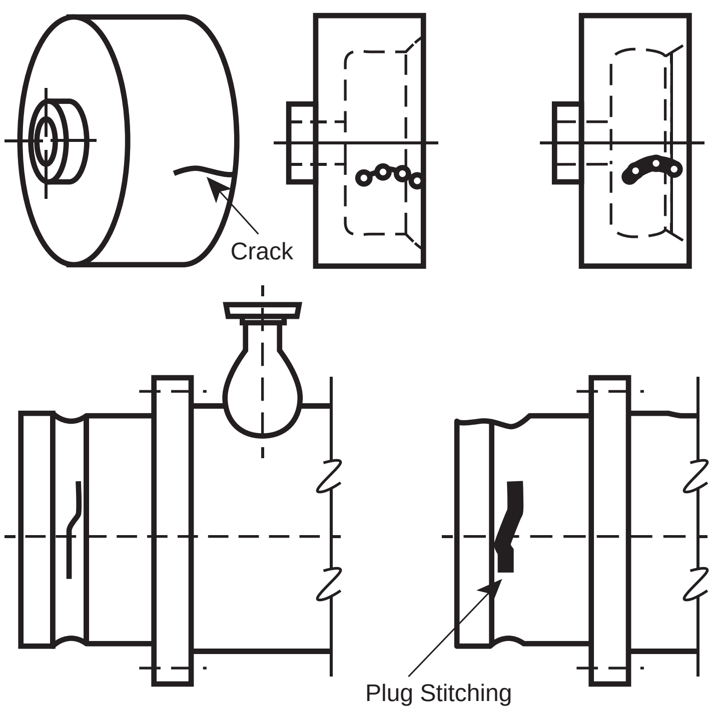
**FIGURE S3.5.2.2**
EXAMPLE OF INTERMEDIATE FRACTURE REPAIR




### S3.5.2.3 MINOR FRACTURE

For minor fractures, such as those shown in NBIC Part 3, Figure S3.5.2.3, plug stitching can be used. The crack is removed by drilling and plugging a continuous chain of overlapping holes along the length and depth of fracture.

**FIGURE S3.5.2.3**
EXAMPLES OF MINOR FRACTURE REPAIR



(15)

### S3.5.2.4 FINISHING THE REPAIR

a) The parts should be held in place to prevent movement while curing the cemented joint to achieve a proper repair. The repair firm should take care to ensure that the cement joint thickness is within the range recommended by the cement manufacturer. Care spent in precisely aligning the parts while clamping will avoid many finishing and machining operations later. Particular attention should be given to gasket and other bearing surfaces.

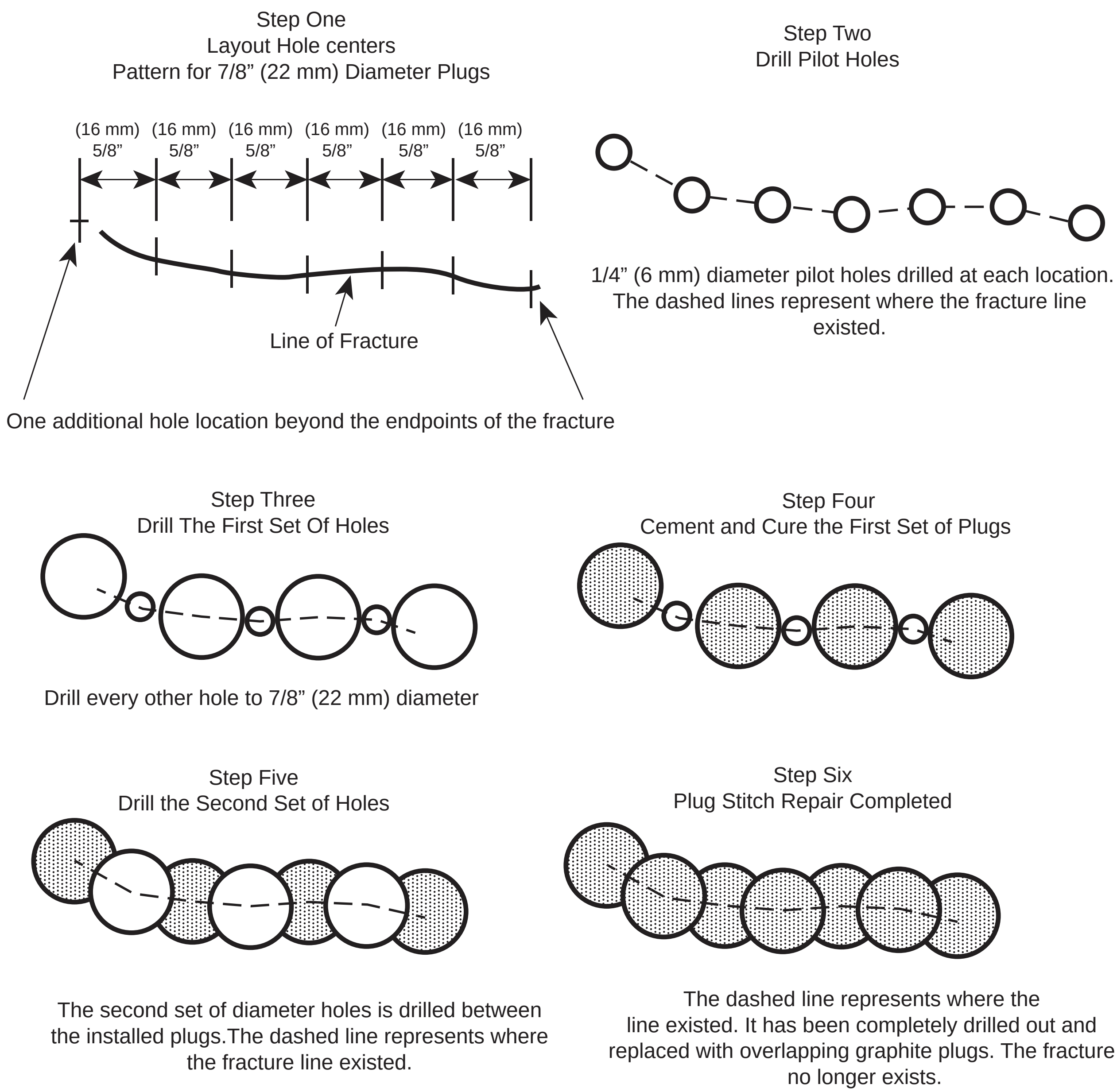
b) Gasket and bearing surfaces may have to be machined, filed, or sanded before the job is completed. Gasket serrations must be clean and continuous. Serrations can be easily re-cut into graphite and any repair plugs that cross the gasket surface.

### S3.5.3 GRAPHITE REPAIR BY PLUG STITCHING

a) Plug stitching is a form of repair by material inlaying. In this case, the inlays are small cylindrical impervious graphite plugs. The crack or fracture is removed by drilling and plugging a continuous series of overlapping holes along its length and depth.

b) Most plug stitching is done with 7/8 in. (22 mm) diameter plugs. The plugs are laid out along the fracture line on a pitch of 5/8 in. (16 mm) centers. The overlap of plug material is 1/4 in. (6 mm) along the fracture line. A number of plug sizes are available and are used in repair, and the amount of overlapping is proportional to their diameters.

## FIGURE S3.5.3




### S3.5.3.1 PLUG STITCHING PROCEDURE (SEE NBIC PART 3, FIGURE S3.5.3)

The following procedure is defined for 7/8 in. (22 mm) diameter plugs (an undersized plug will allow the use of common size tooling). Dimensions for other size plugs shall be adjusted proportionally to the diameter.

a) Trace the line of fracture with a hydrophilic solvent and mark its length and direction.

b) Beyond the end points of the fracture (crack), one additional plug shall be installed.

c) Starting 5/8 in. (16 mm) beyond the end point of the crack, mark drilling centers every 5/8 in. (16 mm) along its length. Make sure there is a plug to be installed outside both end points of the line of fracture.

d) Drill a 1/4 in. (6 mm) pilot hole at each location.

e) Redrill a 7/8 in. (22 mm) hole at every other pilot hole. Holes must be drilled the full depth of the crack. The depth and direction of the crack can be checked with hydrophilic solvent.

f) A 7/8 in. (22 mm) diameter reamer may be used to true the drilled holes.

g) Dry fit a plug into the holes. There should be 0.005 in. to 0.010 in. (0.13 mm to 0.25 mm) clearance for the cement joint. At no time should there be a force fit of plugs into any drilled hole. Provisions shall be provided for venting trapped air.

h) Sand the outside surface of the plugs. Thoroughly clean all the surfaces of the repair, plugs, and drilled holes with hydrophilic solvent.

i) Apply graphite cement to both plugs and holes. All surfaces of plugs and holes to be joined are to be wetted with cement.

j) Insert the cemented plugs into the holes allowing 1/16 in. (1.5 mm) of the plug to extend beyond the surface of the graphite part.

k) Cure the graphite cement according to the cement manufacturer's instruction.

l) At this point, half of the plug stitch repair is completed. A row of plugs has been installed with 1/4 in. (6 mm) pilot holes between them.

m) Redrill the remaining pilot holes to 7/8 in. (22 mm) diameter. The drill will remove part of the plugs that were installed. It is important to have the plugs replace all of the fracture. If the new holes do not cut into the installed plugs, it will be necessary to repeat the procedure between these holes and plug locations to ensure that all of the crack has been repaired. The line of fracture is completely removed by the overlapping effect of the graphite plugs.

n) After the second set of holes have been drilled, repeat the plug cementing procedures.

o) Contour the plugs to provide a smooth transition into the adjoining surface area. The finished repair may be coated with a wash coat for appearance.

### S3.5.3.2 FIGURES — TYPICAL PLUG STITCHING PROCEDURE

a) Step one: Layout hole centers.

b) Step two: Drilling pilot holes.

c) Step three: Drilling the first set of holes.

d) Step four: Cementing and curing the first set of plugs.

e) Step five: Drilling the second set of holes.

f) Step six: Plug stitching repair completed.

### S3.5.4 REIMPREGNATION OF GRAPHITE PARTS (TUBESHEETS, HEADS, AND BLOCKS)

a) As a function of time, temperature, and chemical exposure, the resin used to impregnate graphite may shrink and/or degrade. As such, it is possible for voids to develop in impregnated graphite that has been in chemical service for a period of time. The resin loss can vary from slight to almost complete loss of impregnation. There is no practical way to determine the amount of resin remaining in the pores. However, a pressure test will determine if the graphite has continuous porosity.

b) Reimpregnation of a graphite component may be used to reduce porosity in an existing graphite component, which in turn will improve the performance and expected life of the existing graphite components. A written re-impregnation procedure acceptable to the Inspector is required. The reimpregnation procedure shall include as a minimum:

1) Decontamination and drying of the graphite component

2) Subjecting the component to a vacuum

3) Introducing resin under pressure

4) Curing the resin at a specified temperature and time

5) Leak test

### S3.5.4.1 CONTROL OF IMPREGNATION MATERIAL

a) Impregnation material shall be the same as that specified in the Reimpregnation Procedure. Each impregnation material shall be traceable by the name of its manufacturer and the trade name or number of that manufacturer.

b) The impregnation material manufacturer shall supply the Certificate Holder a *Certificate of Analysis* for each material. It shall include the following:

1) Impregnation material identification

2) Batch number(s)

3) Date of manufacture

4) Shelf life

5) Viscosity per ASTM D 2393

6) Specific gravity

c) Prior to reimpregnation, and at subsequent intervals not to exceed 14 days, the Certificate Holder shall test each batch of impregnation material to assure that the characteristics of the material have not changed from values specified in the Reimpregnation Procedure. The values obtained for viscosity and specific gravity for the impregnation material shall be within the limits specified by the manufacturer and as listed in the Reimpregnation Procedure. The test values shall be made available to the Inspector.

### S3.5.4.2 FINISHING THE REPAIR

a) The parts should be held in place to prevent movement while curing the cemented joint to achieve a proper repair. The repair firm should take care to ensure that the cement joint thickness is within the range recommended by the cement manufacturer. Care spent in precisely aligning the parts while clamping will avoid many finishing and machining operations later. Particular attention should be given to gasket and other bearing surfaces.

b) Gasket and bearing surfaces may have to be machined, filed, or sanded before the job is completed. Gasket serrations must be clean and continuous. Serrations can be easily re-cut into graphite and any repair plugs that cross the gasket surface.

## S3.5.5 PLUGGING OF LEAKING OR DAMAGED TUBES

a) The material used for plugging tubes shall comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG.

b) The point(s) of leakage shall be verified, and the corresponding leak site(s) shall be marked/labeled on the tubesheet, and recorded.

c) A minimum of two (2) graphite plugs, each with a minimum length of 1 in. (25 mm), shall be used to plug each end of the tube(s) in question. This represents a minimum total of four (4) plugs per tube.

d) The tube(s) shall be prepared for plugging by enlarging the inside of the tube(s) with a suitable drill bit or reamer.

   1) To ensure a sound cement joint between the tube sidewall and the plug, a slightly smaller diameter plug shall be selected. The maximum clearance between the tube inside diameter and the outside diameter of the plug shall not exceed 3/32 in. (2.4 mm).

   2) As an alternative to d)1) a mandrel with an abrasive, such as sandpaper, may be used, as long as the maximum tube I.D. to plug O.D. clearance of 3/32 in. (2.4 mm) is not exceeded.

   3) The minimum plug insertion depth of the prepared hole(s) shall meet the minimum combined plug length requirements of "c". When the minimum plug length of "c" is exceeded, the total insertion depth of the plugs may exceed the combined length of the plugs; however, the longer plugs shall not project outside the face of the tube(s) being plugged.

e) Plugging of leaking or damaged tubes shall be performed by certified cementing technicians, using qualified cementing procedures, in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG.

f) The cement shall be prepared per the cement manufacturer's instructions.

g) When cementing the plugs, 100% of individual plugs, as well as the inside diameter of the tube opening(s), shall be coated with cement. The plugs shall then be inserted one by one, against each other, into each end of the tube(s) being plugged.

h) Once the plugging is completed, and before the cement cures, the endplugs may need to be held in place, as newly cemented plugs may exhibit a tendency to dislodge from the plugged tube(s) prior to final curing of the cement.

i) Curing time is dependent upon the cement manufacturer's instructions, and is considered complete when the cement is hardened to the point that it cannot be indented with pressure from a flat screwdriver or other similar instrument.

j) After the cement is completely cured, the plugged, cemented area(s) on the tubesheet face may be dressed with sandpaper or other suitable abrasive.

k) Repaired tubes shall be tested in accordance with this code, using a method acceptable to the Inspector, with a written procedure as approved by the manufacturer's internal quality system, to ensure leaks have been repaired.

l) The scope of the work completed shall be described and reported on a Form R-1.

## S3.5.6 TUBE REPLACEMENT (15)

Tube replacement should be performed with the unit preferably in the horizontal position. Avoid replacing adjacent tubes simultaneously because the replacement areas may overlap or reduce the ligament between



SUPPL. 3

holes and possibly damage the tubesheet. The general steps used in horizontal tube replacement follow below.

a) The material used for tube replacement shall comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG.

b) Tube replacement shall be performed by qualified cementing technicians, using qualified cementing procedures, in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UIG-79(b), (e), and UIG-80(b).

c) Determine the thickness of each tubesheet and inside distance between the tubesheets to obtain tube and sleeve length.

d) Access each tubesheet face, clearly identify and mark each tube hole on each tubesheet of the tubes to be replaced.

e) Prepare/clean the existing tube hole in preparation for extracting the damaged tube. Some holes may contain plugs which require removal. A boring tool slightly larger than the outside diameter of the tube being replaced is required.

f) Drill/bore out the tube hole in each tubesheet to release the tube from the tubesheet. Exercise caution when centering and align cutting to the common axis of the tube.

g) The damaged tube should disengage and become loose. Using guides, remove the damaged tube. Ensure that no debris is trapped in the space where the tube was removed (Fig. S3.5.6-a).

h) Replacement tube shall have sleeves at the ends cemented in the bored holes to replace the material in the tubesheet that was bored out to access the damaged tube (Fig. S3.5.6-b and S3.5.6-c).

    1) Dry-fit a new tube and sleeve.

    2) The sleeve length may vary.

    3) Prior to applying cement, prepare and clean all surfaces to be cemented.

i) Cement the ID of the prepared bore in the floating tubesheet and the tube end OD at the fixed tubesheet. (Fig. S3.5.6-b).

j) Insert the tube through the fixed tubesheet and through the floating tubesheet cemented bore so that it protrudes. Cement the ID of the fixed tubesheet bore as shown in (Fig. S3.5.6-c). The use of alignment dowels can assist/guide in tube handling.

k) Cement the OD of the tube end protruding from the floating tubesheet. Cement the ID of the mating sleeve end, fit it to the cemented tube end and push the assembly part-way into the floating tubesheet. Cement the remainder of the OD of the floating tube end sleeve. Push this cemented assembly the rest of the way into the floating tubesheet (Fig S3.5.6-c).

l) Cement the ID and OD of the sleeve for the fixed tubesheet and insert it until it mates with the tube end inside. Push together cemented tube/sleeve assemblies. (Fig S3.5.6-d). Clean/wipe away any excess cement.

m) Apply slight pressure on the sleeves to seat the joints. Remove excess cement.

n) Maintain pressure and cure both ends of the cemented assembly according to the cement manufacturer's instructions.

o) Sleeves may be trimmed after curing.

p) Replaced tubes shall be tested in accordance with this code per a written procedure acceptable to the Inspector.

q) The scope of work completed shall be described and reported on a Form R-1.

**FIGURE S3.5.6-a** (15)

CLEANED AND PREPARED TUBESHEETS


**FIGURE S3.5.6-b** (15)

STARTING TUBE REPLACEMENT

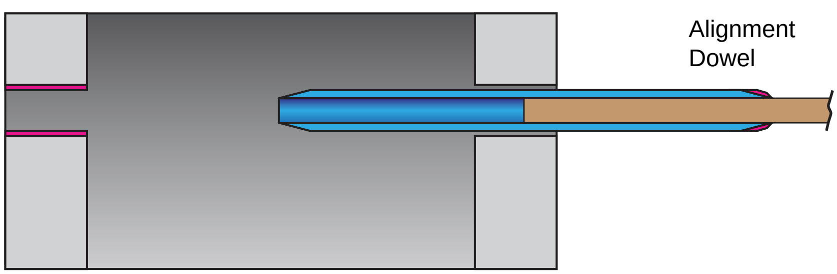
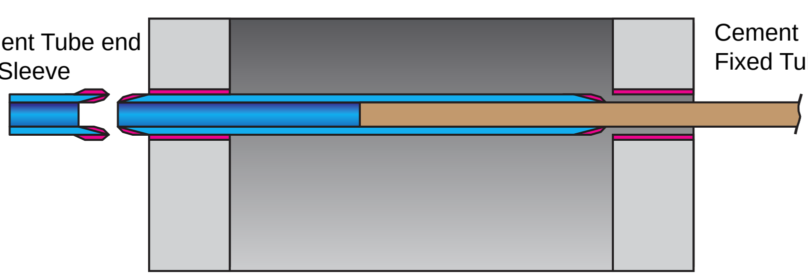


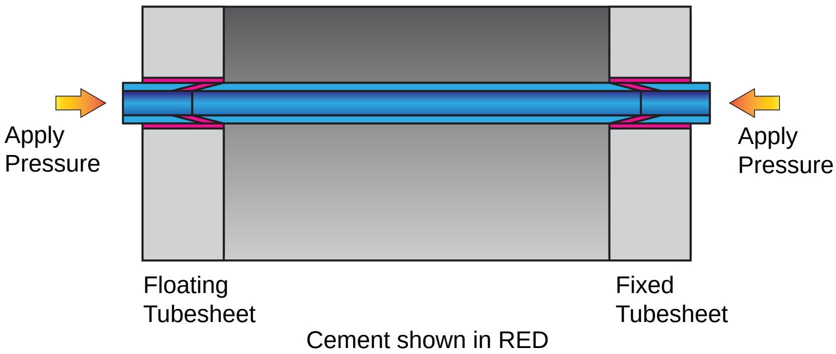

**FIGURE S3.5.6-c** (15)

SLEEVE CEMENTING



(15) **FIGURE S3.5.6-d**

COMPLETED TUBE REPLACEMENT



# SUPPLEMENT 4
# REPAIR AND ALTERATION OF FIBER-REINFORCED THERMOSETTING PLASTIC PRESSURE EQUIPMENT

## S4.1 SCOPE

a) This supplement provides general requirements that apply to repairs and alterations to fiber-reinforced pressure-retaining items.

b) The letters "RP" shall be included on the "R" *Certificate of Authorization* for those organizations authorized to perform repairs/alterations of fiber-reinforced plastic pressure equipment.

## S4.2 INSPECTOR QUALIFICATIONS

The "R" Stamp Holder's inspector shall have the following qualifications:

a) No fewer than five years of current verifiable documented experience in an occupational function that has a direct relationship to Reinforced Thermoplastic (RTP) fabrication and inspection, following customer or national standards, and be directly involved in the following activities:

   1) the development of plans, drawings, procedures, inspection requirements, acceptance criteria, and personnel qualification requirements;

   2) fabrication, construction, and supervision of personnel in the production of assemblies or subassemblies;

   3) detection and measurement of nonconformities by application of visual or other nondestructive evaluation processes to written procedures;

   4) supervision of personnel engaged in material and component examination;

   5) repairs of equipment or supervision of personnel performing repairs;

   6) preparation of written procedures for assembly, acceptance, nondestructive evaluation, or destructive tests;

   7) qualification of secondary bonders, laminators, and welders to applicable codes, standards, or specifications;

   8) operation techniques or activities used to fulfill quality control requirements for RTP fabrication or assembly; and

   9) train the occupational skills of fabrication or assembly of RTP equipment.

b) The Inspector shall meet the following visual and educational requirements:

   1) be able to read a Jaeger Type No. 1 standard chart at a distance of not less than 12 in. (305 mm);

   2) be capable of distinguishing and differentiating contrast between colors;

   3) have visual acuity checked annually to assure natural or corrected near distance vision; and

   4) be a high school graduate or hold a state or military approved high school equivalency diploma.

c) The employer of the inspector shall certify that the employee complies with the above qualification requirements.

## S4.3 TOOLS

The following tools may be required by the Inspector:

a) adequate lighting including overall lighting and a portable lamp for close inspections;

b) handheld magnifying glass;

c) Barcol hardness tester;

d) small pick or pen knife;

e) small quantity of acetone and cotton swabs;

f) camera with flash capability; and

g) liquid penetrant testing kit.

## S4.4 LIMITATIONS

All field work shall be limited to secondary bonding.

## S4.5 REPAIR LIMITATIONS FOR FILAMENT WOUND VESSELS

When the MAWP is greater than 200 psig (1.38 MPa), field repair of filament wound ASME Code Section X, Class I vessels shall be limited to corrosion barrier or liner repairs only, provided there is access to the vessel interior. No structural repairs, re-rating, or alterations are allowed for filament wound ASME Code Section X, Class 1 vessels that have an MAWP greater than 200 psig (1.38 MPa).

## S4.6 VESSELS FABRICATED USING ELEVATED TEMPERATURE CURED RESIN SYSTEMS

Repair of vessels fabricated using elevated temperature cured resin systems shall be limited to the corrosion barrier or liners only, providing there is adequate access to the vessel surface that requires the repair. No structural repairs, re-rating or alterations are permitted with the following exceptions:

a) Repair of vessels fabricated using elevated temperature-cured material is permitted only if the following provisions are met:

   1) Calculations must be submitted by an Engineer meeting the ASME Section X criteria for an Engineer certifying ASME Section X or RTP-1 compliance of the appropriate calculations contained in the Fabricator's Design Report.

   **Note:** The engineer qualification criteria of the Jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

   2) The original fabricator must provide its approval showing that the damage does not compromise the pressure rating of the vessel and that the safety factor required by the ASME Code or the original code of construction is maintained.

b) Repairs that result in a revision to the pressure rating of a vessel covered as a part of this section is permitted, provided the new rating is less than the original rating, and as long as the safety factor required by the ASME Code or the safety factor used as a design basis from the original code of construction is met in its entirety, and all the requirements under NBIC Part 3, S4.17, *Additional Requirements for Alterations*, are met.

## S4.7 CODE OF CONSTRUCTION

a) When the standard governing the original construction is the ASME Code Section X or ASME RTP-1, repairs and alterations shall conform, insofar as possible, to the section and edition of ASME Code Section X or ASME RTP-1 most applicable to the work planned.

b) When the standard governing the original construction is not the ASME Code Section X or ASME RTP-1, repairs and alterations shall conform to the original code of construction or standard. Where this is not possible, it is permissible to use other codes, standards, or specifications, including the ASME Code (Section X or RTP-1), provided the "RP" designated "R" Certificate Holder (hereafter called the certificate holder) has the concurrence of the Inspector and the Jurisdiction where the pressure-retaining item is installed.

## S4.8 MATERIALS

The materials used in making repairs or alterations shall conform to the requirements of the original code of construction. All resins and reinforcements must be properly stored and prevented from being contaminated by water, soil, or other impurities. The certificate holder is responsible for verifying identification of existing materials from original data, drawings, or units records, and identification of the materials to be installed. Consideration shall be given to the condition of the existing laminate, especially in the secondary bond preparation area.

## S4.9 REPLACEMENT PARTS

a) Replacement parts that will be subject to internal or external pressure including liquid head that are preassembled with or without secondary bonds shall have the fabrication performed in accordance with the original code of construction. The fabricator shall certify that the material and fabrication are in accordance with the original code of construction. This certification shall be supplied in the form of bills of material and drawings with statements of certification. Examples include shell and head sections, or flanged nozzles.

b) When ASME is the original code of construction, replacement parts subject to internal or external pressure that require shop inspection by an Authorized Inspector or by a Certified Individual as defined by ASME RTP shall be fabricated by an organization having an appropriate ASME *Certificate of Authorization*. The item shall be inspected and stamped or marked as required by the original code of construction. A completed ASME *Fabricator's Partial Data Report* shall be supplied by the fabricator.

c) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction as required by the original code of construction or equivalent shall be supplied with the item. When this is not possible or practicable, the organization fabricating the part may have a National Board *Certificate of Authorization*. Replacement parts shall be documented on Form R-3 and the "R" Symbol Stamp applied as described in NBIC Part 3, 5.7.

## S4.10 SECONDARY BONDING

Secondary bonding shall be performed in accordance with the requirements of the original code of construction used for the pressure-retaining item.

### S4.10.1 SECONDARY BONDING PROCEDURE SPECIFICATIONS

Secondary bonding shall be performed in accordance with the lamination procedure qualified in accordance with the original code of construction.

### S4.10.2 PERFORMANCE QUALIFICATIONS

Secondary bonders shall be qualified for the lamination process that is used. Such qualifications shall be in accordance with the requirements of the original code of construction.

### S4.10.3 RECORDS

The Certificate Holder shall maintain a record of the results obtained in secondary bonder procedure qualifications. These records shall be certified by the Certificate Holder and shall be available to the Inspector.

### S4.10.4 SECONDARY BONDER'S IDENTIFICATION

The Certificate Holder shall establish a system for the assignment of a unique identification mark for each secondary bonder qualified in accordance with the requirements of the NBIC. The Certificate Holder shall also establish a written procedure whereby all secondary bonds can be identified as to the secondary bonder who made them. The procedure shall be acceptable to the Inspector. The Certificate Holder shall keep a record of all secondary bonded joints and the secondary bonders who made the joints.

### S4.10.5 SECONDARY BONDER'S CONTINUITY

The performance qualification of a secondary bonder shall be affected when one of the following conditions occur:

a) When the secondary bonder has not made joints using a specific qualified lamination procedure during a period of 18 months or more, the bonder's qualifications for that procedure shall expire.

b) When there is specific reason to question the bonder's ability to make secondary bonds that meet the specification, the qualification which supports the secondary bonding that is being performed shall be revoked. All other qualifications not questioned remain in effect.

## S4.11 CURING

Curing techniques shall be performed as required by the original code of construction or by the resin manufacturer's recommendations in accordance with a written procedure. The procedure shall contain the parameters for curing.

## S4.12 NONDESTRUCTIVE EXAMINATION

Except as required by this supplement, the nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualifications, and acceptance criteria, shall be in accordance with the original code of construction used for the construction of the pressure-retaining item. Secondary bonded repairs and alterations shall be subjected to the same nondestructive examination requirements as the original secondary bonds. As a minimum, all secondary bonded joints made for repairs and alterations shall be subjected to a Barcol hardness test in accordance with ASTM D-2583 and an acetone wipe test for all polyester and vinyl ester resins. A visual inspection in accordance with NBIC Part 3, Table S4.12 is always required. The criteria for visual acceptance shall be the same as the original code of construction.

**TABLE S4.12**
VISUAL INSPECTION ACCEPTANCE CRITERIA

| Definition of Visual Inspection Levels (to be Specified User or User's Agent): Level 1 = Critically Corrosion Resistant Level 2 = Standard Corrosion Resistant | | Maximum Size and Cumulative Sum of Imperfections Allowed After Repair. (See General Notes (a) and (b). Imperfections Subject to Cumulative Sum Limitations are indicated with an asterisk). | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Inner Surface Veil(s), Surfacing Mat | | Interior Layers Thick Mat or Chopped Strand Spray Layers | | Structural Layers Balance of Laminate (Including Outer Surface) | | |
| **Imperfection Name** | **Definition of Imperfection** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Notes** |
| **Burned Areas** | Showing evidence of thermal decomposition through discoloration or heavy distortion | NONE | NONE | NONE | NONE | NONE | Never in more than one ply and not to exceed 16 sq. in. (10,500 $mm^2$) in any vessel | Discoloration only, never delamination or decomposition |
| **Chips surface)** | Small pieces broken off an edge or surface | *1/8 in. (3 mm) dia. max. by 30% of veil(s) thickness max. | *1/8 in. (3 mm) dia. max. by 50% of veil(s) thickness max. | | | *1/4 in. (6 mm) dia. or 1/2 in. (13 mm) length max. by 1/16 in. (1.5 mm) deep | *1/4 in. (6 mm) dia. or 1/2 in. (13 mm) length max. by 1/16 in. (1.5 mm) deep | |
| **Cracks** | Actual ruptures or debond of portions of the structure | NONE | NONE | NONE | NONE | NONE | NONE | Not to include areas to be covered by joints |
| **Crazing (surface)** | Fine cracks at the surface of a laminate | NONE | NONE | | | Max. 1 in. (25 mm) long by 1/64 in. (0.4 mm) deep, max. density 3 in. (75 mm) any sq. ft. | Max. 2 in. (50 mm) long by 1/64 in. (0.4 mm) deep, max. density 5 in. (125 mm) any sq. ft. | |
| **Delamination (internal)** | Separation of the layers in a laminate | NONE | NONE | NONE | NONE | NONE | *None in three plies adjacent to interior layer, none larger than 1 sq. in. (650 $mm^2$) in total area | |

## TABLE S4.12 (CONTINUED)
VISUAL INSPECTION ACCEPTANCE CRITERIA

| Definition of Visual Inspection Levels (to be Specified User or User's Agent): Level 1 = Critically Corrosion Resistant Level 2 = Standard Corrosion Resistant | | Maximum Size and Cumulative Sum of Imperfections Allowed After Repair. (See General Notes (a) and (b). Imperfections Subject to Cumulative Sum Limitations are indicated with an asterisk). | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Inner Surface Veil(s), Surfacing Mat | | Interior Layers (-0.125 in. [3 mm] Thick) Mat or Chopped Strand Spray Layers | | Structural Layers Balance of Laminate (Including Outer Surface) | | |
| **Imperfection Name** | **Definition of Imperfection** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Notes** |
| **Dry Spot (surface)** | Areas of surface where the reinforcements have not been wetted with resin | NONE | NONE | | | NONE | NONE | |
| **Edge Exposure** | Exposure of multiple layers of the reinforcing matrix to the vessel contents, usually as a result of shaping or cutting a section to be secondary bonded (interior of vessel only) | NONE | NONE | | | NONE | NONE | Edges exposed to contents must be covered with same number of veils as inner surface |
| **Foreign Inclusion** | Particles included in a laminate which are foreign to its composition (not a minute speck of dust) | *3/16 in. (5 mm) long max. by dia. or thickness not more than 30% of veil(s) thickness | *1/4 in. (6 mm) long max. by dia. or thickness not more than 50% of veil(s) thickness | *1/2 in. (13 mm) long max. by dia. or thickness not more than 30% of veil(s) thickness | *1/2 in. (13 mm) long max. by dia. or thickness not more than 50% of veil(s) thickness | *Dime size, never to penetrate lamination to lamination | *Nickel size, never to penetrate lamination to lamination | Must be fully resin wetted and encapsulated |

# TABLE S4.12 (CONTINUED)
## VISUAL INSPECTION ACCEPTANCE CRITERIA

| Definition of Visual Inspection Levels (to be Specified User or User's Agent): Level 1 = Critically Corrosion Resistant Level 2 = Standard Corrosion Resistant | | Maximum Size and Cumulative Sum of Imperfections Allowed After Repair. (See General Notes (a) and (b). Imperfections Subject to Cumulative Sum Limitations are indicated with an asterisk). | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Inner Surface Veil(s), Surfacing Mat | | Interior Layers (-0.125 in. [3 mm] Thick) Mat or Chopped Strand Spray Layers | | Structural Layers Balance of Laminate (Including Outer Surface) | | |
| **Imperfection Name** | **Definition of Imperfection** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Notes** |
| **Pimples (surface)** | Small, sharp, conical elevations on the surface of a laminate | *Max. height of diameter 1/64 in. (0.4 mm) | *Max. height of diameter 1/64 in. (0.4 mm) | | | No Limit | No Limi | Must be fully resin filled and wetted; generally captured sanding dust |
| **Pit (surface)** | Small crater in the surface of a laminate | *1/8 in. (3 mm) max. by 30% of veil(s) thickness max. | *1/8 in. (3 mm) max. by 30% of veil(s) thickness max. | | | *1/4 in. (6 mm) max. by 1/16 in. (1.5 mm) deep max. | *1/4 in. (6 mm) max. by 3/32 in. (2.5 mm) deep max. | No fibers should be exposed |
| **Porosity (surface)** | Presence of numerous visual tiny pits (pinholes), approximate dimension 0.005 in. (0.1 mm) (for example, 5 in. any sq. in. [630 sq. mm]) | None more than 30% of veil(s) thickness | None more than 50% of veil(s) thickness | | | None to fully penetrate the exterior get coat or get coated exterior veil. No quantity limit. | | No fibers should be exposed |
| **Scratches (surface)** | Shallow marks, grooves, furows, or channels caused by improper healing | NONE | NONE | | | *None more than 6 in. long (150 mm) | *None more than 12 in. long (300 mm) | No fibers should be exposed |
| **Wet Blisters (surface)** | Rounded elevation of the surface, somewhat resembling a blister of the human skin, not reinforced | *None over 3/16 in. (5 mm) dia. by 1/16 in. (1.5 mm) in height | *None over 3/16 in. (5 mm) dia. by 1/16 in. (1.5 mm) in height | | | No Limit | No Limit | Must be fully resin filled; not drips loosely glues to surface, which are to be removed |
| **Wet Out Inadequate** | Resin has failed to saturate reinforcing (particularly woven roving.) | NONE | NONE | NONE | NONE | Dry mat or prominent and dry woven roving pattern not acceptable; discernible but fully saturated woven pattern acceptable | | Split tests on cutouts may be used to discern degree of saturation on reinforcing layers |



SUPPL. 4

## TABLE S4.12 (CONTINUED)
VISUAL INSPECTION ACCEPTANCE CRITERIA

| Definition of Visual Inspection Levels (to be Specified User or User's Agent): Level 1 = Critically Corrosion Resistant Level 2 = Standard Corrosion Resistant | | Maximum Size and Cumulative Sum of Imperfections Allowed After Repair. (See General Notes (a) and (b). Imperfections Subject to Cumulative Sum Limitations are indicated with an asterisk). | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Inner Surface Veil(s), Surfacing Mat | | Interior Layers (-0.125 in. [3 mm] Thick) Mat or Chopped Strand Spray Layers | | Structural Layers Balance of Laminate (Including Outer Surface) | | |
| **Imperfection Name** | **Definition of Imperfection** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Level 1** | **Level 2** | **Notes** |
| **Wrinkles and Creases** | Generally linear, abrupt changes in surface plane caused by laps of reinforcing layers, irregular mold shape, or Mylar® overlap | Max. deviation 20% of wall or 1/16 in. (1.5 mm), which is least | Max. deviation 20% of wall or 1/8 in. (3 mm), which is least | | | Maximum deviation 20% of wall or 1/8 in. (3 mm), whichever is least | | Not to cause a cumulative linear defect (outside defect adding to inside defect) |
| **Allowable Cumulative Sum of Highlighted Imperfections** | Maximum allowable in any square foot (0.9 sq. m) | 3 | 5 | 3 | 5 | 5 | 5 | |
| | Maximum allowable in any square yard (0.8 sq. m) | 16 | 20 | 20 | 30 | 30 | 40 | |

**Note 1:**
Above acceptable criteria apply to condition of laminate after repair and hydro test.

**Note 2:**
Non-catalyzed resin is not permissible to any extent in any area of the laminate.



SUPPL. 4

## S4.13 PRESSURE AND ACOUSTIC EMISSION TESTS

All vessels subject to repairs other than those defined in NBIC Part 3, S4.16.4 shall be tested in accordance with the requirements of the original code of construction. In addition, all structural repairs and alterations shall be pressure tested. All vessels acoustic emission tested as required by the original code of construction shall be retested during the pressure test concentrating on the repaired or altered part of the vessel.

### S4.13.1 PRESSURE GAGES, MEASUREMENT, AND EXAMINATION AND TEST EQUIPMENT

The calibration of pressure gages, measurement, examination and test equipment, and documentation of calibration shall be performed as required by the applicable standard used for construction.

## S4.14 ACCEPTANCE INSPECTION

Before signing the appropriate NBIC report form, the Inspector shall:

a) review the drawings;

b) ensure the secondary bonding was performed in accordance with the original code of construction;

c) witness any pressure or acoustic emission test;

d) ensure that the required nondestructive examinations have been performed satisfactorily; and

e) that the other functions necessary to assure compliance with the requirements of this code have been performed.

### S4.14.1 STAMPING

Stamping requirements for FRP vessels are identified in NBIC Part 3, Section 5.

### S4.14.2 DOCUMENTATION

Documentation requirements for FRP vessels are identified in NBIC Part 3, Section 5.

### S4.14.3 REGISTRATION OF DOCUMENTATION

Organizations performing repairs or alterations under an “R” stamp program shall register such repairs or alterations with the National Board.

### S4.14.4 DISTRIBUTION OF DOCUMENTATION

Distribution of documentation requirements for FRP vessels are identified in NBIC Part 3, Section 5.

## S4.15 PRESSURE TESTING FOR REPAIRS

Except as permitted in e) below, the following requirements apply to all repairs to pressure-retaining items:

a) Repairs shall be pressure tested to 110% of the maximum allowable working pressure stamped on the pressure-retaining item using water or other liquid medium. The Certificate Holder is responsible for all activities relating to pressure testing of repairs.

b) Replacement parts used in repairs shall be pressure tested at the maximum allowable working pressure indicated on the pressure-retaining item being repaired.

c) During a pressure test, where the test pressure will exceed the set pressure of the pressure relief device, the device shall be prepared as recommended by the device manufacturer.

d) Hold time for the examination by the Inspector shall be the time necessary for the Inspector to conduct the examination.

e) When pressure testing using liquids is not practical, other methods shall be used as follows:

   1) The pressure test may be a pneumatic test provided the Certificate Holder has the concurrence of the Inspector, the jurisdictional authority where required, and the owner. Precautionary requirements of the applicable section of the original code of construction shall be followed. In addition, a pneumatic test shall always be monitored by acoustic emission examination.

   2) For vessels designed for vacuum, a vacuum test shall be carried out to the original test vacuum level of the vessel. During the vacuum test, the vacuum source may be left connected to the vessel to compensate for leakage at fittings. All vessels acoustic emission tested, as required by the original code of construction, shall be retested during the vacuum test concentrating on the repaired or altered part of the vessel.

## S4.16 ADDITIONAL REQUIREMENTS FOR REPAIRS

### S4.16.1 SCOPE

This section provides additional requirements for repairs to pressure-retaining items and shall be used in conjunction with NBIC Part 3, S4.1 through S4.14 and S4.18.

### S4.16.2 DRAWINGS

Drawings shall be prepared or modified to describe the repair. Drawings shall include sufficient information to satisfactorily perform the repair.

### S4.16.3 REPAIR PLAN

When repairs other than those defined in NBIC Part 3, S4.16.4 are being made to ASME Section X or RTP-1 stamped equipment, the user shall prepare or cause to have prepared a detailed plan covering the scope of the repair.

a) Engineer Review and Certification

   The repair plan shall be reviewed and certified by an engineer meeting the ASME Section X or RTP-1 criteria for an engineer certifying ASME Section X or RTP-1 compliance of the appropriate calculations contained in the Fabricator's Design Report. The review and certification shall be such to ensure that the work involved in the repair is compatible with the User's Design Specification or User's Basic Requirements Specification and the Fabricator's Design Report. The certification shall also include any drawings and calculations prepared as part of the repair plan.

   **Note:** The engineer qualification criteria of the Jurisdiction, where the pressure vessel is installed should be verified before selecting the Certifying Engineer. The certification shall also include any drawings and calculations prepared as part of the repair plan.

b) Authorized Acceptance

Following review and certification, the repair plan shall be submitted to the Inspector for his review and acceptance. Repairs to pressure-retaining items shall not be initiated without the authorization of the Inspector. Subject to acceptance of the Jurisdiction, the Inspector may give prior approval for routine repairs, provided the Inspector assures that the Certificate Holder has acceptable procedures covering the repairs.

## S4.16.4 ROUTINE REPAIRS

Prior to performing routine repairs, the Certificate Holder should determine that routine repairs are acceptable to the Jurisdiction where the work is to be performed.

a) Acceptable routine repairs are listed below:

1) The addition or repair of non-load bearing attachments to pressure-retaining items where post curing is not required.

2) Replacement and repair of damaged corrosion liner areas in shells and heads shall not exceed 100 sq. in. (65 sq. cm) and not exceed the original corrosion liner thickness.

b) Routine repairs may be performed under the Certificate Holder's quality system program; however, the requirement for in-process involvement of the Inspector and stamping are waived. (See NBIC Part 3, Section 5).

c) The process of controlling and implementing routine repairs shall be documented in the Certificate Holder's quality system program.

d) Routine repairs shall be documented on a Form R-1 with a statement on line 10, Remarks: "Routine Repair."

## S4.16.5 REPAIR METHODS

The repair methods shall be acceptable to the Inspector. Some methods of repair are contained in NBIC Part 3, S4.18.

## S4.17 ADDITIONAL REQUIREMENTS FOR ALTERATIONS

## S4.17.1 SCOPE

This Section provides additional requirements for alterations to pressure-retaining items, and shall be used in conjunction with NBIC Part 3, S4.1 through S4.14 and S4.18.

## S4.17.2 DESIGN

The Certificate Holder performing alterations shall establish controls to ensure that all required design information, applicable drawings, design calculations, specifications and instructions are prepared, obtained, controlled, and interpreted to provide the basis for an alteration in accordance with the original code of construction. When a *Fabricator's Data Report* is required by the original code of construction, a copy of the original data report shall be obtained for use in the design of the alteration. When the original *Fabricator's Data Report* cannot be obtained, agreements on the method of establishing design basis for the alteration shall be obtained from the Inspector and the Jurisdiction.

### S4.17.3 ALTERATION PLAN

The user shall prepare, or cause to have prepared, a detailed plan covering the scope of the alteration.

a) Engineer Review and Certification

The alteration plan shall be reviewed and certified by an engineer meeting the ASME Section X or RTP-1 criteria for an engineer certifying ASME Section X or RTP-1 compliance of the appropriate calculations contained in the Fabricator's Design Report. The review and certification shall be such as to ensure that the work involved in the alteration is compatible with the user's design specification and the *Fabricator's Data Report*.

**Note:** The engineer qualification criteria of the jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

b) Authorized Acceptance

Following review and certification, the alteration plan shall be submitted to the Inspector for his review and acceptance. Alterations to pressure-retaining items shall not be initiated without the authorization of the Inspector.

### S4.17.4 CALCULATIONS

A set of calculations shall be completed prior to the start of any physical work. All design work shall be completed by an organization experienced in the design portion of the standard used for the construction of the item. All calculations for ASME Code Section X and RTP-1 alterations shall be certified by an engineer meeting the ASME Section X criteria for an engineer certifying ASME Section X compliance of the calculations contained in the Fabricator's Design Report. All calculations shall be made available for review by the Inspector.

**Note:** The engineer qualification criteria of the jurisdiction where the pressure vessel is installed should be verified before selecting the certifying engineer.

### S4.17.5 RE-RATING

a) Re-rating of a pressure-retaining item by increasing the maximum allowable working pressure (internal or external) or temperature , or decreasing the minimum temperature shall be done only after the following requirements have been met to the satisfaction of the Jurisdiction at the location of the installation:

1) Revised calculations verifying the new service conditions shall be prepared in accordance with the Certificate Holder's Quality Control System. Re-rating calculations for ASME Code Section X and RTP-1 vessels shall be performed by a Professional Engineer experienced in the design of reinforced plastic pressure vessels;

2) All re-rating shall be established in accordance with the requirements of the construction standard to which the pressure-retaining item was built;

3) Current inspection records shall verify that the pressure-retaining item is satisfactory for the proposed service conditions;

4) The pressure-retaining item shall be pressure tested, as required, for the new service conditions.

b) This code does not provide rules for de-rating pressure-retaining items; however, when the MAWP and/or allowable temperature of a pressure-retaining item is reduced, the Jurisdiction wherein the object is installed should be contacted to determine if specific procedures should be followed.

## S4.17.6 PRESSURE TESTING

Except as permitted in g) below, the following requirements apply for pressure testing of alterations to pressure-retaining items:

a) When the alteration activity involves the installation of a replacement part and/or the alteration will impact the design pressure, the design temperature, or the design rated capacity, a pressure test, as required by the original code of construction, shall be conducted. An acoustic emission test is also required if the original vessel was so tested, unless a nozzle whose diameter is one-tenth the vessel diameter or less is being added.

   The Certificate Holder is responsible for all activities related to pressure testing of replacement parts. The pressure test may be performed at the point of manufacture or point of installation.

b) The pressure test of replacement parts and connecting secondary bonds shall be tested at 1.1 times the maximum allowable working pressure or the original test pressure, whichever is greatest.

c) During the pressure test, where the test pressure will exceed the set pressure of the pressure relief device, the device shall be prepared as recommended by the device manufacturer.

d) The liquid temperature used for pressure testing shall not be less than 40°F (4°C) nor more than 120°F (49°C) unless the original pressure test was conducted at a higher temperature. If an acoustic emission examination is being conducted, the temperature of the test liquid shall not vary by more than plus 5°F (-15°C) or minus 10°F (-12°C).

e) Hold time for the pressure test shall be a minimum of 30 minutes with an acoustic emission examination or a minimum of four hours without an acoustic emission examination. The following procedure shall be used to retest a vessel that has been tested under the provisions of Article 6 of ASME Section X and has subsequently been repaired.

   1) Load the vessel as specified in Article 6 of ASME Section X without monitoring for acoustic emission.

   2) Hold the maximum load for at least 30 minutes.

   3) Condition the vessel by holding at reduced load as required by Section V, Article 11, T-1121.

   4) Retest the vessel as required by this supplement.

   5) The vessel shall be judged against the evaluation criteria for subsequent loadings.

f) Hold time for the examination by the Inspector shall be the time necessary for the Inspector to conduct the inspection.

g) When pressure testing using liquids is not practical, other methods shall be used as follows:

   1) The pressure test may be a pneumatic test provided the Certificate Holder has the concurrence of the Inspector, the jurisdictional authority where required, and the owner. Precautionary requirements of the applicable section of the original code of construction shall be followed.

   2) For vessels designed for vacuum, a vacuum test shall be carried out to as close as practical to the design vacuum level of the vessel. During the vacuum test the vacuum source may be left connected to the vessel to compensate for leakage at fittings. All vessels originally acoustic emission tested shall be retested during the vacuum test concentrating on the repaired or altered part of the vessel.

## S4.18 REPAIR AND ALTERATION METHODS

### S4.18.1 GENERAL REQUIREMENTS

a) In general, when a defective or damaged vessel wall is to be repaired, the total structural laminate sequence of laminate construction removed as part of the repair shall be replaced. The replacement laminate shall provide structural properties meeting or exceeding the requirement of the original construction standard. Moreover, when damage includes the corrosion barrier, a corrosion barrier of the same type, which shall meet or exceed the barrier properties of the original construction, shall replace the corrosion barrier removed as part of the repair.

b) The repair or alteration shall meet the requirements of the original construction standard.

### S4.18.2 CLASSIFICATION OF REPAIRS

a) Vessel repairs shall be classified into the following types:

1) Type 1a — Corrosion barrier repairs;

2) Type 1b — Corrosion barriers with precision bores;

3) Type 2 — Corrosion barrier and interior structural layer repairs;

4) Type 3 — External structural layer repairs;

5) Type 4 — Alterations;

6) Type 5 — Miscellaneous general external repairs or alterations;

7) Type 6 — Thermoplastic repairs; and

8) Type 7 — Gel coat repairs.

b) Each type of repair shall have its own corresponding general repair procedure as given in the following paragraphs.

#### S4.18.2.1 TYPE 1A — REPAIR OF THE CORROSION BARRIER

a) A corrosion barrier that has been exposed to a process may be permeated to the point that in some cases the entire corrosion barrier laminate may need to be removed.

b) After the Inspector has verified that the repair procedure is acceptable, the repair shall be performed by the Certificate Holder as follows:

1) Surface Preparation

a. The surface area that is damaged must be removed by abrasive blasting or grinding, to remove contaminated laminate and expose sound laminate. The edge of the repaired area must have a bevel of 2 in. (50 mm) minimum.

b. Note that any cracks, delaminations, or permeated surface must be removed. An adequate size abrasive, or proper sanding disc must be used to obtain a 0.002 to 0.003 in. (0.05 to 0.08 mm) anchor pattern.

c. Preparation of any surface requires that basic rules, common to all substrates, be followed. These rules are as outlined below:

1. Surface must be free of contaminants;
2. Surface must be structurally sound;
3. Surface must have adequate anchor pattern;
4. Surface must be dry;
5. Surface must be primed with recommended primer.

**Note**: After the surface has been properly prepared, it must be kept clean and dry until laminating can be started. Dust, moisture, or traces of oil that come in contact with the surface may act as a mold release or inhibit the cure and prevent a good secondary bond.

2) Applying Test Patches to Verify Adequate Surface Preparation

a. Test patches should be applied to any substrate that will require a secondary bond to determine the integrity of the primer bond prior to the application of the laminate.

b. The subsequent steps shall be followed:

1. Apply the primer (0,003 -0.005 in. (0.08 to 0.13 mm)) to the prepared surface, and allow primer to cure.
2. Coat the primed surface with the same resin to be used in the laminate repair. Apply 4 in. (100 mm) x 14 in. (360 mm) piece of polyester, such as Mylar®, strip to one edge of primed area. Allow the polyester film to protrude from beneath the patch.
3. Apply two layers of 1-1/2 oz/sq. ft (0.46 kg/sq. m) chopped strand mat saturated with the same resin that will be used for the repair. Mat shall be 12 in. (305 mm) x 12 in. (305 mm) square.
4. Allow the mat layers to cure completely, this may be verified by checking the hardness of the laminate.
5. Pry patch from surface using a screwdriver, chisel, or pry bar.
6. A clean separation indicates a poor bond.
7. Torn patch laminate or pulled substrate indicates that the bond is acceptable.

c. If the bond is not adequate, go back to step a) and repeat the procedure.

**Note:** If the repair area is smaller than the test patch dimensions, decrease the test patch size accordingly.

d. As a last resort, if the previous procedure does not provide an adequate bond, the permeated laminate must be handled differently using the following procedure:

1. Hot water wash the equipment.
2. Abrasive blast with #3 sand, or equal, and allow to completely dry.
3. Prime with the recommended primer, an area 12 in. (305 mm) x 12 in. (305 mm) and apply a test patch.
4. Prime a second spot 12 in. (305 mm) x 12 in. (305 mm) and prime with a recommended epoxy resin primer.
5. Allow this primer to cure.

6. Water wash, dry, and lightly abrasive blast the epoxy primer.

7. Apply the test patches to both areas.

e. Pull both test patches after they are fully cured.

f. If both test patches are good, prime the vessel with the preferred primer. If only one test patch is good, prime the vessel with the successful primer.

**Note:** If the repair area is smaller than the test patch dimensions, decrease the test patch size accordingly.

g. If neither patch bonds, the vessel is probably not capable of bonding a patch and shall not be repaired.

3) Laminate Repair

a. Repairs can be accomplished by adding back the correct corrosion barrier surface material as specified on the Fabricator's design drawings.

b. All repairs shall be made with the same type of resin and reinforcement materials used to fabricate the original vessel corrosion barrier. Laminate quality shall be in accordance with Table S4.12. The acceptance criteria shall be as agreed by the Certificate Holder and owner or as required by the code of construction.

1. Apply the selected primer (0.003 -0.005 in. (0.08 to 0.13 mm)) and allow to dry to the touch.

2. Continue with the specified laminate using the proper resin and cure. The first layer of chopped strand mat used in the repair shall extend a minimum of 1 in. (25 mm) past the damaged area. The following chopped strand mat layer shall extend a minimum of 1 in. (25 mm) past the first layer, (in this manner, the entire area that was removed will now be filled with the mat layers. If additional layers are required to fill the removed surface, they must be applied), followed by the specified layer(s) of veil. The veil(s) shall extend a minimum of 1 in. (25 mm) past the last chopped strand mat layer.

3. Apply a final coat of resin over entire surfacing veil. This final coat should contain a small amount of wax to prevent air contact, which might inhibit the cure. Allow laminate to achieve the manufacturer's recommended Barcol hardness before finalizing the repair.

**Note:** Apply heat to finalize the cure if hardness is not achieved.

### S4.18.2.2 TYPE 1B — REPAIR OF THE CORROSION BARRIER FOR VESSELS WITH PRECISION BORES

Vessels with precision bores are commonly used when a device is installed inside the vessel and a seal between the device and the inside diameter is required. A corrosion barrier of a precision bore vessel is (susceptible) to scratching and damage that may affect performance and service life of the vessel or the device placed inside the vessel. Many times this damage may extend into areas of the vessel that cannot be reached. Before starting, ensure that the damaged area can be reached. After the Inspector has verified that the repair procedure is acceptable, the repair shall be performed by the Certificate Holder as follows:

a) Surface Preparation

1) The surface area that is damaged must be removed by abrasive blasting or grinding, to expose sound laminate. No more than 0.020 in. (0.51 mm) may be removed from the wall of the vessel. The repaired area shall be beveled into the good areas surrounding the damage.

2) Note that any cracks, delaminations, or permeated surfaces must be removed. If the damage is deeper than the corrosion barrier and the material removed reaches the structural laminate, the vessel is not repairable. An adequate size abrasive, or proper sanding disc must be used to obtain a 0.003 to 0.005 in.(0.05 to 0.08 mm) anchor pattern to the area that requires the repair.

3) Preparation of any surface requires that basic rules, common to all substrates, be followed. These rules are as outlined below:

   a. Surface must be free of contaminants;

   b. Surface must be structurally sound;

   c. Surface must have adequate anchor pattern;

   d. Surface must be dry;

   e. Surface must be primed with recommended primer.

   **Note:** After the surface has been properly prepared, it must be kept clean and dry until laminating can be started. Dust, moisture, or traces of oil that come in contact with the surface may act as a mold release or act to inhibit the cure and prevent a good secondary bond. Laminating should be done within two hours of the surface preparation.

b) Applying Test Patches to Verify Adequate Surface Preparation

1) Test patches may be applied to any substrate that will require a secondary bond to determine the integrity of the bond prior to the application of the laminate.

2) The subsequent steps shall be followed:

   a. Apply the primer ((0.003 to 0.005 in. [0.08 to 0.13 mm]) to the prepared surface, and allow primer to cure;

   b. Coat the surface with the same resin to be used in the laminate repair. Apply a small strip of polyester film, such as Mylar®, strip to one edge of primed area. Allow the polyester film to protrude from beneath the patch;

   c. Apply two layers of 1-1/2 oz. per sq. ft. (0.46 kg per sq. m) chopped strand mat saturated with the same resin that will be used for the repair;

   d. Allow the mat layers to cure completely; this may be verified by checking the hardness of the laminate. If required, heat may be used to cure the material providing it is compatible with the initial resin used in the fabrication of the vessel;

   e. Pry patch from surface using a screwdriver, chisel, or pry bar;

   f. A clean separation indicates a poor bond;

   g. Torn patch laminate or pulled substrate indicates that the bond is acceptable;

   h. If the bond is not adequate, go back to step a) and repeat the procedure again.

   **Note:** If the repair area is smaller than the test patch dimensions, decrease the test patch size accordingly.

3) If neither patch bonds, the vessel is probably not capable of bonding a patch and shall not be repaired.

c) Laminate repair

1) Repairs can be accomplished by adding back the correct corrosion barrier surface material as specified on the Fabricator's design drawings.

2) When possible, repairs shall be made with the same type of resin and reinforcement materials used to fabricate the original vessel corrosion barrier. Laminate quality shall be in accordance with Table S4.12, or the original code of construction. However, when the original material of construction was gelled and post cured at elevated temperatures, using the same resin may not be possible. In this case an alternate resin system may be used.

a. Apply the selected primer (0.003 to 0.005 in. [0.08 to 0.13 mm]) (as required for polyester and vinyl ester resins) and allow to dry to the touch.

b. Continue with the specified laminate using the proper resin and cure. The first layer of non-woven polyester veil used in the repair shall extend to the exact edge of the damaged area. If additional layers are required to fill the removed surface, they must be applied, followed by the specified layer(s) of veil.

c. Apply a final coat of resin over entire surfacing veil. If this final coat is a vinyl ester or polyester material, it should contain a small amount of wax to prevent air contact, which might inhibit the cure. Allow laminate to achieve the manufacturer's recommended Barcol hardness before finalizing the repair.

**Note:** Apply heat to finalize the cure if hardness is not achieved.

d. After the repair has been properly cured, remove any excess material with the appropriate sanding tools to obtain a smooth surface that blends into the surrounding area. Care should be taken to ensure that the final inside diameter of the repaired area matches that of the surrounding area and also conforms to the original supplier's specifications.

### S4.18.2.3 TYPE 2 — CORROSION BARRIER AND INTERNAL STRUCTURAL LAYER REPAIRS

a) The procedure for the Type 1a repair must be followed with the exception of additional layers (structural layers) that must be removed if the structure is also damaged. The repair area must be tapered similar to the Type 1a, and all of the structural layers must be replaced making sure that the mat layers increase in length and width by at least 1 in. (25 mm). The structural laminate sequence and thickness must be approved by the Inspector, and proper calculations and the repair plan must be reviewed and approved by a Professional Engineer familiar with the work involved prior to the job.

b) Surface preparation, priming, and laminate repair must be done per Type 1a procedure.

### S4.18.2.4 TYPE 3 — EXTERNAL STRUCTURAL LAYER REPAIRS

a) Surface Preparation

1) The surface area that is damaged is to be repaired by removing the damaged area either by abrasive blasting or grinding to expose sound laminate. The repair area must have a bevel of 2 in. (50 mm) minimum. The ground or blasted surface must extend a minimum of 4 in. (100 mm) past the damaged area into the sound solid structural laminate (making sure that no layers are removed in these 4 in. (100 mm), or as calculated accordingly).

2) Note that any cracks or delaminations must be removed. An adequate size abrasive or proper sanding disc must be used to obtain a (0.003 to 0.005 in. [0.05 to 0.08 mm]) anchor pattern.

3) Preparation of any surface requires that basic rules, common to all substrates, be followed. These rules are as outlined below:

a. Surface must be free of contaminants;

b. Surface must be structurally sound;

c. Surface must have adequate anchor pattern;

d. Surface must be dry; and

e. Surface must be primed with recommended primer.

**Note:** After the surface has been properly prepared, it must be kept clean and dry until laminating can be started. Dust, moisture, or traces of oil that come in contact with the surface may act as a mold release or inhibit the cure and prevent a good secondary bond. Laminating should be done within two hours of the surface preparation.

b) Applying Test Patches to Verify Adequate Surface Preparation

1) Test patches may be applied to any substrate that will require a secondary bond to determine the integrity of the primer bond prior to the application of the laminate.

2) The subsequent steps shall be followed:

a. Apply the primer (0.003 to 0.005 in. [0.08 to 0.13 mm]) to the prepared surface, and allow primer to cure;

b. Coat the primed surface with resin to be used in the repair. Apply a 4 in. (100 mm) x 14 in. (350 mm) Mylar® strip to one edge of primed area. Allow polyester film to protrude from beneath the patch;

c. Apply two layers of 1-1/2 oz. per sq. ft. (458 g/m$^2$) chopped strand mat saturated with the specified resin that will be used for the repair. Mat shall be 12 in. (305 mm) x 12 in. (305 mm) square;

d. Allow to cure completely; this may be verified by checking the hardness of the laminate;

e. Pry patch from surface using a screwdriver, chisel, or pry bar;

f. A clean separation indicates a poor bond;

g. Torn patch laminate or pulled substrate indicates that the bond is acceptable; and

h. If the bond is not adequate, go back to step one and prepare the surface again.

**Note:** If the repair area is smaller than the test patch dimensions, decrease the test patch size accordingly.

c) Laminate Repair

1) Repairs can be accomplished by adding back the correct equivalent contact molded laminate material as specified on the Fabricator's design drawings, or in the Repair Plan.

2) All repairs shall be made with the same type of resin and reinforcement materials used to fabricate the original vessel. Laminate quality shall be in accordance with the original construction code as specified in the vessel drawings and specifications.

a. Apply the selected primer (0.003 to 0.005 in. [0.08 to 0.13 mm]) and allow to dry to the touch.

b. Continue with the specified laminate using the proper resin and cure.

c. Fill the removed layers with the same sequence as the original structural thickness, making sure that the layers are increasingly larger as the laminate is applied (in the case of filament wound structure, an equivalent contact molded thickness must be used for the repair calculations). The first bond of the repair shall cover one degree times the width in the axial direction and shall be centered. The repair shall extend completely around the circumference using contact molded procedures as set forth in the code of construction.

d. After the area is completely filled with the proper laminate, a reinforcing laminate shall be applied over the entire surface with a minimum overlap of 4 in. (100 mm) over the original shell, or as shown in the calculations, whichever is greater. This overlay thickness shall be calculated in the same way as the reinforcing pad of a nozzle with the diameter equal to the damaged area. The design shall be in accordance with the original construction code. Allow the laminate to achieve the manufacturer's recommended Barcol hardness before finalizing the repair.

   **Note:** Apply heat to finalize the cure if hardness is not achieved.

e. A pressure test shall be performed per NBIC Part 3, 4.4.1.

### S4.18.2.5 TYPE 4 — ALTERATIONS

a) Alterations, such as the addition of a nozzle or supports, must be designed according to the original construction standard. In the case of nozzles, the internal overlay is required according to ASME RTP-1 Figure 4-8 or 4-9 (overlay "ti"). The procedure for preparing the inside surface is the same as the Type 1 repair. The external reinforcing pad shall be designed and installed according to the original construction standard. Surface preparation for the external overlay shall be according to the Type 3 repair procedure.

b) After the alteration is completed, a pressure test shall be performed in accordance with NBIC Part 3, 4.4.1. As an option, an Acoustic Emission test can be performed to monitor the repaired area during the pressure test.

### S4.18.2.6 TYPE 5 — MISCELLANEOUS GENERAL EXTERNAL REPAIRS OR ALTERATIONS

External repairs or alterations that are performed on nonpressure retaining parts, shall be calculated according to the original construction standard. The Inspector and the Professional Engineer must review and approve such modifications. All repairs and alterations shall be done according to the Type 3 repair procedure, with the exception of removing damaged layers from the structure. Surface preparation shall be restricted to the external layer of the vessel.

### S4.18.2.7 TYPE 6 — THERMOPLASTIC REPAIRS

a) The surface area that is damaged must be reconditioned so that the thermoplastic liner geometry matches that of its contacting laminate. Surfaces that are cut or torn, or missing sections, shall be repaired by plastic welding. Welding practice, including choice of welding equipment, weld surface preparation, and weld temperature shall conform to Appendix M-14 of ASME RTP-1. For materials not specified in these documents, the best practice as recommended by the material supplier shall be used. Welding rod, pellets, powder, or plates shall be made with plastic of an identical type with properties such as melt index and specific gravity as close as possible to the original corrosion barrier plastic.

b) Thickness of the repaired barrier between the wetted surface and the original surface shall be equal to or greater than the original corrosion barrier surface specification.

c) The repaired surface shall be capable of supporting the full pressure rating of the vessel at the temperature rating of the vessel with no fluid leakage.

### S4.18.2.8 TYPE 7 — GEL COAT REPAIRS

Following restoration of the structural laminate layers, a gel coat shall be applied to replace the gel coat lost in the repair. The procedure for the Type 1 repair item a) surface preparation shall be followed. Gel coat of the same type is then to be applied to the surface. Gel coat thickness is to be checked with a wet thickness gage at each 36 sq. in. (23,200 sq. mm) area element. Thickness shall be equal to or greater than the original gel coat specification in the "as manufactured" state of the vessel. The entire repair surface, including all seams, shall be coated. There shall be at least a 3 in. (75 mm) overlap of gel coat at the union of repaired surface and nonrepaired surface.

## SUPPLEMENT 5
## GENERAL REQUIREMENTS FOR REPAIRS AND ALTERATIONS TO YANKEE DRYERS

### S5.1 SCOPE

This supplement provides additional requirements for repairs and alterations to Yankee dryer pressure-retaining components and shall be used in conjunction with inspection requirements identified in NBIC Part 2, *Inspection* Supplement 5.

### S5.2 EXAMINATIONS AND TEST METHODS

In addition to the requirements of NBIC Part 3, 4.4.1 and 4.4.2, the following are recommended:

a) Acoustic emission testing; and

b) Metallographic examination when thermal damage is suspected due to operational or repair activities.

### S5.3 YANKEE DRYER REPAIR METHODS

This supplement provides additional requirements for repair methods to Yankee Dryer pressure-retaining components and shall be used in conjunction with NBIC Part 3, Section 2 through 5 of this part, as appropriate.

### S5.3.1 REPLACEMENT PARTS FOR YANKEE DRYERS

a) Yankee dryer replacement pressure-retaining parts shall be fabricated in accordance with the manufacturer's design and the original code of construction. Yankee dryer pressure-retaining parts may include:

   1) shell;

   2) heads;

   3) center shaft, stay, or trunnion;

   4) stay bars;

   5) structural bolting; and

   6) journals.

b) Replacement of nonpressure-retaining parts, when different from the manufacturer's design, shall be evaluated for any possible effect on the pressure-retaining parts.

### S5.4 REPAIR GUIDE FOR YANKEE DRYERS

a) Welding or brazing shall not be used on any Yankee dryer pressure-retaining component manufactured from cast iron. The *Manufacturer's Data Report* shall be carefully reviewed to determine the material of construction of each Yankee dryer component such as shell, heads, and journals.

b) Structural deterioration or damage caused by corrosion, thinning, or cracking shall not be repaired until its extent has been determined by suitable nondestructive examination.

c) The user shall have a plan covering the scope of the repair. The plan shall ensure that the work involved is compatible with the original design specification and good engineering practices.

d) All repair work shall be documented.

## S5.5 PROCEDURES THAT DO NOT REQUIRE STAMPING OR NAMEPLATE ATTACHMENT

All repair procedures, shall be acceptable to the Inspector, and when verified by the owner-user to not affect pressure-retaining capability of the Yankee dryer, do not require stamping or nameplate attachment. Examples of repairs are:

a) Grinding and machining:

  1) removal of shell overhung flange;

  2) removing bolt-stop ring for test specimens;

  3) head/shell joint corrosion removal;

  4) journal grinding;

  5) shell surface grinding (crowning);

  6) crack removal;

  7) head flange OD reduction;

  8) back spot facing of flange surfaces (head, shell, journal).

b) Metallizing (full face, spot, edge):

  1) applying a metallized coating;

  2) grinding of a metallized coating.

c) Epoxy (sealant) repair of steam leaks at bolted joints (using fittings and pumping bolts) and epoxy filling of surface imperfection;

d) Installation of spoiler bars;

e) Maintain/repair/replace internal condensate removal system;

f) Driven plug repair when completed as described in NBIC Part 3, S5.6.3;

g) Threaded plug repair when completed as described in NBIC Part 3, S5.6.4.

## S5.6 DAMAGE REPAIR

### S5.6.1 REPAIR OF LOCAL THINNING

a) A Local Thin Area (LTA) may develop in a pressure-retaining part or may result from the original casting process. Inservice thin areas may result from mechanical wear, erosion-corrosion caused by steam and condensate flow, corrosion, impact damage, or grinding for the removal of material flaws.

b) Evaluation of thinning for repair shall consider the unique design and loading characteristics of the Yankee dryer. Local thin areas are often analyzed as specific cases by the finite element method.

1) When a LTA is evaluated by finite element method, analysis should consider the location of the thin area and account for strength provided by the vessel center shaft and heads in addition to the strength provided by the shell alone. Such structural analysis should consider all relevant loads to ensure safe operation of the shell according to the De-rate Curve, or other pressure-retaining parts as indicated on the original *Manufacturer's Data Report*.

2) Following evaluation and determination of maximum allowable operating parameters, an LTA can be coated or filled to prevent further wear or deterioration. Grooves and gouges should always be lightly ground to remove sharp notches and edges. Welding or brazing repairs are NOT permitted on cast-iron pressure-retaining components.

3) Where the LTA is of sufficient size to cause a reduction in maximum allowable operating parameters according to the De-rate Curve, an R-2 form shall be submitted.

4) Depending upon the cause of the LTA, further monitoring may be necessary to ensure deterioration has been arrested.

5) Inspection data, including all thickness readings and corresponding locations used to determine the minimum and average thicknesses, and the accompanying stress analysis, should be included in the documentation and retained for the life of the vessel.

## S5.6.2 TREATMENT OF CRACK-LIKE FLAWS

a) Crack-like flaws are planar flaws that are predominantly characterized by a length and depth with a sharp root radius. They may either be embedded or surface breaking. In some cases it may be advisable to treat volumetric flaws, such as aligned porosity, inclusions, and laps, as planar flaws, particularly when such volumetric flaws may contain microcracks at the root.

1) Knowledge of local stress level and classification, and of flaw origin, type, size, location, and angle relative to the principal stress direction is essential in making determinations regarding remediation. It is also important to know whether the crack is active. Acoustic Emissions testing can be used to determine if the crack is active. Various other methods of nondestructive examination should be employed to determine crack length and depth. Ultrasonics is the recommended sizing technique for depth and inclination of crack-like flaws. Magnetic particle, specifically the wet fluorescent technique, and liquid penetrant methods are applicable in determining the length of a surface flaw. Radiographic methods may also be useful. Metallographic analysis is crucial in differentiating between original casting flaws and cracks.

2) Evaluation of crack-like flaws, that have been determined to be cracks is most often accomplished through removal via grinding or machining. Because cast iron is categorized as a brittle material, this is the conservative approach regarding crack-like flaws. Welding or brazing repairs are not permitted for cast-iron parts. Metal-stitching is permitted as a repair. However this method of repair requires evaluation as to whether a reduction in allowable operating conditions is required. This evaluation shall be performed by the manufacturer or by another qualified source acceptable to the Inspector.

3) Crack-like flaws that have been identified as cracks, but which developed from normal service exposure or excessive operating conditions, shall be remediated by appropriate means regardless of location.

4) Crack-like flaws that have been identified as cracks that developed through non-standard load events, such as by water hoses from operation or firefighting or mechanical damage, shall be remediated if in the shell. Cracks in other pressure-retaining parts shall be analyzed, documented, and monitored to ensure their presence will not be, or has not been, affected by current operating conditions.

5) Crack-like flaws that are not identified as cracks, but which existed in the original material, i.e., material flaws, shall be analyzed, documented, and monitored to ensure their presence will not be, or have not been, affected by current operating conditions.

b) All documents pertaining to the crack-like flaw assessment shall be retained for the life of the vessel. Documentation should address the engineering principles employed, including stress analysis methods and flaw sizing, the source of all material data used, identification of any potential material property degradation mechanisms and the associated influence on the propagation of flaw, and the criteria applied to the assessment procedures.

### S5.6.3 DRIVEN PLUG REPAIR

Shell surface imperfections should be repaired with smooth, driven plugs as described in ASME Section VIII, Div. 1, UCI-78, with the following additional requirements:

a) Maximum plug length (depth) shall be limited to 20% of shell effective thickness, and plug diameter shall not exceed the plug length (depth);

b) Total surface area of plugs shall not exceed 4 sq. in. in an 8 in. diameter circle (2580 sq. mm in a 200 mm diameter circle);

c) Average number of shell plugs shall not exceed 1 plug per 1 sq. ft. (1 plug per 0.1 sq. m) of the surface;

d) The land distance between edges of plugs shall be at least equal to the diameter of the larger plug;

e) The plug material shall conform in all respects to the material specification of the base material;

f) The installed plug shall have an interference fit. The average hole diameter is determined after the plug hole is drilled or reamed. The maximum plug diameter shall not exceed 1.012 times the average hole diameter. This provides an interference fit while minimizing the residual stresses;

g) All plug repair work shall be documented in the form of a plug repair map or other suitable method of recording and retained in the dryer's permanent file.

### S5.6.4 THREADED PLUG REPAIR

Casting defects, leaks and local thin areas should be repaired with threaded plugs as described in ASME Section VIII, Division 1, UCI-78 with the additional requirement that a threaded plug shall not be used in an area subject to dynamic loading (e.g.,Yankee dryer shell) as determined by the manufactuter or another qualified source acceptable to the Inspector.

## S5.7 ALTERATIONS TO YANKEE DRYERS

### S5.7.1 SCOPE

This supplement provides additional requirements for alterations to Yankee dryer pressure-retaining components and shall be used in conjunction with NBIC Part 3, Sections 2 through 5, as appropriate.

### S5.7.2 ALTERATION TYPES

a) Any change in the Yankee dryer (shell, heads, center shaft, fasteners), as described on the original *Manufacturer's Data Report*, which affects the pressure-retaining capability, shall be considered an alteration. Examples of alterations are:

1) Drilling/enlarging of bolt holes in castings for larger diameter bolts;

2) Replacement of structural bolts differing in size, material, or design, from those described on the *Manufacturer's Data Report*;

3) Removal of shell overhung flange;

4) Journal machining;

5) Head flange outside diameter reduction;

6) Machining of head flange or shell flange surface to remove corrosion; and

7) Operating above the nameplate temperature.

b) Alteration procedures shall be written, reviewed, approved, and accepted by the Inspector prior to the start of work.

# SUPPLEMENT 6
# REPAIR, ALTERATION, AND MODIFICATION OF DOT TRANSPORT TANKS

## S6.1 SCOPE

This supplement provides general requirements that apply to the repairs, alterations, or modifications to DOT Transport Tanks used for the transportation of dangerous goods via highway, rail, air, or water.

## S6.2 CONSTRUCTION STANDARDS

When the standard governing the original construction is the ASME Code or other regulations of the Competent Authority, repairs, alterations, or modifications shall conform, insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practical, it is permissible to use other codes, standards or specifications, including the ASME Code provided the "TR" Certificate Holder has the concurrence of the Inspector or the Competent Authority.

## S6.3 ACCREDITATION

Organizations performing repairs, alterations, or modifications shall be accredited as in accordance with the National Board "TR" Program.

## S6.4 MATERIALS

The materials used in making repairs, alterations, or modifications shall conform to the original code of construction including the material specification requirements. Carbon or alloy steel having a carbon content of more than 0.35% (0.30% for ton tanks) shall not be welded unless permitted by the original code of construction. The "TR" Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the material to be installed.

## S6.5 REPLACEMENT PARTS

a) Replacement parts that will be subject to internal or external pressure that consist of new material which may be formed to the required shape by spinning, forging, die forming, and on which no fabrication welding is performed shall be supplied as material. Such parts shall be marked with the material and part identification and the name or trademark of the parts manufactured. In lieu of full identification marking on the material or part, the part manufacturer may use a coded marking system traceable to the original marking. Such markings shall be considered as the part manufacturer's certification that the part complies with the original code of construction. Examples include seamless or welded tube or pipe, forged nozzles, heads or subassemblies attached mechanically.

b) Replacement parts that will be subject to internal or external pressure, that are preassembled by attachment welds, shall have the welding performed in accordance with the original code of construction. This certificate shall be supplied in the form of a bill of material or drawings with statement of certification.

c) Replacement parts subject to internal or external pressure fabricated by welding that require shop inspection by an Authorized Inspector shall be fabricated by an organization having an appropriate ASME *Certificate of Authorization*. The item shall be inspected and stamped as required by the applicable section of the ASME Code and DOT specification requirements. A completed ASME *Manufacturer's Partial Data Report* shall be supplied by the manufacturer.

d) When the original code of construction is other than ASME, replacement parts subject to internal or external pressure fabricated by welding shall be manufactured by an organization certified as required by the original code of construction. The item shall be inspected and stamped as required by the original code of construction. Certification to the original code of construction as required by the original code of construction or equivalent shall be supplied with the item. When this is not possible or practicable the organization fabricating the part may have a National Board *Certificate of Authorization*. Replacement parts shall be documented on Form TR-1 and the "TR" Stamp applied as described in NBIC Part 3, S6.14.

## S6.6 AUTHORIZATION

The Inspector's written authorization to perform a repair, alteration, or modification shall be obtained prior to initiation of the repair or modification to a transport tank.

## S6.7 INSPECTION

Inspection and certification shall be made by an Inspector employed by one of the following:

a) An organization authorized and recognized by the Competent Authority.

b) The Authorized Inspection Agency of the "TR" Certificate Holder making the repair or modification.

## S6.7.1 INSPECTOR DUTIES FOR REPAIRS, ALTERATIONS, AND MODIFICATIONS

a) Repair Organizations that possess the National Board "TR" *Certificate of Authorization* and DOT's Cargo Tank Registration (CTR) number when applicable shall use inspection services of a Registered Inspector while performing repairs, or Modifications of Transport Tanks. The Registered Inspector must have satisfied the following requirements:

1) Has satisfied DOT requirements as a Registered Inspector.

2) Has successfully completed the National Board's Web-based training program for Registered Inspectors and has been issued a National Board *Certificate of Completion*.

3) Has received authorization from DOT as a Registered Inspector.

4) Has been registered by DOT for the Classification(s) of Transport Tanks to be inspected.

b) Inspectors performing repair or modification inspections under the requirements of this supplement shall satisfy the requirements of S6.7.1 to be authorized to sign the Form TR-1, *Repairs or Modifications* and Form TR-2, *Supplemental Form*.

c) For repairs and modifications of transport tanks, the duties of the Registered Inspector are detailed in Part 2, S6.10 through S6.15, as required by the Competent Authority.

d) In addition, the duties of the Registered Inspector are summarized below:

1) Verify the organization performing the repair or modification activity is properly accredited and in possession of a current *Certificate of Authorization* to apply the "TR" Stamp issued by the National Board and is working to an approved Quality Control System;

2) Verify that the design, if required, for the modification of the vessel is approved by a Design Certifying Engineer, or Designated Approval Agency or other applicable individual;

3) Verify the materials to be used to make the repair or modification are approved for use and comply with applicable code requirements;

4) Verify the welding procedures and welders or welding operators are properly qualified;

5) Verify that all heat treatments, if required, including PWHT have been performed in accordance with the applicable standards and that the results are acceptable;

6) Verify that all NDE, impact tests, and other tests have been performed when required, and that the results are acceptable;

7) Make a visual inspection of the work performed to confirm there are no visible defects or deviations from code requirements;

8) Perform external and internal visual inspections, if the vessel is equipped with a manway, and witness the hydrostatic or pneumatic pressure test and/or leak tightness test when they are required;

9) Verify the correct nameplate is properly attached to the vessel and that the current test and inspection markings are properly attached and displayed on the proper vessel;

10) Sign the Form TR-1 and, as appropriate, form TR-2.

## S6.8 WELDING

a) Welding shall be performed in accordance with the requirements of the original code of construction used for the fabrication of the pressure vessel. For hydrogen control when low alloy steel filler metals are used, the filler metal classification shall include an H4 supplemental diffusible hydrogen designator (maximum 4 ml [H2]/100 g deposited metal) for each of the following:

   1) electrodes for shielded metal arc welding conforming to SFA-5.5;

   2) electrodes and fluxes for submerged arc welding conforming to SFA-5.26;

   3) electrodes and rods for gas shielded metal arc welding conforming to SFA-5.28;

   4) electrodes for flux-cored arc welding conforming to SFA 5.29.

b) Practices used for controlling storage and exposure of filler metals shall be those developed by the “TR” Certificate Holder or those recommended by the filler metal manufacturer.

### S6.8.1 WELDING PROCEDURE SPECIFICATION

Welding shall be performed in accordance with a Welding Procedure Specification (WPS) qualified in accordance with the original code of construction. When this is not possible or practicable, the WPS may be qualified in accordance with ASME Section IX.

### S6.8.2 STANDARD WELDING PROCEDURE SPECIFICATIONS

A “TR” Certificate Holder may use one or more applicable *Standard Welding Procedure Specifications* shown in NBIC Part 3, 2.3 without supporting *Procedure Qualification Records* (PQRs) since SWPS are pre-qualified and the PQR will not be supplied.

### S6.8.3 PERFORMANCE QUALIFICATION

Welders or welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction or ASME Section IX. Use of Standard Welding Procedures Specification shown in NBIC Part 3.2.3 is permitted for performance qualification testing.

### S6.8.4 WELDING RECORDS

The "TR" Certificate Holder shall maintain a record of the results obtained in welding procedure qualification, except for those qualifications for which the provisions of NBIC Part 3, S6.8.2 are used and of the results obtained in welding performance qualifications. These records shall be certified by the "TR" Certificate Holder and shall be available to the inspector.

### S6.8.5 WELDERS' IDENTIFICATION

The "TR" Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The "TR" Certificate Holder shall also establish a written procedure whereby all welded joints can be identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and be acceptable to the Inspector. The welder's or welding operator's identification mark may be stamped (low stress stamp) adjacent to all welded joints made by the individual or, in lieu of stamping, the "TR" Certificate Holder may keep a record of the welded joints and the welders or welding operators used in making the joint.

### S6.8.6 WELDERS' CONTINUITY

The performance qualification of a welder or welding operator shall be affected when one of the following conditions occurs:

a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire;

b) When there is specific reason to question their ability to make welds that meet the specification, the qualification which supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.



## S6.9 HEAT TREATMENT

### S6.9.1 PREHEATING

Preheating may be employed during welding to assist in completion of the welded joint (see NBIC Part 3, 2.5.1). The need for and the temperature of preheat are dependent on a number of factors such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties of the base metals being joined. The Welding Procedure Specification for the material being welded shall specify the preheat temperature requirements.

### S6.9.2 POSTWELD HEAT TREATMENT

Postweld heat treatment may be performed as required by the original code of construction in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment. Local PWHT that is not specified by the original code of construction may be performed in accordance with an Alternative Postweld Heat Treatment Method described in NBIC Part 3, 2.5.3 with acceptance by the Inspector and required by the Competent Authority.

### S6.9.3 ALTERNATIVES TO POSTWELD HEAT TREATMENT

a) Under certain conditions, postweld heat treatment in accordance with the original code of construction may be inadvisable or impractical. In such instances, alternative methods of postweld heat treatment or special welding methods acceptable to the Inspector and Competent Authority may be used.

b) When the standard governing the original construction is the Code of Federal regulation for DOT/MC 331 cargo tanks for propane, butane, anhydrous ammonia, and other DOT permitted commodities, and the tanks are made to the ASME Code, Section VIII, Division 1, Part UHT, repairs, alterations, or modifications shall conform insofar as possible, to the edition of the construction standard or specification most applicable to the work. Where this is not possible or practicable, it is permissible to use other codes, standards, or specifications provided the "TR" Certificate Holder has the concurrence of the DOT. Shells and heads of MC 331 cargo tanks were made from quenched and tempered alloy steel plate, SA517, Grade E (originally Code Case 1298) and Grade F (originally Code Case 1204) prior to 1994.

c) The 1994 ASME Code Addenda revised UHT-5(b) to permit the joining of UHT materials to UCS or UHA materials in head and shell sections. Propane, butane, and anhydrous ammonia are the most common transported commodities and the shipper is required by DOT to comply with certain composition limitations. Propane and butane transported must have sufficiently low hydrogen sulfide content so as not to exceed the limitations for Classification One of the ASTM D1838-74 copper strip test, and the anhydrous ammonia transported must be inhibited with a minimum water content of 0.2% by weight. In addition, such cargo tanks made for propane, butane, and anhydrous ammonia service must be postweld heat treated, unless specifically exempted by a DOT special permit that exempts PWHT.

## S6.10 NONDESTRUCTIVE EXAMINATION

a) The nondestructive examination (NDE) requirements, including technique, extent of coverage, procedures, personnel qualification, and acceptance criteria, shall be in accordance with the original code of construction used for the pressure vessel, and repairs, alterations, and modifications shall be subjected to the same nondestructive examination requirements as the original welds. Where this is not possible or practicable, alternative NDE methods acceptable to the Inspector and the Competent Authority may be used on a case-by-case basis.

b) NDE personnel shall be qualified and certified in accordance with the requirements of the original code of construction. When this is not possible or practicable, NDE personnel may be qualified and certified in accordance with their employer's written practice. ASNT SNT-TC-1A, *Recommended Practice for Nondestructive Testing Personnel Qualification and Certification*, or ACCP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel*, may be used to fulfill the examination and demonstration requirements of SNT-TC-1A and the employer's written practice. Provisions for qualification and certification of NDE personnel shall be described in the "TR" Certificate Holder's written quality system.

## S6.11 COATINGS AND LININGS

When coatings or linings are to be inspected, such inspections shall be done in accordance with the Structural Steel Painting Council, SSPC publication, No. 91-12, *Coating and Lining Inspection Manual*.

## S6.12 MEASUREMENT, EXAMINATION, AND TEST EQUIPMENT

There shall be a system for calibration of pressure gages, measurement, examination, and test equipment. This system shall be documented.

## S6.13 ACCEPTANCE INSPECTION

The Inspector making the acceptance inspection shall be the same Inspector who authorized the repairs, alterations, or modifications. Where this is not possible or practical, another Inspector may perform the acceptance inspection; however, in all cases, the Inspector who performs the acceptance inspection shall be an employee of the same organization as the Inspector who authorized the repairs, alterations, or modifications.

## S6.14 GENERAL STAMPING REQUIREMENTS

The stamping of or attaching of a nameplate to a pressure-retaining item shall indicate that the work was performed in accordance with the requirements of this code and any requirements of the Competent Authority. Such stamping or attaching of a nameplate shall be done only with the knowledge and authorization of the Inspector and Competent Authority. The "TR" Certificate Holder responsible for the repair or the construction portion of the modification/alteration shall apply the stamping. For a re-rating where no physical changes are made to the pressure-retaining item, the "TR" Certificate Holder responsible for the design shall apply the stamping. Requirements for stamping and nameplate information are shown in NBIC Part 3, Section 5.

## (15) S6.14.1 SPECIFIC "TR" STAMPING AND NAMEPLATE REQUIREMENTS

The holder of a "TR" Certificate of Authorization is required to affix a stamping or nameplate on the Transport Tank that indicates, the repair, alteration, or modification has been performed in accordance with the requirements of NBIC Part 3, Supplement 6 and the additional requirements of the code of construction. All repairs, alterations, and modifications, after acceptance by the Registered Inspector, shall have the "TR" Symbol affixed to the stamping or the nameplate. The stamping or nameplate information shall satisfy the requirements of a) thru g) below:

a) The required data shall be in characters at least 4 mm (5/32 in.) high;

b) The markings may be produced by casting, etching, embossing, debossing, stamping, or engraving;

c) The selected method shall not result in any harmful contamination or sharp discontinuities to the pressure- retaining boundary of the Transport Tank;

d) Stamping directly on the Transport Tank, when used, shall be done with blunt-nose continuous or blunt-nose interrupted dot die stamps. If direct stamping would be detrimental to the item, required markings and the embossed Code Symbol stamping may appear on a nameplate affixed to the Transport Tank;

e) The "TR" Certificate Holder shall use its full name as shown on the Certificate of Authorization or an abbreviation acceptable to the National Board;

f) The non-embossed Code Symbol stamping, when directly applied on the item or when a nameplate is used shall be applied adjacent to the original manufacturer's stamping or nameplate. A single repair, alteration, or modification stamping or nameplate may be used for more than one repair to a Transport Tank, provided the repair, alteration, or modification activity is carried out by the same certificate holder;

g) The date of each repair, alteration, or modification corresponding with the date on the Form TR-1 shall be stamped on the nameplate.

## S6.14.2 REMOVAL OF ORIGINAL STAMPING OR NAMEPLATE

If it becomes necessary to remove the original stamping, the Inspector shall, subject to the approval of the Competent Authority, witness the making of a facsimile of the stamping, the obliteration of the old stamping, and the transfer of the stamping. When the stamping is on a nameplate, the Inspector shall witness the transfer of the nameplate to the new location. Any relocation shall be described on the applicable NBIC "TR" Form. The restamping or replacement of a code symbol stamp shall be performed only as permitted by the governing code of construction.

## S6.15 "TR" FORMS

### S6.15.1 DOCUMENTATION (15)

Repairs, alterations, or modifications that have been performed in accordance with the NBIC shall be documented on Form TR-1, *Report of Repair, Alteration, or Modification*, as shown in NBIC Part 3, Section 5. Form TR-2, *Report Supplementary Sheet*, shall be used to record additional data when space is insufficient on Form TR-1.

### S6.15.2 PREPARATION OF "TR" FORMS (15)

Preparation of "TR" Forms shall be the responsibility of the "TR" Certificate Holder performing the repairs, alterations, or modifications. An Inspector shall indicate acceptance by signing the appropriate "TR" form.

### S6.15.3 DISTRIBUTION (15)

a) Legible copies of the completed Form TR-1 together with attachments shall be distributed to the owner or user, the Inspector, and the Competent Authority, as required, and the Authorized Inspection Agency responsible for the inspection.

b) Distribution of the Form TR-1 and attachments shall be the responsibility of the organization performing the repair.

### S6.15.4 REGISTRATION OF FORM TR-1 AND FORM TR-2 (15)

a) Organizations performing repairs, alterations, or modifications under the "TR" program must register such repairs, alterations, or modifications with the National Board.

b) The repair organization shall maintain a sequential Form "TR" Log that shall identify the following:

   1) Form number assigned for Form TR-1;

   2) Identify if the activity was a repair, alteration, or modification; and

   3) Date sent to the National Board.

## S6.16 ADDITIONAL REQUIREMENTS FOR REPAIRS, ALTERATIONS, OR MODIFICATIONS

### S6.16.1 SCOPE (15)

This section provides additional requirements for repairs, alterations, or modifications to DOT Transport Tank pressure-retaining items and shall be used in conjunction with NBIC Part 3.

### S6.16.2 REPAIRS OF DEFECTS (15)

Before a repair is made to a defect in a welded joint or base metal, care should be taken to investigate its cause and to determine its extent and likelihood of recurrence. This information shall be made available to the Inspector.



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## (15) S6.16.3 MODIFICATIONS

All modifications to the pressure-retaining item shall meet the requirements of NBIC Part 3, Section 6.

## (15) S6.16.4 DRAWINGS

Drawings or instructions shall be prepared to describe the repair, alterations, or modification. Drawings shall include sufficient information to satisfactorily perform the activity.

## (15) S6.16.5 AUTHORIZATION

Repairs, alterations, or modifications to a pressure-retaining item shall not be initiated without the authorization of the Inspector, who shall determine that the repair methods are acceptable and subject to acceptance of the Competent Authority.

## (15) S6.17 EXAMINATION AND TEST

The following requirements shall apply to all repairs, alterations, or modifications to DOT Transport Tank pressure-retaining items:

a) The integrity of repairs and replacement parts used in repairs, alterations, or modifications shall be verified by examination and test;

b) The “TR” Certificate Holder is responsible for all activities relating to examination and test of repair, alterations, or modifications;

c) Examination and tests to be used shall be subject to acceptance of the Inspector and the Competent Authority.

## (15) S6.17.1 METHODS

One, or a combination of the following examination methods, shall be applied to DOT Transport Tank pressure-retaining itmes with the concurrence of the Inspector and the Competent Authority.

a) Liquid Pressure Test

Pressure testing of repairs shall meet the following requirements:

1) Pressure tests shall be conducted using water or other suitable liquid. The test pressure shall be the minimum required to verify the leak tightness integrity of the repair, but not more than 150% of the maximum allowable working pressure (MAWP) stamped on the pressure-retaining item, as adjusted for temperature. When original test pressure included consideration of corrosion allowance, the test pressure may be further adjusted based on the remaining corrosion allowance;

2) During a pressure test where the test pressure will exceed 90% of the set pressure of the pressure relief device, the device shall be removed whenever possible. If not possible, a test gag should be used using the valve manufacturer’s instructions and recommendations; and

3) Hold time for the pressure test shall be a minimum of 10 minutes prior to examination by the Inspector. Where the test pressure exceeds the MAWP of the item, the test pressure shall be reduced to the MAWP for close examination by the Inspector. Hold time for close examination shall be as necessary for the Inspector to conduct the examination.

b) Pneumatic Test

A pneumatic test may be conducted. Concurrence of the owner shall be obtained in addition to that of the Inspector and the Competent Authority where required. The test pressure shall be the minimum required to verify leak tightness integrity of the repair, but shall not exceed the maximum pneumatic test pressure of the original code of construction. Precautionary requirements of the original code of construction shall be followed.

c) Nondestructive Examination

Nondestructive examination (NDE) may be conducted. NDE methods shall be suitable for providing meaningful results to verify the integrity of the repair.

## S6.18 REPAIRS, ALTERATIONS, OR MODIFICATION REPORTS (15)

a) If repairs, alterations, or modifications are performed on a Transport Tank, i.e., cargo tank, portable tank, or ton tank, the owner or User shall have the activity performed by a Repair Organization that has a valid “TR” *Certificate of Authorization* issued by the National Board.

b) The repair, alteration, or modification shall be recorded on the Form TR-1. If additional space is needed to properly record the repair, alteration, or modification, Form TR-2 shall be used.

c) It is the responsibility of the “TR” Symbol Stamp Holder to prepare, distribute, and maintain the Form TR-1 and, if required, Form TR-2. The Form(s) shall be distributed as follows:

   1) Owner or User;

   2) Registered Inspector;

   3) Competent Authority (DOT); and

   4) National Board.

d) The Form TR-1 shall be signed by a Registered Inspector as defined in NBIC Part 3, S6.7.1.

## SUPPLEMENT 7
## REQUIREMENTS FOR REPAIRS TO PRESSURE RELIEF DEVICES

### ~~S7.1 SCOPE~~

~~This supplement provides general requirements that apply to repairs to pressure relief valves. Repairs may be required because of defects found during periodic inspections because testing has identified that valve performance does not meet the original code of construction requirements, failure during operation, or for routine preventative maintenance.~~

### ~~S7.2 GENERAL REQUIREMENTS~~

~~a) Repair of a pressure relief valve is considered to include the disassembly, replacement, re-machining, or cleaning of any critical part, lapping of a seat and disc, reassembly, adjustment, testing, or any other operation that may affect the flow passage, capacity, function, or pressure-retaining integrity.~~

~~b) Conversions, changes, or adjustments affecting critical parts are also considered repairs. The scope of conversions may include changes in service fluid and changes such as bellows, soft seats, and other changes that may affect Type/Model number provided such changes are recorded on the document as required for a quality system and the repair nameplate. (See NBIC Part 3, 5.12.1).~~

~~c) The scope of repair activities shall not include changes in ASME Code status.~~

~~d) When a repair is being performed under the administrative requirements for National Board Accreditation, a repair shall consist of the following operations as a minimum:~~

~~1) Complete disassembly, cleaning, and inspection of parts, repair or replacement of parts found to be defective, reassembly, testing as required by NBIC Part 3, 4.5, sealing and application of a repair nameplate. When completed, the valve's condition and performance shall be equivalent to the standards for new valves.~~

~~2) The administrative requirements for National Board Accreditation apply only to valves that are stamped with an ASME "V," "UV," or "NV" Code symbol or marked with an ASME "HV" symbol and have been capacity certified on the applicable fluid by the National Board.~~

### ~~S7.3 WELD REPAIRS TO PRESSURE RELIEF VALVE PARTS~~

~~a) The Quality System Manual may include controls for the "VR" Certificate Holder to have the pressure relief valve part repaired by a National Board "R" Certificate Holder, per this supplement provided the following documentation is provided to the "R" Certificate Holder:~~

~~1) Code of construction, year built;~~

~~2) Part identification;~~

~~3) Part material specified; and~~

~~4) "VR" Certificate Holder's unique identifier for traceability as required by the Repair Inspection Program.~~

~~b) Prior to performing weld repairs to pressure relief valve (PRV) parts, the "R" Certificate Holder shall receive repair information required by NBIC Part 3, S7.3 a) from the "VR" Certificate Holder responsible for the pressure relief valve repair.~~

1) ~~PRV part weld repairs shall be performed under the “R” Certificate Holder’s quality system; however, the requirements for in-process involvement of the Inspector (see NBIC Part 3, 1.3.2) may be waived. The requirement for stamping is waived.~~

2) ~~The process of identifying and controlling repairs shall be documented in the “R” Certificate Holder’s quality system.~~

3) ~~PRV part repairs shall be documented on a Form R-1 with a statement under Remarks “PRV Part Repair.” The owner’s name and location of installation shall be that of the “VR” Certificate Holder. The information received from the “VR” Certificate Holder as required in NBIC Part 3, S7.3 a) shall be noted under “Description of Work.”~~

4) ~~Upon completion of the repair, the repaired part and completed Form R-1 shall be returned to the “VR” Certificate Holder responsible for completing the PRV repair.~~

## ~~S7.4 MATERIALS FOR PRESSURE RELIEF DEVICES~~

~~The materials used in making repairs shall conform to the requirements of the original code of construction. The “VR” Certificate Holder is responsible for verifying identification of existing materials from original data, drawings, or unit records and identification of the materials to be installed.~~

## ~~S7.5 REPLACEMENT PARTS FOR PRESSURE RELIEF DEVICES~~

a) ~~Critical parts shall be fabricated by the valve manufacturer or to the manufacturer’s specifications. Critical parts are those that may affect the valve flow passage, capacity, function, or pressure-retaining integrity.~~

b) ~~Critical parts not fabricated by the valve manufacturer shall be supplied with material test certification for the material used to fabricate the part.~~

c) ~~Replacement critical parts receiving records shall be attached or be traceable to the valve repair document (see NBIC Part 3, S7.3 a). These records shall conform to at least one of the following:~~

1) ~~Receiving records documenting the shipping origin of the part fabricated by the valve manufacturer (such as packing list) from the valve manufacturer or assembler of the valve type;~~

2) ~~A document prepared by the “VR” Certificate Holder certifying that the replacement part used in the repair has the manufacturer’s identification on the part or is otherwise labeled or tagged by the manufacturer and meets the manufacturer’s acceptance criteria (e.g., critical dimensions found in maintenance manual);~~

3) ~~Receiving records for replacement critical parts obtained from a source other than the valve manufacturer or assembler of the valve type shall include a *Certificate of Compliance* that provides as a minimum:~~

a. ~~The part manufacturer and part designation;~~

b. ~~A certifying statement that either:~~

1. ~~The part was fabricated by the valve manufacturer and meets the manufacturer’s acceptance criteria (e.g., critical dimensions found in maintenance manual), or~~

2. ~~The part meets the manufacturer’s specifications and was fabricated from material as identified by the attached material test report.~~

c. ~~The signature of an authorized individual of the part source;~~

~~d. The name and address of the part source for whom the authorized individual is signing.~~

~~d) Material for bolting shall meet the manufacturer's specification, but does not require material test certification, if marked as required by the material specification.~~

## ~~S7.6 INITIAL ADJUSTMENTS TO PRESSURE RELIEF VALVES~~

~~The initial installation testing and adjustments of a new pressure relief valve on a boiler or pressure vessel are not considered a repair if made by the manufacturer or assembler of the valve.~~

## ~~S7.7 FIELD REPAIR~~

~~Repair organizations may obtain a "VR" *Certificate of Authorization* for field repair, either as an extension to their in-shop/plant scope, or as a field-only scope, provided that:~~

~~a) Qualified technicians in the employ of the certificate holder perform such repairs;~~

~~b) An acceptable quality system covering field repairs, including field audits, is maintained;~~

~~c) Functions affecting the quality of the repaired valves are supervised from the address of record where the "VR" certification is issued.~~

## ~~S7.8 AUDIT REQUIREMENTS~~

~~Upon issuance of a *Certificate of Authorization*, provided field repairs are performed, annual audits of the work carried out in the field shall be performed to ensure that the requirements of the certificate holder's quality system are met. The audit shall include, but not be limited to, performance testing, in accordance with NBIC Part 3, 4.5, of valve(s) that were repaired in the field. The audits shall be documented.~~

## ~~S7.9 USE OF OWNER-USER PERSONNEL~~

~~For the repair of pressure relief valves at an owner-user's facility for the owner-user's own use, the "VR" Certificate Holder may utilize owner-user personnel to assist certificate holder technician(s) in the performance of repairs provided:~~

~~a) The use of such personnel is addressed in the "VR" Certificate Holder's quality system;~~

~~b) The owner-user personnel are trained and qualified in accordance with NBIC Part 3, S7.11;~~

~~c) Owner or user personnel work under direct supervision and control of the "VR" Certificate Holder's technician(s) during any stage of the repair when they are utilized;~~

~~d) The "VR" Certificate Holder shall have the authority to assign and remove owner-user personnel at its own discretion; and~~

~~e) The names of the owner-user personnel utilized are recorded on the document, as required, for a quality system.~~

## ~~S7.10 GUIDE TO JURISDICTIONS FOR AUTHORIZATION OF OWNER OR USERS TO MAKE ADJUSTMENTS TO PRESSURE RELIEF VALVES~~

### ~~S7.10.1 GENERAL~~

~~The Jurisdiction may authorize properly trained and qualified employees of boiler and pressure vessel owners or users or their designees to confirm or restore nameplate set pressure and/or performance of~~

~~pressure relief valves. All external adjustments shall be resealed with a seal identifying the responsible organization and a metal tag that identifies the organization and the date the adjustment shall be installed.~~

## ~~S7.10.2 TRAINING~~

a) ~~The user shall establish a documented in-house training program. This program shall establish training objectives and provide a method of evaluating the training effectiveness. As a minimum, training objectives for knowledge level shall include:~~

   1) ~~Applicable ASME Code and NBIC requirements;~~

   2) ~~Responsibilities within the organization's quality system;~~

   3) ~~Knowledge of the technical aspects and mechanical skills for making set pressure and/or blowdown adjustments to pressure relief valves;~~

   4) ~~Knowledge of the technical aspects and mechanical skills for marking of pressure relief valve adjustments.~~

b) ~~If the user established a designee, the designee shall establish a training program and make their documentation available to the user and the jurisdictional authority.~~

## ~~S7.10.3 DOCUMENTATION~~

~~Each user shall document the evaluation and acceptance of an employee's or designee's qualifications.~~

## ~~S7.10.4 QUALITY SYSTEM~~

a) ~~A written quality system shall be established by either the user or the designee with a written description available to the jurisdictional authority.~~

b) ~~The written description shall include at a minimum:~~

   1) ~~Calibration of Test Equipment: This shall describe a system for the calibration of measuring and test equipment. Documentation of these calibrations shall include the standard used and the results. Calibration standards shall be calibrated against the equipment having valid relationships to nationally recognized standards.~~

   2) ~~Valve Testing, Setting, and Sealing: This system shall include provisions that each valve shall be tested, set, and all external adjustments sealed according to the requirements of the applicable ASME Code Section and NBIC Part 3, S7.10.1.~~

   3) ~~Valve Marking: An effective marking system shall be established to ensure proper marking of the metal tag required by NBIC Part 3, S7.10.1. The written quality system shall include a description of drawing of the metal tag.~~

## ~~S7.10.5 EXTERNAL ADJUSTMENTS~~

~~Only external adjustments to restore the nameplate set pressure and/or performance of a pressure relief valve shall be made under the provisions of NBIC Part 3, S7.10.1 and NBIC Part 2, 2.5.7.~~

## ~~S7.10.6 REPAIRS~~

~~If disassembly, change of set pressure, or additional repairs are necessary, the valve shall be repaired by an organization that meets the requirements of the NBIC.~~

## ~~S7.11 TRAINING AND QUALIFICATION OF PERSONNEL~~

### S7.11.1 GENERAL

### ~~S7.11.2 CONTENTS OF TRAINING PROGRAM~~

~~The repair organization shall establish a documented in-house training program. This program shall establish training objectives and provide a method of evaluating training effectiveness. As a minimum, training objectives for knowledge level shall include:~~

~~a) Applicable ASME Code and NBIC requirements;~~

~~b) Responsibilities within the organization's quality system; and~~

~~c) Knowledge of the technical aspects and mechanical skills for the applicable position held.~~

### ~~S7.11.3 QUALIFICATION OF PERSONNEL~~

~~Each repair organization shall establish minimum qualification requirements for those positions within the organization as they directly relate to pressure relief valve repair. Each repair organization shall document the evaluation and acceptance of an individual's qualification for the applicable position.~~

### ~~S7.11.4 ANNUAL REVIEW OF QUALIFICATION~~

~~The repair organization shall annually review the qualifications of repair personnel to verify proficiency as well as compliance with the certificate holder's quality system. This review shall include training records, documented evidence of work performed, and when necessary, monitoring job performance. The review shall be documented.~~

## ~~S7.12 WELDING FOR PRESSURE RELIEF VALVES~~

~~a) Welding shall be performed in accordance with the requirements of the original code of construction used for the pressure relief valve.~~

~~b) Cast iron and carbon or alloy steel having a carbon content of more than 0.35% shall not be welded.~~

~~c) Defects in pressure relief valve parts such as cracks, pits, or corrosion that will be repaired by welding shall be completely removed before the weld repair of the part is performed. Removal of the defect shall be verified by suitable NDE as required.~~

~~d) Consideration shall be given to the condition of the existing material, especially in the weld preparation area.~~

### ~~S7.12.1 WELDING PROCEDURE SPECIFICATIONS~~

~~Welding shall be performed in accordance with Welding Procedure Specifications (WPS) qualified in accordance with the original code of construction. When this is not possible or practicable, the WPS may be qualified in accordance with ASME Section IX.~~

### ~~S7.12.2 STANDARD WELDING PROCEDURE SPECIFICATIONS~~

~~A "VR" Certificate Holder may use one or more applicable Standard Welding Procedure Specifications shown in NBIC Part 3, 2.3.~~

## ~~S7.12.3 PERFORMANCE QUALIFICATION~~

~~Welders or welding operators shall be qualified for the welding processes that are used. Such qualification shall be in accordance with the requirements of the original code of construction or ASME Section IX.~~

## ~~S7.12.4 WELDING RECORDS~~

~~The “VR” Certificate Holder shall maintain a record of the results obtained in welding procedure qualifications, except for those qualifications for which the provisions of NBIC Part 3, S7.12.2 are used, and of the results obtained in welding performance qualifications. These records shall be certified by the “VR” Certificate Holder and shall be available to the National Board.~~

## ~~S7.12.5 WELDERS’ IDENTIFICATION~~

~~The “VR” Certificate Holder shall establish a system for the assignment of a unique identification mark to each welder/welding operator qualified in accordance with the requirements of the NBIC. The “VR” Certificate Holder shall also establish a written procedure whereby welded joints can be identified as to the welder or welding operator who made them. This procedure shall use one or more of the following methods and shall be described in the quality control system written description. The welder’s or welding operator’s identification mark may be stamped (low stress stamp) adjacent to welded joints made by the individual, or the “VR” Certificate Holder may keep a documented record of welded joints and the welders or welding operators used in making the joints.~~

## ~~S7.12.6 WELDERS’ CONTINUITY~~

~~The performance qualification of a welder or welding operator shall be affected when one of the following conditions occur:~~

~~a) When the welder or welding operator has not welded using a specific process during a period of six months or more, their qualifications for that process shall expire.~~

~~b) When there is specific reason to question their ability to make welds that meet the specification, the qualification that supports the welding that is being performed shall be revoked. All other qualifications not questioned remain in effect.~~

## ~~S7.13 HEAT TREATMENT~~

## ~~S7.13.1 PREHEATING~~

~~Preheating may be employed during welding to assist in completion of the welded joint (NBIC Part 3, 2.5.1). The need for and the temperature of preheat are dependent on a number of factors, such as chemical analysis, degree of restraint of the items being joined, material thickness, and mechanical properties. The welding procedure specification for the material being welded shall specify the preheat temperature requirements.~~

## ~~S7.13.2 POSTWELD HEAT TREATMENT~~

~~Postweld heat treatment shall be performed as required by the original code of construction in accordance with a written procedure. The procedure shall contain the parameters for postweld heat treatment.~~

## S7.14 RECOMMENDED PROCEDURES FOR REPAIRING PRESSURE RELIEF VALVES

### ~~S7.14.1 INTRODUCTION~~

~~a) It is essential that the repair organization establish basic, specific procedures for the repair of pressure relief valves. The purpose of these recommended procedures is to provide the repair organization with guidelines for this important aspect of valve repair. It is realized that there are many types of valves and conditions under which they are repaired and, for this reason, the specific items in these recommended procedures may not apply, or they may be inadequate for each of those types or to the detailed repairs that may be required for each valve.~~

~~b) NBIC Part 3, S7.14.2 contains recommended procedures for the repair of spring-loaded pressure relief valves, and NBIC Part 3, S7.14.3 contains recommended procedures for the repair of pilot-operated types of safety relief valves.~~

### ~~S7.14.2 SPRING-LOADED PRESSURE RELIEF VALVES~~

~~Prior to removal of a valve from a system for a repair or any disassembly, ensure that all sources of pressure have been removed from the valve.~~

~~a) Visual Inspection as Received~~

~~1) This information is to be recorded:~~

~~a. Record user (customer) identification number;~~

~~b. Complete original PRV nameplate data, plus any important information received from customer;~~

~~c. Check external adjustment seals for warranty repair;~~

~~d. Check bonnet for venting on bellow-type valves; and~~

~~e. Check appearance for any unusual damage, missing, or misapplied parts.~~

~~2) If sufficient damage or other unusual conditions are detected that may pose a safety risk during preliminary testing, then proceed directly to NBIC Part 3, S7.14.2 c).~~

~~3) Valves that are to be repaired in place proceed to NBIC Part 3, S7.14.2 c), unless preliminary testing has been authorized by the owner.~~

~~b) Preliminary Test as Received~~

~~1) Information from the recommended preliminary performance test and subsequent disassembly and inspections will provide a basis for any repair interval change that should be necessary to ensure that the valve will function as intended.~~

~~2) Determine set pressure or Cold Differential Test Pressure (CDTP) in accordance with manufacturer's recommendations and appropriate ASME Code Section. Do not allow test pressure to exceed 116% of set pressure unless otherwise specified by the owner. A minimum of three tests is usually required to obtain consistent results.~~

~~3) If results do not correlate with field performance, then steps to duplicate field conditions (fluid and temperature) may be necessary.~~

~~4) Record preliminary test results and test bench identification data.~~

~~c) Disassembly~~

~~1) Remove cap and lever assembly, if applicable.~~

~~2) Remove release nut assembly, if applicable.~~

~~3) Loosen jam nut on adjusting (compression) screw.~~

~~4) Record measurement and remove adjusting (compression) screw.~~

~~5) Remove bonnet or yoke.~~

~~6) Remove spring and washers, and tag (identify) including upper and lower washers, as appropriate.~~

~~7) Remove spindle and disk assembly.~~

~~8) Remove ring pins.~~

~~9) Record measurement and remove adjusting rings, nozzle, and guide, as applicable.~~

~~d) Cleaning~~

~~1) Wire all small parts together and clean. (Caution: do not use a cleaning method that will damage the parts.)~~

~~2) Do not clean in a chemical solution except under acceptable circumstances.~~

~~3) Protect seating surfaces and nameplates prior to cleaning.~~

~~e) Inspection~~

~~1) Check spring for correct range damage such as erosion, corrosion, cracking, or compression below free height.~~

~~2) Check nozzle for cracks (NDE as applicable) or unusual wear.~~

~~3) Check disk assembly for cracks (NDE as applicable) or unusual wear.~~

~~4) Check spindle for trueness, bearing areas, and thread condition.~~

~~5) Check guide for wear and galling.~~

~~6) Check adjusting ring(s) for worn threads and wear.~~

~~7) Check ring pins for bent or broken pin and thread condition.~~

~~8) Check bellows, if provided, for pinholes and corrosion.~~

~~9) Check flange gasket facings for wear and cuts.~~

~~f) Machining~~

~~Machine nozzle and disk, as necessary, to the manufacturer's critical dimension charts.~~

~~g) Lapping~~

~~1) Machine or hand lap disk and nozzle to be sure of flatness.~~

~~2) Lap bevel seats to a grey finish; then re-machine disk or plug to the manufacturer's critical dimension.~~

~~h) Bearing Points~~

~~Grind all bearing areas with grinding compound to make sure they are round and true.~~

~~i) Assembly~~

~~1) Install nozzle.~~

~~2) Install lower ring and guide ring to the, or to measurement from c) 9) above or to manufacturer's specifications.~~

~~3) Install guide.~~

~~4) Install disc and holder.~~

~~5) Install spindle.~~

~~6) Install spring washers.~~

~~7) Install bonnet.~~

~~8) Install bonnet bolting.~~

~~9) Install adjusting screw and lock nut to the measurment from c) 4) above.~~

~~10) Install release nut and lock nut, and cap and lever assembly, and~~

~~11) Document intallation of replacement parts.~~

~~j) Testing~~

~~Test data shall be recorded. Testing will be done in accordance with manufacturer's recommendations and appropriate ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.~~

~~k) Sealing~~

~~After final adjusting and acceptance by quality control inspection, all external adjustments will be sealed with a safety seal providing a means of identification of the organization performing the repair.~~

~~l) Nameplate~~

~~The repairer will place a repair nameplate on each repaired valve. The nameplate shall, as a minimum, meet the requirements of NBIC Part 3, 5.12.1.~~

~~m) Packaging, Shipping and Transportation~~

~~1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces.~~

~~2) Threaded and socket weld valves up to 2 in. (50 mm) may be securely packaged and cushioned during transport.~~

~~3) 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.~~

~~4) Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored.~~

~~5) Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.~~

## ~~S7.14.3 PILOT OPERATED SAFETY RELIEF VALVES~~

~~a) Visual Inspection as Received~~

~~1) This information is to be recorded:~~

~~a. Complete nameplate data, plus any other important information received from the customer;~~

~~b. User identification number, if applicable;~~

~~c. Seals on external adjustment (yes/no);~~

~~d. Identification on seal; and~~

~~e. Obvious damage and external condition including missing or misapplied parts.~~

~~b) Disassembly~~

~~1) Remove pilot and disassemble per manufacturer's maintenance instruction.~~

~~2) Disassemble main valve. Where lift adjustments are provided, do not remove the locking device or change the lift unless it is required as part of conversion.~~

~~3) Remove the nozzle if recommended by the manufacturer's maintenance instructions and/or when required as part of conversion.~~

~~c) Cleaning~~

~~1) Pilot — Components of pilot are small and must be handled carefully to prevent damage or loss. Clean parts and nameplates with solvents that will not affect the parent metal and/or polish with 500 grit paper.~~

~~2) Main Valve — Clean by appropriate means such as abrasive blast. Finishes of machined surfaces must not be affected. (Caution: Do not use a cleaning method that will damage the parts or nameplates.)~~

~~d) Inspection~~

~~1) Pilot~~

~~a. Check spring for damage such as corrosion, cracks, out of square ends, etc.~~

~~b. Inspect all parts for damage. Small burrs or scratches may be removed by polishing. Severely damaged parts should be replaced. (Internal components or pilots should not be repaired by machining as the functions of the pilot could easily be impaired.)~~

~~c. Check strainers on inlet and outlet lines.~~

~~d. Replace all soft goods per manufacturer's recommendation.~~

~~2) Main Valve~~

~~a. Check nozzle seating surface for nicks. These can be removed by machining or lapping as required.~~

~~b. Check the piston and liner (or other moving member) for galling or excessive wear. The piston should move freely in the liner.~~

~~c. Replace soft goods or re-lap disk as required.~~

~~d. Where lift adjustments are provided, measure the lift per the manufacturer's specifications.~~

~~e) Testing~~

~~Test data shall be recorded. Testing will be done in accordance with the manufacturer's recommendation and in accordance with the applicable ASME Code section. To preclude unsafe and unstable valve operations or erroneous performance test results, it is recommended that low volume testing equipment (e.g., gas cylinders without a test vessel, hand pumps, tubing) should be avoided.~~

~~f) Sealing~~

~~After final adjustment and acceptance by quality control, all external adjustments will be sealed by means assuring positive identification of the organization performing the repair.~~

~~g) Nameplate~~

~~The repairer will place a repair nameplate on each repaired valve. The nameplate, as a minimum, shall meet the requirements of NBIC Part 3, 5.12.1.~~

~~h) Packaging, Shipping and Transportation~~

~~1) Valves should be securely fastened to pallets in the vertical position to avoid side loads on guiding surfaces.~~

~~2) Threaded and socket weld valves up to 2 in. (50 mm) may be securely packaged and cushioned during transport.~~

~~3) Valve inlet and outlet connection and drain connections 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.~~

~~4) Lifting levers should be wired or secured so they cannot be moved while the valve is being shipped or stored.~~

~~5) Tubing should be protected during shipment and storage to avoid damage and/or breakage.~~

~~6) Valves for special services, including but not limited to oxygen, chlorine, and hydrogen peroxide, should be packaged in accordance with appropriate standards and/or owner procurement requirements.~~

## ~~SUPPLEMENT 8~~
## ~~RECOMMENDED GUIDE FOR THE DESIGN OF A TEST SYSTEM FOR PRESSURE RELIEF DEVICES IN COMPRESSIBLE FLUID SERVICE~~

### ~~S8.1 INTRODUCTION~~

~~This supplement provides guidance for the design of a test system using compressible fluids (e.g., steam or air/gas) and permits the determination of pressure relief valve set pressure and valve operating characteristics such as blowdown. The size of the test vessel needed depends on the size of the valve, its set pressure, the design of the test system, and whether blowdown must be demonstrated. A repair organization may use the information provided in this supplement to determine the minimum size test vessel needed so that the measured performance is characteristic of the valve and not the test system.~~

### ~~S8.2 GENERAL~~

~~a) The National Board administrative rules and procedures for the "VR" *Certificate of Authorization* and Symbol Stamp require that pressure relief valves, after repair, be tested in accordance with the manufacturer's recommendations and the applicable ASME Code. The purpose of this testing is to provide reasonable assurance that valves will perform according to design when they are returned to service.~~

~~b) It is recognized that a full evaluation of the performance of some pressure relief valve designs requires testing at maximum allowable overpressure. However, it is beyond the scope of this supplement to define test equipment or facilities for such testing.~~

~~c) NBIC Part 3, Section 9 provides a glossary, NBIC Part 3, S8.3 describes typical test equipment, and NBIC Part 3, S8.4 provides data for estimating the size of test vessels required.~~

### ~~S8.3 TEST SYSTEM DESCRIPTION~~

~~a) An optimum configuration, particularly when the test medium source is of small capacity, is shown in NBIC Part 3, Figure S8.3-a. The test medium flows from the pressure source, usually a compressor or boiler, to an accumulator. It then flows through a pressure-controlling valve into the test vessel, from which it is discharged, through the pressure relief valve mounted on the test vessel. The pressure-controlling valve is usually a globe valve, although any throttling valve is acceptable. If the pressure-controlling valve is of adequate size and can open quickly, large transient flows can be generated, increasing the pressure above the pressure relief valve set pressure, causing it to lift, and be sustained in its lifted condition.~~

~~b) NBIC Part 3, Figure S8.3-b shows a simpler test system in which the test vessel is pressurized directly from the pressure source without the use of an accumulator. In this configuration, flow rates through the pressure relief valve and any consequent over-pressure are dependent on the flow generating capacity of the pressure source.~~

~~c) In a test facility, the pressure relief valve is usually mounted on an isolating valve that should be of sufficient size that it will not choke flow to the pressure relief valve. There should be no intervening piping between the two valves to avoid any significant pressure drop between the test vessel and the pressure relief valve.~~

~~d) The isolating valve and any adapter flanges or valve test nozzles must be designed to sustain pressure relief valve discharge forces, and so secured that these forces are not transmitted to the test vessel. This is especially important for larger valves set at pressures greater than 100 psig (700 kPa).~~

~~e) The vessel should have a length-to-diameter ratio as low as is practical, and should be suitably anchored.~~

~~f) Pressure sensing lines should be connected to the test vessel well away from any inlet or outlet connections where pressure distortions due to transient changes in flow velocity during testing could cause erroneous pressure readings. When testing with steam, any water head that develops in the gage line must be taken into consideration.~~

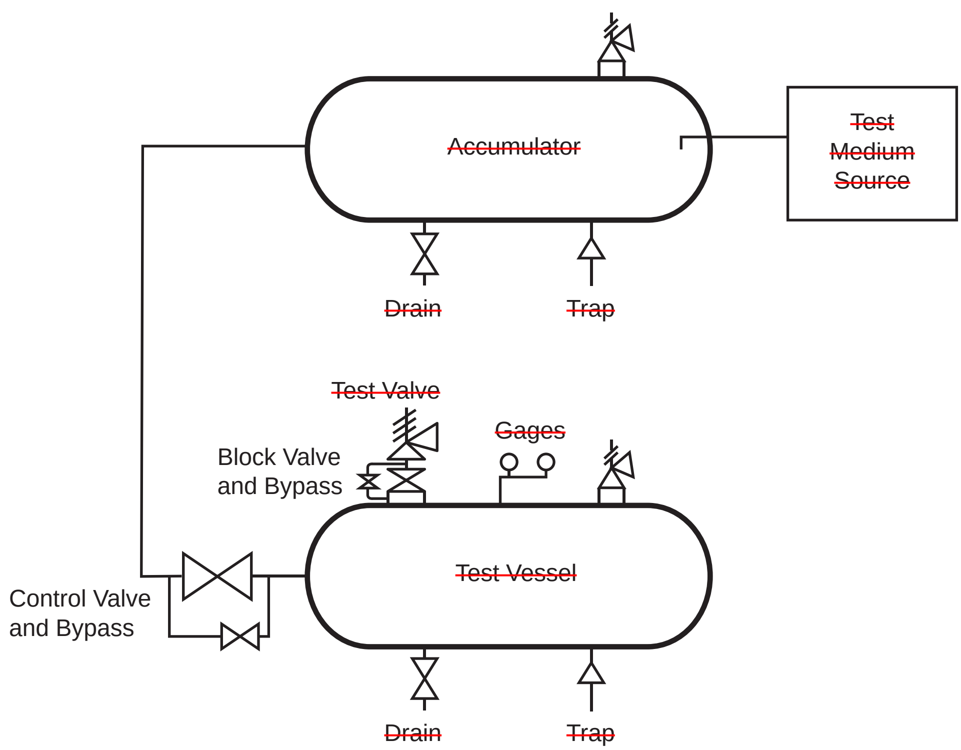
~~g) Any intervening piping between the test vessel and the pressure relief valve should be as short and as straight as possible and be of adequate size to minimize inlet pressure drop.~~

~~h) In the case of steam, the equipment should be insulated and steam traps should be installed, as appropriate, to ensure that the test steam is dry, saturated steam with a minimum quality of 98%.~~

~~i) Safety valves shall be used to protect the test vessel and the accumulator.~~

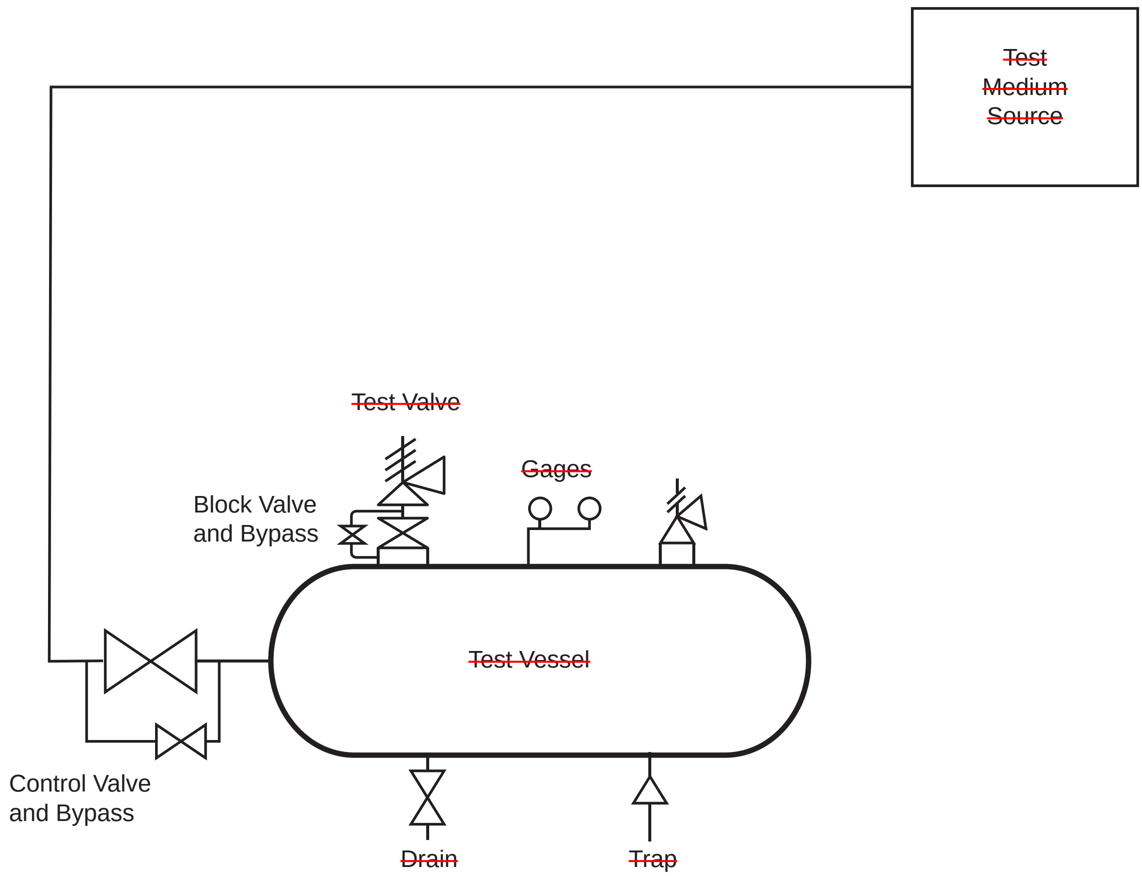
~~**FIGURE S8.3-a**~~

~~SCHEMATIC OF TEST EQUIPMENT WITH ACCUMULATOR~~



## ~~FIGURE S8.3-b~~

## ~~SCHEMATIC OF TEST EQUIPMENT WITHOUT ACCUMULATOR~~



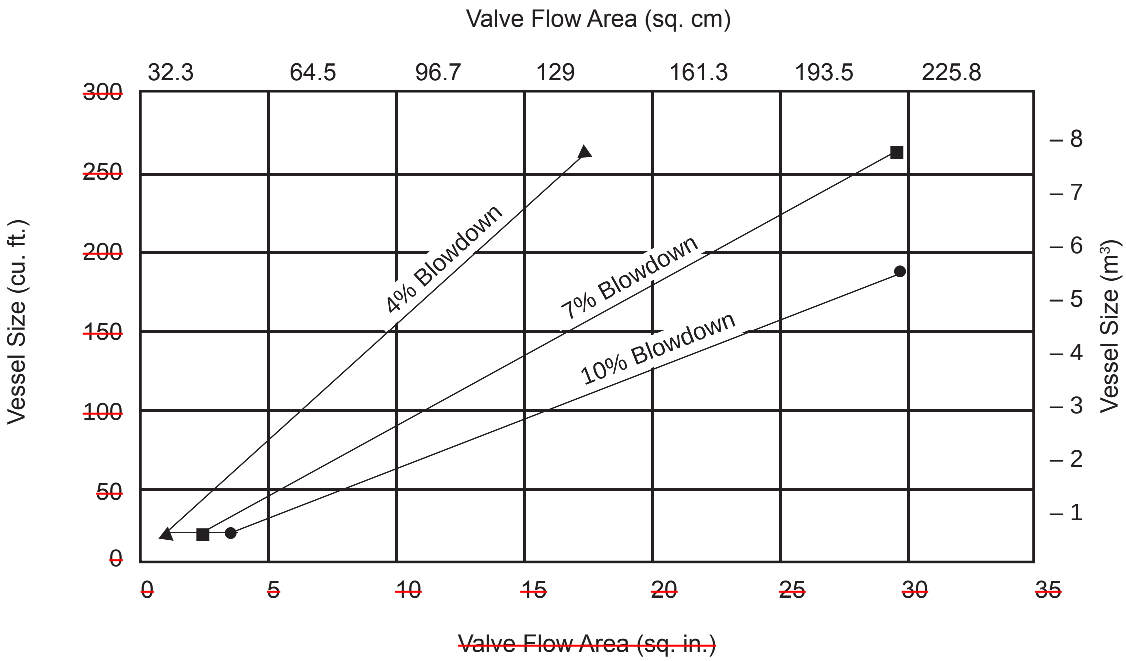

## ~~S8.4 TEST VESSEL SIZING DATA~~

~~a) Recommended test vessel sizes are given in NBIC Part 3, Figures S8.4-a and S8.4-b for a configuration using one vessel fed directly from the source of the test medium. Figure S8.4-a gives the test vessel size in cu. ft. vs. the valve orifice area in sq. in. for dry, saturated steam. Curves are shown for set pressures up to 500 psig (3.45MPa) for three different blowdowns: 4%, 7%, and 10%. The source is assumed to be capable of feeding the test vessel at 2,500 lbs/hr. (1,135 kg/hr). Figure S8.4-b gives similar curves for air with a source capable of feeding the test vessel at 200 SCFM (5.66 cu. m./minute).~~

~~b) For valves, with effective orifices less than 1.28 sq. in. (826 sq. mm), the size of the test vessel needed becomes less dependent on the flow capacity of the source. For these valves, a 15 cu. ft. (0.42 cu. m.) minimum size test vessel is recommended. This should allow the accurate measurement and setting of blowdown for small valves. This minimum size should also be adequate for determining set pressures of larger valves; however, larger test vessels must be used if blowdown is to be set accurately. It is recognized that there are practical limits on the size and maximum pressure of a test vessel used to demonstrate pressure relief valve operational characteristics. In such cases, determination of valve set pressure remains the only viable production and repair test option. The recommended minimum size test vessel is 15 cu. ft. (0.42 cu. m).~~

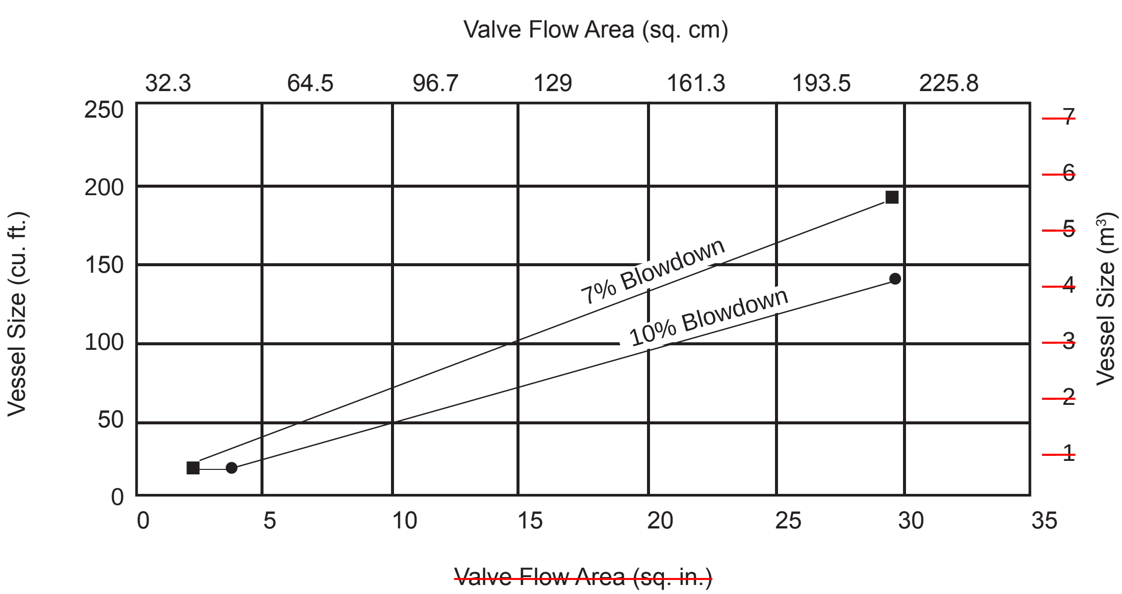
~~FIGURE S8.4-a~~

~~RECOMMENDED TEST VESSEL SIZE, TEST MEDIUM: STEAM~~




~~FIGURE S8.4-b~~

~~RECOMMENDED TEST VESSEL SIZE, TEST MEDIUM: AIR OR GAS~~



## ~~SUPPLEMENT 9~~
## ~~PROCEDURES TO EXTEND THE "VR" CERTIFICATE OF AUTHORIZATION AND STAMP TO ASME "NV" STAMPED PRESSURE RELIEF DEVICES~~

### ~~S9.1 INTRODUCTION~~

~~Approval to extend the scope of the National Board "VR" *Certificate of Authorization* to the Certificate Holder to use the "VR" Stamp on ASME Code "NV" Class 1, 2, or 3 stamped pressure relief devices, which have been capacity certified by the National Board, may be given subject to the provisions that follow.~~

### ~~S9.2 ADMINISTRATIVE PROCEDURES~~

~~a) The repair organization shall hold a valid "VR" *Certificate of Authorization*.~~

~~b) The repair organization shall obtain a National Board "NR" *Certificate of Authorization* and stamp. The requirements for said certificate and stamp include, but are not limited to, the following. The repair organization shall:~~

~~1) Maintain a documented quality assurance program that meets the applicable requirements of NBIC Part 3, 1.8. This program shall also include all the applicable requirements for the use of the "VR" stamp;~~

~~2) Have a contract or agreement with an Inspection Agency to provide inspection of repaired "NV" stamped pressure relief devices by Inspectors who have been qualified in accordance with the requirements of ASME QAI-1, *Qualifications for Authorized Inspection*;~~

~~3) Successfully complete a survey of the quality assurance program and its implementation. This survey shall be conducted by representatives of the National Board, the Jurisdiction wherein the applicant's repair facilities are located, and the applicant's Authorized Inspection Agency. Further verification of such implementation by the survey team may not be necessary if the applicant holds a valid ASME "NV" certificate and can verify by documentation the capability of implementing the quality assurance program for repair of "NV" stamped pressure relief devices, covered by the applicant's ASME "NV" certificate.~~

~~c) The application of the "NR" *Certificate of Authorization* and stamp shall clearly define the scope of intended activities with respect to the repair of Section III, "NV" stamped pressure relief devices.~~

~~d) Revisions to the quality assurance program shall be acceptable to the Authorized Nuclear Inspector Supervisor and the National Board before being implemented.~~

~~e) The scope of the "VR" *Certificate of Authorization* shall include repair of "NV" stamped pressure relief devices.~~

~~f) Verification testing of valves repaired by the applicant shall not be required provided such testing has been successfully completed under the applicant's "VR" certification program.~~

~~g) A survey of the applicant for the "VR" *Certificate of Authorization* and endorsement of the repair of "NV" stamped pressure relief devices may be made concurrently.~~

### ~~S9.3 GENERAL RULES~~

~~a) ASME Code Section III, "NV" stamped pressure relief devices, which have been repaired in accordance with these rules, shall be stamped with both the "VR" and "NR" stamps.~~

~~b) The "VR" and "NR" stamps shall be applied only to "NV" stamped (Class 1, 2, or 3) National Board capacity certified pressure relief devices that have been disassembled, inspected, and repaired as~~

~~necessary, such that the valves' condition and performance are equivalent to the standards for new valves.~~

~~c) All measuring and test equipment used in the repair of pressure relief devices shall be calibrated against certified equipment having known valid relationships to nationally recognized standards.~~

~~d) Documentation of the repair of "NV" stamped pressure relief devices shall be recorded on the National Board Form NVR-1, *Report of Repair/ Replacement Activities for Nuclear Pressure Relief Devices*, in accordance with the requirements of NBIC Part 3, 1.8.~~

~~e) When an ASME "NV" stamped pressure relief device requires a duplicate nameplate because the original nameplate is illegible or missing, it may be applied using the procedures of NBIC Part 3, 5.12.5 provided concurrence is obtained from the Authorized Nuclear Inspector and Jurisdiction. In this case the nameplate shall be marked "SEC. III" to indicate original ASME Code stamping.~~

## SUPPLEMENT 10
## REPAIR AND ALTERATIONS OF PRESSURE VESSELS IN LIQUEFIED PETROLEUM GAS SERVICE

### S10.1 SCOPE

This supplement provides general and specific requirements that apply to the repairs or alterations to pressure vessels designed for storing Liquid Petroleum Gas (LPG) and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquid and Gases. When the standard governing the original construction is not the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquid and Gases, the requirements of NBIC Part 3, 1.2 b, shall apply. In addition to this supplement, the applicable paragraphs of Part 3 of the NBIC shall be met. Vessels used for anhydrous ammonia service shall not be considered for repair or alteration in accordance with this supplement.

### S10.2 GENERAL AND ADMINISTRATIVE REQUIREMENTS

a) Refer to NBIC Part 3, Section 1 for all applicable post construction activities pertaining to general and administrative requirements.

b) Repairs or alterations shall conform to the edition of the ASME Code or standard most applicable to the work.

### S10.3 WELDING

Refer to NBIC Part 3, Section 2 for all applicable post construction activities pertaining to welding requirements.

### S10.4 REQUIREMENTS FOR REPAIRS AND ALTERATIONS

a) Refer to NBIC Part 3, Section 3 for all applicable post construction activities pertaining to requirements for repairs and alterations.

   Excluded is NBIC Part 3, 3.3.4.8 *Repair of Pressure-Retaining Items Without Complete Removal of Defects*.

b) Radiographic or ultrasonic examinations are considered to be suitable alternative nondestructive examination methods to ensure complete removal of the defect, as described in NBIC Part 3, 3.3.4.1.

### S10.5 EXAMINATION AND TESTING

Refer to NBIC Part 3, Section 4 for all applicable post construction activities pertaining to examination and testing.

### S10.6 CERTIFICATION/DOCUMENTATION AND STAMPING

a) Section 5 of this part is applicable for all post construction activities pertaining to certification/documentation and stamping.

b) The “R” Certificate Holder shall assure all repairs or alterations involving a change to the following are recorded on the proper NBIC form and marked on the NBIC nameplate or stamping without changing the required format of the NBIC markings.

1) Service for which the container is designed (for example, underground, aboveground, or both).

2) Dip tube length.

3) Maximum filling limit with liquid temperature reference.

## S10.7 INSPECTION

Refer to NBIC Part 2, Supplement 7 for all applicable post construction activities pertaining to inspection.

## S10.8 COATINGS

When coatings are reapplied, the user should verify the coating is compatible with any coating that remains intact and is suited for the intended service application.

# PART 3, SECTION 7
# REPAIRS AND ALTERATIONS — NBIC POLICY FOR METRICATION

## 7.1 GENERAL

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

## 7.2 EQUIVALENT RATIONALE

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

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

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

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

## 7.3 PROCEDURE FOR CONVERSION

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

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

b) Soft conversion calculations will be reviewed for accuracy;

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

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

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

**Note:** Care shall be taken to minimize percentage difference between units.

## 7.4 REFERENCING TABLES

The following tables are provided for guidance and convenience when converting between US customary units and metric units. See NBIC Part 1, 2, 3, Tables 7.4-a through 7.4-j.

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

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

**Note:**

The actual pressure corresponding to the height of a vertical column of fluid depends on the local gravitational field and the density of the fluid, which in turn depends upon the temperature. This conversion factor is the conventional value adopted by ISO. The conversion assumes a standard gravitational field (gn – 9.80665 N/kg) and a density of water equal to 1,000 kg/m$^3$. NBIC Part 1, 2, 3, 7.4-a through 7.4-j.

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

**TABLE 7.4-b**
TEMPERATURE EQUIVALENTS

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

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

**TABLE 7.4-c**
US FRACTIONS/METRIC EQUIVALENTS

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

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

**TABLE 7.4-d**
PIPE SIZES/EQUIVALENT

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

Areas in square inches (in²) were converted to square mm (mm²) and areas in square feet (ft²) were converted to square meters (m²). See examples in NBIC Parts 1, 2 or 3, Tables 7.4-e and 7.4-f.

### TABLE 7.4-e

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

### TABLE 7.4-f

| Area (US Customary) | Area (Metric) |
|---|---|
| 5 $ft^2$ | 0.46 $mm^2$ |

Volumes in cubic inches (in.³) were converted to cubic mm **(**mm³**)** and volumes in cubic feet (ft³) were converted to cubic meters (m³). See examples in NBIC Parts 1, 2 or 3, Tables 7.4-g and 7.4-h.

### TABLE 7.4-g

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

### TABLE 7.4-h

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

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

**TABLE 7.4-i**
PRESSURE/EQUIVALENTS

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

**TABLE 7.4-j**

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

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

# PART 3, SECTION 8
# REPAIRS AND ALTERATIONS — PREPARATION OF TECHNICAL INQUIRIES TO THE *NATIONAL BOARD INSPECTION CODE* COMMITTEE

## 8.1 INTRODUCTION

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

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

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

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

## 8.2 INQUIRY FORMAT

Inquiries submitted to the Committee shall include:

a) Purpose
Specify one of the following:

1) Revision of present code rules;

2) New or additional code rules; or

3) code Interpretation.

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

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

## 8.3 CODE REVISIONS OR ADDITIONS

Request for code revisions or additions shall provide the following:

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

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

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

## 8.4 CODE INTERPRETATIONS

Requests for code Interpretations shall provide the following:

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

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

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

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

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

3) A request seeking the rationale for code requirements.

## 8.5 SUBMITTALS

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

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

Secretary, NBIC Committee
The National Board of Boiler and
Pressure Vessel Inspectors
1055 Crupper Avenue
Columbus, OH 43229

As an alternative, inquiries may be submitted via fax or email to:
Secretary NBIC Committee
Fax: 614.847.1828
Email: *NBICinquiry@nationalboard.org*

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

# PART 3, SECTION 9
# REPAIRS AND ALTERATIONS — GLOSSARY OF TERMS

## 9.1 DEFINITIONS

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

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

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

**Alteration** — A change in the item described on the original Manufacturer's Data Report which affects the pressure containing capability of the pressure-retaining item. (See NBIC Part 3, 3.4.3, *Examples of Alteration*) Nonphysical changes such as an increase in the maximum allowable working pressure (internal or external), increase in design temperature, or a reduction in minimum temperature of a pressure-retaining item shall be considered an alteration.

**ANSI** — The American National Standards Institute.

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

**ASME** — The American Society of Mechanical Engineers.

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

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

**Authorized Inspection Agency (AIA)**

**Inservice**: An Authorized Inspection Agency is either:

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

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

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

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

**Biomass Fired Boiler** — A boiler which fires biomass as its primary fuel. (15)

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

**Boiler** — A boiler is a closed vessel in which water or other liquid is heated, steam or vapor generated, steam or vapor is superheated, or any combination thereof, under pressure for use external to itself, by the direct application of energy from the combustion of fuels or from electricity or solar energy. The term boiler also shall include the apparatus used to generate heat and all controls and safety devices associated with such apparatus or the closed vessel.

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

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

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

**Power Boiler** — A boiler in which steam or other vapor is generated at a pressure in excess of 15 psig (100 kPa) for use external to itself. The term power boiler includes fired units for vaporizing liquids other than water, but does not include fired process heaters and systems. (See also High-Temperature Water Boiler).

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

**Carbons Recycle** — See Flyash Recycle.

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

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

**Conversion**

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

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

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

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

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

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

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

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

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

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

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

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

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

**Fluidized Bed (Circulating)** — A fluidized bed in which the fluidizing velocities exceed the terminal velocity of the individual bed particles.

**Flyash** — Suspended ash particles carried in the flue gas.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**Metering Device** — A method of controlling the amount of fuel, or air, flowing into the combustion zone.

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

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

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

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

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

**Original Code of Construction** — Documents promulgated by recognized national standards writing bodies that contain technical requirements for construction of pressure-retaining items or equivalent to which the pressure-retaining item was certified by the original manufacturer.

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

**Owner or User** — As referenced in lower case letters means any person, firm, or corporation legally responsible for the safe operation of any pressure-retaining item.

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

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

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

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

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

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

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

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

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

**Pressure Test** — A test that is conducted using a fluid (liquid or gas) contained inside a pressure-retaining item.

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

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

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

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

**Re-rating** — See alteration.

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

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

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

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

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

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

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

**Thermal Fluid Heater** — A thermal fluid heater is a closed vessel in which a fluid other than water is heated by the direct application of heat from a thermal energy source. Depending on the process heating requirements, the fluid may be vaporized with normal circulation but, more often, the fluid is heated and circulated by a pump.

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

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

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

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

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

# PART 3, SECTION 10
# REPAIRS AND ALTERATIONS — NBIC APPROVED INTERPRETATIONS

## 10.1 SCOPE

a) This section provides a list of all approved interpretations for previous editions and addenda of the NBIC. A complete list of interpretations including approved interpretations for this edition is provided on the National Board website.

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

c) Technical inquiries (also known as "request for interpretation") may be submitted to the NBIC committee to clarify the meaning or intent of existing rules to the NBIC. The requirements for submitting technical inquiries are described in NBIC Parts 1, 2, and 3 (Section 8), Preparation of Technical Inquiries to the NBIC Committee.

### 2013 INTERPRETATIONS

| Interpretation | Edition | Part | Section | Subject |
|---|---|---|---|---|
| 13-04 | 2013 | 3 | 3.3.2 e) | Seal Welding of Inspection Opening Covers |
| 13-03 | 2011 | 3 | 3.3.2 d) 1) | Standard Threaded Fitting Welded through ASME VIII, Div. 1 Vessel |
| 13-02 | 2011 | 3 | 5.7.5 | Stamping Requirements for Alterations |
| 13-01 | 2013 | 3 | 1.8.5 q) | Personnel Qualified IAW ANSI/ASME N45.2.23 |

### 2011 INTERPRETATIONS

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

### 2007 INTERPRETATIONS

| Interpretation | Edition | Addenda | Part | Section | Subject |
|---|---|---|---|---|---|
| 07-16 | 2007 | | 3 | 3.3.5.2 | Requirement for Repair / Alteration Plan |
| 07-15 | 2007 | 2008 | 2 | S2.10.6 | Average Pitch |
| 07-14 | 2007 | 2009 | 3 | 3.3.3 | Replacement of Pressure Retaining Parts |
| 07-13 | 2007 | 2009 | All | | The Original Code of Construction |
| 07-12 | 2007 | 2009 | 3 | 3.4.3 | Replacement of Heads with Different Types |

## 2007 INTERPRETATIONS

| Interpretation | Edition | Addenda | Part | Section | Subject |
|---|---|---|---|---|---|
| 07-11 | 2007 | 2010 | 3 | 3.2.2 a) | Replacement Parts |
| 07-10 | 2007 | 2009 | 3 | 3.3.2–3.3.3 | Routine Repairs |
| 07-09 | 2007 | 2008 | 2 | S2.9 b) & S2.11 b) 7) b) | Schedule 80 Pipe in External Piping |
| 07-08 | 2007 | 2009 | 3 | 3.4.3 c) | Handhole Replacement with Flush Patch |
| 07-07 | 2007 | 2009 | 3 | 3.3.4.3 e) & 3.3.2 d) 3) | Weld Buildup of Wasted Area / Routine Repair |
| 07-06 | 2007 | | 3 | | Replacement Parts for Repairs and Alterations |
| 07-05 | 2007 | 2008 | 1 | 2.9.5.1 c) | Change-Over Valve Permitted in ASME Code Case-2254 Use |
| 07-04 | 2007 | | 1 | 4.5.1 a) | Installation of New Rupture Disc in an Existing Holder |
| 07-03 | 2007 | | 3 | 2.5.3 | Use of Alternative Welding Method 2 on P-No 4 and P-No 5A Base Material |
| 07-02 | 2007 | | 3 | 1.6.2, 1.7.5.4, & 1.8.2 | NBIC Manual Requirements for "R", "VR", and "NR" Stamp Holders |
| 07-01 | 2004 | 2006 | | RB-8400 & RB-8410 | "Try Testing" of Pressure Relief Valves |

## 2004 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 04-23 | 2004 | 2005 | RC-1110, RC-2050(c), RC-3030(c), & RC-3031(e) | Jurisdictional Acceptance of NDE |
| 04-22 | 2004 | | RC-1130 | Inspector Verification of NDE Performed |
| 04-21 | 2004 | 2005 | RC-1130 | Inspector Involvement in NDE in Lieu of Pressure Test |
| 04-20 | 2004 | 2005 | RC-2051(d) & RC-3031(b) | Pneumatic Test in Lieu of Liquid Pressure Test |
| 04-19 | 2004 | 2005 | RD-2020 | Repair of Threaded Bolt Holes |
| 04-18 | 2004 | 2005 | RD-3010 | Re-rating Using a Later Edition/Addenda of The Original Code of Construction |
| 04-17 | 2001 | 2003 | RD-2020(c) | Procedures for Repairing Cracks and Crack Classification |
| 04-16 | 2004 | | RA-2370 | "NR" Certificate Interface with Owner's Repair/ Replacement Program |
| 04-15 | 2004 | | RD-2060 | Utilizing a Flush Patch to Gain Access Window in Pressure Retaining Items |
| 04-14 | 2004 | | RC-1000 & RC-3000 | Replacement Safety Valves with Different Capacities and Set Pressures than Boiler Data Report |

### 2004 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 04-13 | 2004 | | RC-1020, RC-1030, Appendix 4, & RC-3022 | Replacement of a Cast Iron Section |
| 04-12 | 2001 | 2003 | RD-1030, RC-1050(c) | Post Weld Heat Treatment of Parts |
| 04-11 | 2001 | 2003 | RC-1050(c), RC-2050, & RC-2051 | Requirements for Testing Replacement Parts |
| 04-10 | 2004 | | RC-2031 | Flush Patches in Pipes and Tubes NPS 5 or less |
| 04-09 | 2004 | | RC-2031 | Routine Repairs |
| 04-08 | 2004 | | RE-1050 | Fabricated Replacement Critical Parts |
| 04-07 | 2004 | | RE-1050 | Source for Critical Parts |
| 04-06 | 2004 | | RC-1050(c), RC-2050, RC-2051, & RC-1110 | Written Procedure Requirements for Non-Destructive Examinations |
| 04-05 | 2001 | 2003 | RC-1050(c) & RC-2050 | "R" Stamp Holder Installation of Code Manufacturer Supplied Parts |
| 04-04 | 2004 | | RC-3022(b) & (d) | Re-rating of Pressure-Retaining Items for Lethal Service/Removal of Insulation |
| 04-03 | 2004 | | RC-3022(b) & (d) | Re-rating of Pressure-Retaining Items/Removal of Insulation |
| 04-02 | 2004 | | RA-2213 | "VR" Certificate Holder Verification of Manufacturer's Nameplate Capacity |
| 04-01 | 2004 | | RD | Use of Welded Encapsulation Box in Lieu of Weld Build Up or Flush Patch |

### 2001 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 01-41 | 2001 | 2003 | Appendix 2 & 5 | Alteration Increasing Boiler Heating Surface & Stamping |
| 01-40 | 2001 | 2003 | RC-2051(e), RC-3031(c), RC-2050, & RC-3030(c) | Use of VT when Pressure Test Is Not Practicable |
| 01-39 | 2001 | 2003 | RC-3051 | Inspector Responsibilities for Form R-2 after Witnessing Pressure Test |
| 01-38 | 2001 | 2003 | RD-3022(d) | Design Only "R" Stamp Holders Pressure Testing and Form R-2 |
| 01-37 | 2001 | 2003 | RC-1140 & RC-3040 | Construction Phase & Stamping when Re-rating without Physical Changes |
| 01-36 | 2001 | 2002 | RC-1020(b) | Application of "R" Stamp on Non-Code Pressure Retaining Items |
| 01-35 | 2001 | 2002 | RC-1040 | Is Pre-Assembly of a Part Considered Fabrication |
| 01-34 | 2001 | 2002 | RD-1060(h)(2) | Butter Layers Using the SMAW Process |
| 01-34 | 2001 | 2002 | RD-1040(i)(6) | Shielding Gas Dewpoint Temperature |

## 2001 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 01-33 | 2001 | 2002 | UG-45 | Evaluation of Inservice Pressure Vessels and Requirement of UG-45 |
| 01-32 | 2001 | 2002 | Introduction | Are Reference Codes and Standards Acceptable |
| 01-31 | 2001 | 2002 | RB-3238 | Determination of Remaining Life Applicable to Boilers and Pressure Vessels |
| 01-30 | 2001 | 2002 | RC-1050(c) | Fabrication and Installation by "R" Stamp Holder |
| 01-29 | 2001 | 2002 | RC-2070 | Installation of Replacement Parts |
| 01-28 | 2001 | 2002 | RC-1040 | Use of Material That Has Been Previously Inservice |
| 01-27 | 2001 | 2002 | RC-1090 | Welding Using Welders Who Are Not Employed by the "R" Stamp Holder |
| 01-26 | 2001 | 2002 | RB-3238(f) | Criteria for Determining Actual Thickness and Maximum Deterioration |
| 01-25 | 2001 | | RC-3050 | Documenting Alterations Performed by Two "R" Stamp Organizations |
| 01-24 | 2001 | | RC-1110(a) | NDE of Tack Welds by Welders and Welder Operators |
| 01-23 | 2001 | | RC-2031(a)(1) | Routine Repairs |
| 01-22 | 2001 | | RC-2031 | Routine Repairs |
| 01-21 | 2001 | | Appendix 6, Part B | Alternative Welding Methods in Lieu of Post Weld Heat Treatment |
| 01-20 | 2001 | | RC-2031(a)(1) | Routine Repairs |
| 01-19 | 2001 | | RC-2031(a)(1) | Routine Repairs |
| 01-18 | 2001 | | 8-5000(b) | Repairs |
| 01-17 | 2001 | | RC-3021 | Calculations |
| 01-16 | 2001 | | RC-3000 | Alterations to ASME Section VIII, Div. 2 Vessels |
| 01-15 | 2001 | | RC-2051 | Pressure Test Repairs and Alterations by Isolating the Repaired Portion of a Pressure Retaining Item |
| 01-14 | 2001 | | RC-2082(b) | Repair Plan (Sec. VIII, Div. 2) AIA Acceptance |
| 01-13 | 2001 | | RB-4010 | Replacement of Stamped Data |
| 01-12 | 2001 | | RA-2274 | Use of Owner/User Personnel during Repairs of Pressure Relief Valves |
| 01-11 | 2001 | | RC-3022 | Re-rating Based on Joint Efficiency |
| 01-10 | 1998 | 2000 | RD-1000 | Alternative Postweld Heat Treatment Methods |
| 01-09 | 1998 | 2000 | RC-2031(a)(1) | Routine Repairs |

## 2001 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 01-08 | 1998 | 2000 | RB-3853 | Manually Operated Locking Devices |
| 01-07 | 1998 | 2000 | RA-2030(a) | Owner-User Inspection Organizations |
| 01-06 | 1998 | 2000 | RA-2010 | Accreditation of Repair Organizations |
| 01-05 | 1998 | 2000 | RA-2330(n) | "NR" Program Audits |
| 01-04 | 1998 | 2000 | RC-2050, RC-3030, RA-2151(m) | Calibration of Pressure Gages |
| 01-03 | 1998 | 2000 | Appendix 4 | Pressure Retaining Items |
| 01-02 | 1998 | 1999 | RC-2031(a)(3) | Weld Metal Build-Up |
| 01-01 | 1998 | 1999 | RA-2330(g) | Demonstration for an "NR" Certificate of Authorization |

## 1998 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 98-44 | 1995 | 1997 | RC-1093 | Welder Performance Qualification Using SWPS |
| 98-43 | 1998 | 1999 | Forward, Appendix 4 & Appendix 5 | Alterations |
| 98-42 | 1998 | 1999 | RC-2031, RD-2030(d) | Weld Buildup of Wasted Area of Boiler Tubes |
| 98-41 | 1998 | | RA-2330(g) | Compliance with Part RA-2330(g) |
| 98-40 | 1998 | | RD-2070 | Replacement of Threaded Stays with Welded Stays |
| 98-39 | 1998 | 1999 | R-1 & R-2 Forms | Inspector Requirements |
| 98-38 | 1998 | 1999 | RC-3031(c) | NDE in Lieu of Pressure Test |
| 98-37 | 1998 | 1999 | RC-1050(a) | Material Requirements |
| 98-36 | 1998 | 1999 | RD-2050 | Original Code of Construction |
| 98-35 | 1998 | 1999 | RB-4000 | Restamping or Replacement of Nameplate |
| 98-34 | 1995 | 1996 | RC-3030 | Examination and Testing |
| 98-33 | 1998 | | RC-2051 | Liquid Pressure Test of Repairs |
| 98-32 | 1998 | | RC-3022 | Re-rating Using Higher Joint Efficiency |
| 98-31 | 1998 | | RC-2031 | Replacement of a Nozzle as Routine Repair |
| 98-30 | 1998 | | Appendix 6C | Example of Alteration Due to Grinding or Machining |
| 98-29 | 1998 | | Appendix 6 | Tube Placement |
| 98-28 | 1998 | | RC-1050(c) | Replacement Parts Fabricated by an "R" Certificate Holder |
| 98-28 | 1998 | | Appendix 6 | Pressure Retaining Replacement Items |
| 98-28 | 1998 | | RC-1050 | Definition of New Replacement Parts |
| 98-27 | 1995 | 1996 | RC-2050(b) | Pressure Test |
| 98-27 | 1995 | 1996 | RC-1050 | Replacement Parts |

## 1998 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 98-26 | 1998 | | RA-2262(b)(1) | Resetting of PRV Springs per ASME Section 1, PG-72.3 or Section VIII, Div. 1, UG-126(c) |
| 98-25 | 1998 | | RA-2262(b)(3) | Stamping on Repair Nameplate |
| 98-24 | 1998 | | RA-2242(c) | "VR" Certificate Holders and Code Case 1923 & 1945 |
| 98-23 | 1995 | | Appendix 6, B-7 | Head and Shell Thickness Limitations when Installing Nozzles |
| 98-22 | 1998 | | RC-1010 | Scope |
| 98-21 | 1998 | | RA-2130(f) | Requirements for Applicants for "R" Certificate of Authorization |
| 98-20 | 1998 | | RC-3022 | Re-rating |
| 98-19 | 1998 | | RB-3237 | Inspection Interval |
| 98-18 | 1998 | | RC-2031(a)(1) | Routine Repairs |
| 98-17 | 1998 | | RA-2281 | Testing Medium and Testing Equipment |
| 98-16 | 1998 | | RA-3020 | Prerequisites for Accreditation |
| 98-15 | 1995 | 1996 | RC-3022 & RC-3030(h) | Pressure Testing Requirements Related to Re-rating Activities |
| 98-14 | 1998 | | Appendix 6 | Examples of Repairs and Alterations |
| 98-14 | 1998 | | RC-1050 | Replacement Parts |
| 98-14 | 1998 | | RC-3022 | Re-rating |
| 98-14 | | | RC-3020 | Design |
| 98-13 | 1995 | 1996 | RA-2151(r) | QC Manual Requirements |
| 98-12 | 1995 | 1996 | RA-2231(b)(1) | Use of Code Case 2203 in Repairs |
| 98-11 | 1995 | 1996 | RA-3050 | Owner-User Program Accreditation and Inspections |
| 98-10 | 1995 | | RC-1110 | NDE Requirements for ASME Section I Tube Sheet Repairs |
| 98-09 | 1995 | | RB-3640 | Inspection Requirements |
| 98-08 | 1995 | 1996 | RD-2010 | Repair Methods |
| 98-07 | 1995 | 1996 | RA-2330(d) | ASME Section XI Program Boundary Components |
| 98-06 | 1995 | 1996 | RC-1090 | Welding Non-Pressure Parts in a Pressure Retaining Item |
| 98-06 | 1995 | 1996 | RD-1010 | Alternative Methods of NDE |
| 98-05 | 1995 | 1996 | Forward | Determination of Repairs Must be Made |
| 98-04 | 1995 | 1996 | RC-2031 | Routine Repairs |
| 98-03 | 1995 | | RB-3238(f) | Interrupted Service |
| 98-02 | 1995 | 1996 | RA-2231 | Conditions of Use |
| 98-01 | 1995 | 1997 | RC-2031(a)(1) | Attachments |

## 1995 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 95-57 | 1995 | 1996 | RB-3238(e) | Above Ground Vessels |
| 95-56 | 1995 | 1996 | RA-2231(b)(1) | Acceptance of Code Cases 1923 & 1945 |
| 95-55 | 1995 | 1996 | RB-3550 | Operational Inspection |
| 95-54 | 1995 | 1996 | RC-2050 | Pressure Testing |
| 95-53 | 1995 | | RD-2031 | Routine Repairs |
| 95-52 | 1995 | 1996 | RD-2060 | Patches, Figure 8 |
| 95-51 | 1995 | 1996 | RC-1090 | Weld Procedures/Qualified Welders |
| 95-50 | 1995 | 1996 | RC-2072 & RC-3052 | R-3, R-4, & Manufacturer's Partial Data Report |
| 95-49 | 1995 | | Appendix 6, B-17 | P Numbers |
| 95-48 | 1995 | | RC-1020, RB-1050(a) & Appendix 6, B-6 | R-1 Forms |
| 95-47 | 1995 | | RB-4020 | Replacement Name Plates & National Board Numbers |
| 95-46 | 1995 | | Appendix 6, B-7 | Examples of Repairs |
| 95-45 | 1995 | | Appendix 4 | Repairs and Alterations |
| 95-44 | 1995 | | Appendix 6, C-5 | Alterations |
| 95-43 | 1995 | | Appendix 5 | Repairs |
| 95-42 | 1995 | | RC-2070 & RC-3050 | R-1 & R-2 Forms |
| 95-41 | 1995 | | RC-1110 | Indications in Excess of that Allowed by the Original Code of Construction |
| 95-40 | 1995 | | Appendix 5 | Form R-2 |
| 95-39 | 1995 | | RC-2050 | Pressure Testing of Routine Repairs |
| 95-38 | 1995 | | RB-3234 | Inservice Pressure Test |
| 95-37 | | | | Withdrawn |
| 95-36 | 1995 | | RC-1020 | Work Performed to a Code Other than the Original Code of Construction |
| 95-35 | 1992 | 1994 | R-200 | Welding of Tube Plugs |
| 95-34 | 1995 | | Appendix 4 | Inspector Responsibilities |
| 95-33(a) | 1992 | 1994 | Appendix C-R, 4.0 (f) | Field Repairs in Other Shops Owned by the Certificate Holder |
| 95-33 | 1995 | | RC-2031(a)(2) | Non-Load Bearing Attachments |
| 95-32 | 1995 | | RC-2050 | Pressure Testing |
| 95-31 | 1995 | | RC-2031 | Waiving the Inprocess Involvement of the Inspector |
| 95-30 | 1995 | | Data Report Forms | API-510 Reporting and Inspector Involvement |
| 95-29 | 1995 | | RC-1070 | Non National Board Member Jurisdiction Inspectors |
| 95-28 | 1995 | | RC-2031 | R-1 Forms Inspector Involvement for Routine Repairs |
| 95-27 | 1995 | | RC-2031 | Routine Repairs |

## 1995 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 95-27 | 1995 | | RC-2050 | Registration of R-1 Forms |
| 95-27 | 1995 | | RC-2060 | Application of the "R" Symbol Stamp |
| 95-27 | 1995 | | RC-2072 | Responsibility for Performing Pressure Test |
| 95-26 | 1995 | | RA-2262 | Valve Nameplate Contents |
| 95-25 | 1995 | | Appendix 5 | Inspectors Requirements for Form R-1 on Routine Repairs |
| 95-24 | 1995 | | Appendix 2 | Nameplate Stamping and Layout |
| 95-23 | 1995 | | RC-1010 | Documentation of Repairs to Non-Symbol Stamped Cargo Vessels |
| 95-22 | 1995 | | RC-3020 & RC-3021 | Reclassification of Pressure Retaining Items |
| 95-21 | 1995 | | Appendix 4 | Repairs to PWHT Vessels Without Subsequent PWHT |
| 95-20 | 1995 | | Foreword | Use of Earlier Edition and Addenda |
| 95-19 | 1995 | | RC-1000 | Original Code of Construction/Edition/Addenda |
| 95-18 | 1992 | 1994 | Appendix C-NR & NR-1000 | Scope and Applicability |
| 95-17 | 1992 | 1994 | R-404 | Documenting Repairs/Responsibility for Work Performed by Others |
| 95-16 | 1992 | 1994 | R-302.1 | Owner/User Supplied Weld Procedures |
| 95-15 | 1992 | 1994 | R-307 | Use of Replacement Parts/Assemblies from Other Inservice Vessels |
| 95-14 | 1992 | 1994 | R-202 | Repairs to PWHT Vessels without Subsequent PWHT |
| 95-13 | 1992 | 1994 | U-106 | Maximum Period between Inspection Intervals |
| 95-12 | 1992 | 1994 | U-107 | Inspection of Corrosion and Other Deterioration |
| 95-11 | 1992 | 1994 | R-503 | Re-rating of Complete Boilers or Pressure Vessels |
| 95-10 | 1992 | 1994 | R-301.2.2 | Owner User Acceptance Inspection of Repairs and Alterations |
| 95-09 | 1992 | 1994 | Chapter III, Supplement 3 | Welding Methods as an Alternative to Postweld Heat Treatment |
| 95-08 | 1992 | 1994 | Appendix C-R | Guide for Completing Form R-1 |
| 95-07 | 1992 | 1994 | Appendix C-R, 3.0 | Renewal of "R" Certificate of Authorization |
| 95-06 | 1992 | 1993 | R-401.2.2 | Access Openings |
| 95-05 | 1992 | 1993 | Purpose and Scope | When Does the NBIC Take Effect on New Boilers or Pressure Vessels |
| 95-04 | 1992 | 1993 | U-107 | Inspection for Corrosion and Other Deterioration |
| 95-03 | 1992 | 1993 | R-200, R-404, R-505 | Use of Similar & Non-Similar Base Metals/Repair-Alteration |
| 95-02 | 1992 | 1993 | R-307 | Use of R-Form When Replacing Parts with Different Materials without Welding |
| 95-01 | All | | | What Editions of the NBIC Governs |

## 1992 INTERPRETATIONS

| Interpretation | Edition | Addenda | Section | Subject |
|---|---|---|---|---|
| 94-2 | 1992 | | Chapter III, R-301.1 | Inspector Approval for Routine Repairs |
| 94-1 | 1989 | | Chapter III | Repair of Valves Covered by B31.1 |
| 93-6 | 1992 | | Chapter III | Re-rating by Performing Radiography & Recalculating Joint Efficiency |
| 93-5 | 1992 | | Chapter III, R-503(d) | Requirement for Pressure Test when Re-rating a Vessel |
| 93-4 | 1992 | | Chapter III, R-301.2 | Owner User Acceptance Inspection of Alterations |
| 93-2 | 1992 | | | Alterations |
| 93-1 | 1992 | | | Requirements when More than One Inspector is Involved in a Repair |
| 92-7 | 1992 | | | Alterations with Different Certificate Holders Performing Design Calculations and Physical Work |
| 92-6 | 1992 | | | Out of State Organizations Performing Repairs |
| 92-5 | 1992 | | | Alternative Requirements of NBIC when There is No Jurisdiction |
| 92-4 | 1992 | | Chapter III, Supplement 1 | Replacement of Tubes with Equal or Greater Allowable Stress |

# PART 3, SECTION 11
# REPAIRS AND ALTERATIONS — INDEX

## Q

## R



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## V



## W



## X

## Y



## Z

THE NATIONAL BOARD

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| Comments for Ballot: NB11-04-01B | | Response |
|---|---|---|
| Richards,Michael voted: Approve 12/28/2015 1:54:48 PM | No additional comment other than those stated. | Thank you for your comment |
| Newton,Venus voted: Disapprove 12/22/2015 1:37:11 PM | I'm against this entire Part as I think it removes vital PRD information from the areas of concern in the other Parts. | Nothing is being removed from Parts 1 & 2, only from 3 |
| Pillow,James voted: Approve 12/22/2015 11:46:47 AM | I approve but noted some things that the editor may catch. In ToC and the index, reference to 1.4 is still there but 1.4 has been deleted in text. There are others. Also, on pages 213, the header for Supplement 7 should be deleted as well as S711.1 and S7.14.As I said, these and other items may be picked up by the editor. | Thank you for your observation. Will make sure the editor picks this up |
| Pulliam,Ronald voted: Approve 12/19/2015 7:32:36 AM | I have no comments beyond those already supplied. | Thank you for your comment |

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Manufacturer & Repair Directory

| Comments for Ballot: NB11-04-01A | | Response |
|---|---|---|
| Richards,Michael voted: Abstention 12/28/2015 1:56:30 PM | Abstention based on hearing further discussion. | Thank you for your comment |
| Newton,Venus voted: Disapprove 12/22/2015 1:35:30 PM | I'm against this entire Part as I think it removes vital PRD information from the areas of concern in the other Parts. | Nothing is being removed from Parts 1 & 2, only from 3 |
| Pulliam,Ronald voted: Approve 12/19/2015 7:34:40 AM | I have no comments beyond those already posted. | Thank you for your comment |

| Archived Comments for Ballot: NB11-0401-SC RA | | Response |
|---|---|---|
| Webb,Michael 10/27/2015 12:41:15 PM | I approve the item as presented and offer comment/question. Please see the attachment for consideration of those comments. M.Webb, 10-27-15 Reference Document: LB-item NB11-0401, approve and comment.p | Thank you for your observation. These are editorial issues and we will make sure the editor picks this up |
| Miletti,Ray 10/27/2015 7:34:56 AM | Support development of Part 4 | Thank you for your comment |
| Boseo,Brian 10/6/2015 2:12:08 PM | Should the following also be included in Part 4? 5.7.5 b) will have a change. 5.13.6 NVR Definitions "VR" Certificate Holder | NVR will stay in Part 3 for now. 5.7.5b is stated in Part 4 3.7.2b2 states "VR symbol stamp." Clarification can be made with a future action. |
| Pillow,James 10/6/2015 11:39:05 AM | I approve, but have a question. Is it intended to move the Form NVR-1 to Part 4? In the proposal reference to the NVR-1 has been deleted in certain places but the instructions for completing the form have not. | No, Form NVR-1 will stay in Part 3 for now. |
| Jones,Wayne 10/6/2015 10:31:32 AM | I agree. | Thank you for your comment |
| Sekely,Jim 10/6/2015 10:16:43 AM | I support the development of Part 4. | Thank you for your comment |

| Archived Comments for Ballot: NB11-0401-SC PRD | | Response |
|---|---|---|
| **Patel,Thakor** 9/9/2015 2:43:56 PM | There are duplicate paragraphs such as valve discharge piping 1.5.1.4 and 1.5.4.7, Paragraph 1.5.3 (g) and 1.5.4 (d) etc. out of which one paragraph can be deleted. First paragraphs reference should be inserted where paragraphs are repeated or duplicated. | Although the paragraphs are duplicate they are under separate headings. 1.5.1 is for heating boilers. 1.5.3 is for hot water heating and hot water supply boilers. 1.5.4 is for potable hot water heaters. The intent was to have separate paragraphs to make it easier for the user and maintain the structure of the current Part 1. However combining common requirements into one paragraph could be considered in the future. |
| **Cox,Alton** 9/9/2015 9:42:39 AM | While I have serious reservations regarding the structure and specific items in the document, I will accept the concept of the Part 4 addition. Many of the issues that I have exist in the current version as well, so I will work to address them in the new Part 4 if it is approved. | Thank you for your comment |
| **Renaldo,Adam** 8/27/2015 6:51:50 AM | There were several comments and questions on the draft that needed to be addressed. I have attached an edited draft that addresses all the comments and questions except for issues with low resolution images and table creation. I assume NB staff will fix those problems in the final release. Reference Document: NB11-0401 with AMR comments and edits 8-27-15.doc | A number of changes in your markup appear to be editorial and will be incorporated into the final draft being sent to the main committee. Other changes will be addressed as new business |

NB-14-0603 AMR proposed edits
Rev 1
1-13-15

Edits to Part 3…

1.7.5.4
i) **Repair and Inspection Program**
The repair and inspection program section shall include reference to a document (such as a report, traveler,
or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure
relief valves. Repair procedures shall require verification that the critical parts meet the valve manufacturer's
specification. NBIC Part 3, S7.14 outlines recommended procedures covering some specific items.
~~Provisions shall be made to retain this document for a period of at least five years.~~
This document shall be retained in accordance with Table 1.7.5.4(s).

1.7.5.4
m) **Calibration**
1) The manual shall describe a system for the calibration of examination, measuring, and test equipment
used in the performance of repairs. Documentation of these calibrations shall include the standard used and the results. Calibration records shall be retained in accordance with Table 1.7.5.4(s).

4.5.1(b)
2) Prior to use, all performance testing equipment shall be qualified by the certificate holder to ensure
that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark
testing, comparisons to equipment used for verification testing as specified in the quality system, or
comparisons to field performance. This qualification shall be documented. Documentation of this qualification shall be retained in accordance with Table 1.7.5.4(s).
~~and provisions made to~~
~~retain such documentation for a period of at least five years after the testing equipment is retired.~~
Documentation of this qualification shall include, but not be limited to:

4.5.3

c) Prior to use, all lift assist devices shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented and provisions made to retain such documentation ~~for a period of at least five years after the lift assist device is retired~~in accordance with Table 1.7.5.4(s). Documentation of this qualification shall include but not be limited to:

New section in Part 3…

1.7.5.4

s) **Records Retention**
The quality manual shall describe a system for filing, maintaining, and easily retrieving records supporting or substantiating the administration of the Quality System within the scope of the "VR" *Certificate of Authorization*.

1) Records may represent any information used to further substantiate the statements used to describe the scope of work completed to a pressure-retaining item (PRI), and documented on a Form "R" report.
2) Records include, but are not limited to, those depicting or calculating an acceptable design, material compliance or certifications, NDE-reports, PWHT-charts, a WPS used, a welder, bonder, or cementing technician's process continuity records, drawings, sketches, or photographs.
3) The record retention schedule described in the Quality System Manual is to follow the instructions identified in NBIC Part 3, Table 1.6.1.

Table 1.7.5.4(s)

| **Reports, Records, or Documents for "VR" Certificate Holders** | **Instructions** | **Minimum Retention Period** |
|---|---|---|
| Form "R" reports associated with a pressure relief valve that required welding as part of the repair | Record retention shall be in accordance with Table 1.6.1 | Refer to Table 1.6.1 |

| | | |
|---|---|---|
| a) Record of repair or inspection | The repair and inspection program section shall include reference to a document (such as a report, traveler, or checklist) that outlines the specific repair and inspection procedures used in the repair of pressure relief valves. | 5 years |
| b) Records related to equipment qualification | Prior to use, all performance testing equipment shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment. This qualification may be accomplished by benchmark testing, comparisons to equipment used for verification testing as specified in the quality system, or comparisons to field performance. | 5 years after the subject piece of equipment or instrument is retired. |
| c) Record of lift assist device qualification | Prior to use, all lift assist devices shall be qualified by the certificate holder to ensure that the equipment and testing procedures will provide accurate results when used within the ranges established for that equipment used for verification testing as specified in the quality system or comparisons to field performance. This qualification shall be documented. | 5 years after the lift assist device is retired. |
| d) Records of employee training and qualification | Each repair organization shall establish minimum qualification requirements for those positions within the organization as they directly relate to pressure relief valve repair. Each repair organization shall | 5 years after termination of employment. |

| | | |
|---|---|---|
| | document the evaluation and acceptance of an individual’s qualification for the applicable position. | |
| e) Examination, measuring, and test equipment | A calibration record shall be generated each time examination, measuring, or test equipment is checked or calibrated. Documentation shall include the calibration standard used and the results. | 5 years from date of calibration |
| | | |

# NBIC – ASME Liaison Report

- Separation of Conformity Assessment Requirements
  - CA-1 – 2014 edition published to establish a uniform Standard for ASME Conformity Assessment Requirements
  - Working with BPV Book Sections to incorporate CA-1 as Evergreen reference
  - Ongoing work at CAR Committee to address Certificate Scope Statements, Field Sites, CAP-21, and CAP-22
  - Future coverage planned for Nuclear Conformity Assessment

- BPV Parts Fabrication Certificate Program
  - New Certificate scope with "PRT" Designator, providing for fabrication w/o design responsibility
  - Published in 2015 Edition for BPV I, IV and XII; work continues at BPV VIII
  - 2 applications processed
  - Follow-up clarification on scope statements and identification of "PRT" Designator

# NBIC – ASME Liaison Report

- Authorized Inspection Agency Oversight
  - Program implemented for feedback on AIA performance, by Team Leaders during Certificate holder surveys/reviews
  - Proposal under consideration for an interim audit between triennial surveys
- AI / ANI Inspection Requirements
  - QAI Task Group developing uniform AI / ANI inspection requirements
  - Coordinating alignment with NB-263, RC-1 *"Rules for Commissioned Inspectors"*
- ASME NDE Personnel Certification Program
  - Transportable ASME certification for NDE personnel and QC Technicians
  - ANDE-1 Standard published, testing program in development
  - Alternative program to current Book Section requirements

# NBIC – ASME Liaison Report

- ❖ Field Site Task Group
  - ❖ Joint TOMC / C-CAR / C-BPVCA / Staff effort
  - ❖ Develop generic definition of "field site"
  - ❖ Identify Code activities warranting review / reporting to ASME

- ❖ Future Conformity Assessment Considerations
  - ➢ New ASME Section XIII, *"Rules for Overpressure Protection"*
  - ➢ Certificate Numbers on Data Plates
  - ➢ Proposed certification program for ASME B31.1 Covered Piping

# NBIC - AWS Liaison Report

The following listed actions are currently in process within the American Welding Society.

- Additional SWPS-N are in process of development (two have been through the approval process and are at the printers. They will not be offered to the NBIC for adoption since their use is primarily intended for NAVSHIPS application.
- The amendment to B2.1-14 was approved by the various AWS Committees and is available through the AWS Bookstore.
- A new PWHT document is under consideration by the D10 Committee on Piping and Tubing. The AWS Permission to Prepare has been approved by the AWS Technical Activities and development of the standard is in process by that Committee.

Jim Sekely