

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

- 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;
- 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 inservice 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 its under pressure;
- c) If the test is successful, the operator shall assure that the delivery hose assembly is permanently marked with the month and year of the test;
- d) It should be noted that after July 1, 2000, the operator shall complete a record docu-

menting 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 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

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

- a) The measuring device shall be capable of accurately measuring thickness to within \pm ~~0.002 of an inch;~~ **.50 mm (.002 inch).**

Table S6.13.11.2 -a
Minimum Thickness for Heads

| Materials | Volume capacity in liter per mm of length (gallons per inch of length) | | | | | | | | |
|---------------------|--|-------------|-------------|------------------------------|-------------|-------------|----------------|-------------|-------------|
| | 14 (0.21) or less | | | Over 14 to 23 (0.21 to 0.36) | | | Over 23 (0.36) | | |
| | MS | HSLA SS | AL | MS | HSLA SS | AL | MS | HSLA SS | AL |
| Thickness, mm (in.) | 2.54 (.100) | 2.54 (.100) | .160 (4.06) | .115 (2.92) | .155 (3.94) | .173 (4.39) | .129 (3.28) | .129 (3.28) | .187 (4.75) |

Table S6.13.11.2-b
Minimum Thickness for Shells, in. (mm)

| Cargo tank motor vehicle rated capacity in liters (gallons) | MS | SS/HSLA | AL |
|--|--------------|--------------|--------------|
| More than 0 to at least 4,500 (0 to 17,000) | 2.54 (0.100) | 2.54 (0.100) | 3.84 (0.151) |
| More than 4,500 to at least 8,000 (17,000 to 30,300) | 2.92 (0.115) | 2.54 (0.100) | 4.06 (0.160) |
| More than 8,000 to at least 14,000 (30,300 to 53,000) | 3.28 (0.129) | 3.28 (0.129) | 4.39 (0.173) |
| More than 14,000 (53,000) | 3.63 (0.143) | 3.63 (0.143) | 4.75 (0.187) |
| Note: The maximum distance between bulkhead, baffles, or ring stiffeners shall not exceed 1,525 mm (60 inches) | | | |

bulkheads and baffles when used as tank reinforcement that is based on the volume capacity in ~~gallons per~~ per mm **(gallons per inch)** 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) 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.

Steel (HSLA), Austenitic Stainless Steel (SS), or Aluminum.

- b) The minimum required thickness of materials specified in 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)** square ~~mm (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 thickness of materials specified in 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)** ~~square mm (inch)~~ for the cargo tank shell. All thicknesses are expressed in decimals of a mm (inch) after forming.

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

Table S6.13.11.3-a
Minimum Thickness for Heads (DOT 407), mm (in.)

| Volume capacity sq. mm (in gal./sq. in. l/) | 10 (0.122) or less | Over 10 to 14 (0.122 to 0.171) | Over 14 to 18 (0.171 to 0.22) | Over 18 to 22 (0.22 to 0.268) | Over 22 to 26 (0.268 to 0.317) | Over 26 to 30 (0.317 to 0.365) | Over 30 (0.365) |
|---|-----------------------|---|--|--|---|---|--------------------|
| Thickness (MS) | 2.54 (0.100) | 2.54 (0.100) | 2.92 (0.115) | 3.28 (0.129) | 3.28 (0.129) | 3.63 (0.143) | 3.96 (0.156) |
| Thickness (HSLA) | 2.54 (0.100) | 2.54 (0.100) | 2.92 (0.115) | 3.28 (0.129) | 3.28 (0.129) | 3.63 (0.143) | 3.96 (0.156) |
| Thickness (SS) | 2.54 (0.100) | 2.54 (0.100) | 2.92 (0.115) | 3.28 (0.129) | 3.28 (0.129) | 3.63 (0.143) | 3.96 (0.156) |
| Thickness (A) | 4.06 (0.160) | 4.06 (0.160) | 4.39 (0.173) | 4.75 (0.187) | 4.92 (0.194) | 5.49 (0.216) | 6.02 (0.237) |

Table S6.13.11.3-b
Minimum Thickness for Shells (DOT 407), mm (in.)

| Volume capacity in gal./sq. in. (l/sq. mm) | 10 (0.122) or less | Over 10 to 14 (0.122 to 0.171) | Over 14 to 18 (0.171 to 0.22) | Over 18 to 22 (0.22 to 0.268) | Over 22 to 26 (0.268 to 0.317) | Over 26 to 30 (0.317 to 0.365) | Over 30 (0.365) |
|--|-----------------------|---|--|--|---|---|--------------------|
| Thickness (MS) | 2.54 (0.100) | 2.54 (0.100) | 2.92 (0.115) | 3.28 (0.129) | 3.28 (0.129) | 3.63 (0.143) | 3.96 (0.156) |
| Thickness (HSLA) | 2.54 (0.100) | 2.54 (0.100) | 2.92 (0.115) | 3.28 (0.129) | 3.28 (0.129) | 3.63 (0.143) | 3.96 (0.156) |
| Thickness (SS) | 2.54 (0.100) | 2.54 (0.100) | 2.92 (0.115) | 3.28 (0.129) | 3.28 (0.129) | 3.63 (0.143) | 3.96 (0.156) |
| Thickness (A) | 3.84 (0.151) | 3.84 (0.151) | 4.06 (0.160) | 4.39 (0.173) | 4.92 (0.194) | 5.49 (0.216) | 6.02 (0.237) |

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 specified in Table S6.13.11.4-a 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) ~~square mm (inch)~~ for cargo tanks head, 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 thickness of materials specified in 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) ~~mm (inch)~~ square for the cargo tank's shell. All thicknesses are expressed in decimals of mm (inch) after forming.

cular 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 tonne (2600 pounds)
- b) Ton tanks shall not be insulated;
- c) Thickness of plates for DOT Specification's 106A and 110A ton tanks shall be in accordance with 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 percent;
- e) Permitted materials can be either an ASME, SA material, or an ASTM Material permitted by 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 4 inches (100 mm) 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 1-1/2 inches (38 mm) 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.⁵ 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 housing⁵ 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 device 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);

⁵ The forged-welded joint shall be thoroughly hammered or rolled to ensure a sound weld.

NATIONAL BOARD INSPECTION CODE • PART 3 — REPAIRS AND ALTERATIONS

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| A08 | 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 |
| A08 | 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 1-1/2 in. (38 mm) Thick, E7018, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-208-96(R2007) |
| GTAW — Gas Tungsten Arc Welding | | |
| A08 | 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 |
| A08 | 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 1-1/2 in. (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 1-1/2 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 CO ₂ 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-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% CO ₂ 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. | B2.1-1-027-1998 B2.1-1-027:1995 and B2.1-1-027-1998 |

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| A07 | 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 1-1/2 in. (38 mm) Thick, E7XT-XM, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-234: 2006 |
| GMAW – Gas Metal Arc Welding | | |
| A07 | 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 1-1/2 in. (38 mm) Thick, ER70S-3, Flat Position Only, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-233: 2006 |
| A07 | 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 1-1/2 in. (38 mm) Thick, ER70S-3, Flat Position Only, As-Welded or PWHT Condition, Primarily Pipe Applications. | B2.1-1-235: 2006 |
| A07 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 1-1/2 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 |
| A08 | 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 1-1/2 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 |
| A07 | 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 1-1/2 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 1-1/2 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/S8Materials)

| SMAW — Shielded Metal Arc Welding | | |
|--|---|--|
| A08 | 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 1-1/2 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 1-1/2 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 1-1/2 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 1-1/2 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 1-1/2 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 1-1/2 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 1-1/2 in. (38 mm) Thick, IN3XX and ER3XX As-Welded Condition, Primarily Pipe Applications. | B2.1-8-215:2001 B2.1-8-215:1998 and 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 1-1/2 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 1-1/2 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 1-1/2 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 1-1/2 in. (38 mm) Thick, ER3XX and E3XX-XX, As-Welded Condition, Primarily Pipe Applications. | B2.1-8-214:2001 |

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 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1-1/2 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 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1-1/2 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 1-1/2 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 1-1/2 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 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, 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 1-1/2 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 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1-1/2 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 1-1/2 in. (38 mm) Thick, As-Welded Condition, 1/8 in. (3.2 mm) through 1-1/2 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 Welding followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), 1/8 (3.2mm) through 1/2 in. (13 mm) Thick, As-Welded Condition, 1/8 (3.2 mm) through 1-1/2 in. (38 mm) Thick, PWHT Condition, ER80S-B2 and E8018-B2, Primarily Pipe Applications. | B2.1-4-219:1999 |

This text was inadvertently omitted in from the 2007 edition during the restructure of the NBIC. It belongs in Part 3, 2.5.3.

Part 3 Repairs and Alterations

2.5.3 ALTERNATIVE WELDING METHODS WITHOUT POST-WELD HEAT TREATMENT

e) Non Destructive Examination of Welds

- 1) 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, 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 systems 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 nonradiographed 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.

PART 3, SECTION 6 REPAIRS AND ALTERATIONS — SUPPLEMENTS

SUPPLEMENT 1

STEAM LOCOMOTIVE FIRETUBE BOILER REPAIRS

S1.1.3 MATERIALS

S1.1 GENERAL REQUIREMENTS

- 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. **A07**

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, 1999.¹¹ 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.

- 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. **A07**

S1.1.3.1 MATERIAL LIST FOR STEAM LOCOMOTIVE BOILERS

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.

¹¹ Steam locomotive inspection and maintenance standards, which is now codified at 49 CFR Part 230, may be obtained at the FRA Web site. The final rule at www.fra.dot.gov/downloads/counsel/fr/slfr.pdf