

APPENDIX R REPAIR, ALTERATION, AND CONVERSION TO TANK CAR TANKS

1.0 INTRODUCTION

1.1 Scope

1.1.1 Appendix R describes repairs, alterations, or conversions that affect tank heads, shells, sumps, and welds attaching connections car tank components and welds attached directly thereto. Appendix R also ~~and~~ defines the required documentation for reporting these activities. Unless otherwise specified within this appendix, other welding ~~Repairs to connections~~ shall be in accord with the American Welding Society (AWS) Railroad Welding Specification D15.1, ~~except for welds attaching connections to the tank shell or heads.~~ See R24 for NDE and PWHT requirements.

1.1.2 Forms (Exhibit R-1, Exhibit R-2, and Form SS-3), at the owners discretion, may be transmitted electronically for any car that has received an inbound inspection and estimate prior to January 1, 2015, at which time electronic submittal via the Web-based Tank Car Inspection Database (TCID) becomes mandatory. To obtain access to the TCID system, use the following URL: <http://www.rsiaarproject.com>.

1.2 Certified Facilities

Repairs, alterations, or conversions to tank car tanks requiring welding, riveting, or removal of deformations must be performed only by facilities certified by the AAR for fabrication, alterations, conversions, or repairs. See Appendix B.

1.3 General

1.3.1 When special materials, procedures, or dimensional requirements must be maintained, the car owner must provide such data and drawings to the facility performing repair, alteration, or conversion.

1.3.2 ~~Unacceptable imperfections~~ Rejectable discontinuities shall be removed and reexamination made to ensure complete removal. Whenever ~~an imperfection~~ a rejectable discontinuity is removed by chipping or grinding and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners. Where welding is required after removal of ~~an imperfection~~ a rejectable discontinuity, the area shall be cleaned and welding performed in accord with Appendix W for tank heads, shell, sumps, and welds attaching connections car tank components and welds attached directly thereto. ~~Repairs to connections~~ Other repairs shall be in accord with the American Welding Society (AWS) Railroad Welding Specification D15.1, ~~except for welds attaching connections to the tank shell or heads.~~

1.3.3 After ~~an imperfection~~ a rejectable discontinuity has been removed, and prior to making weld repairs, the area shall be examined by suitable methods to ensure that the ~~imperfection~~ rejectable discontinuity has been eliminated.

1.3.4 After repairs have been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners, and reexamined using the same NDT method that failed the initial repair, and by all other methods of examination that were originally required for the affected area.

1.4 Personnel

~~Repairs, alterations, and conversions shall be examined by NDT examiners, qualified per Appendix T for methods employed.~~

2.0 QUALIFICATION OF PERSONNEL AND PROCEDURES

2.1 Welders and Welding Operators

Qualification of welders and welding operators must comply with Appendix W for tank ~~heads, shell, sumps, and welds attaching connections~~ car tank components and welds attached directly thereto. For other repairs, qualification of welders and welding operators shall be in accord with AWS D15.1.

2.2 Welding Procedures

Qualification of welding procedures must comply with Appendix W for tank ~~heads, shell, sumps, and welds attaching connections~~ car tank components and welds attached directly thereto. For other repairs, qualification of welding procedures shall be in accord with AWS D15.1.

2.3 Nondestructive Testing (NDT) Personnel and Procedures

Qualification of NDT personnel and procedures must comply with Appendix T.

~~2.4 Nondestructive Testing (NDT) Procedures~~

~~Qualification of NDT procedures must comply with Appendix T.~~

3.0 APPROVALS AND REPORTS

3.1 New Procedures or Materials

When repairs, alterations, or conversions to tank car tanks are to be made using procedures or materials that have not been previously approved, an application for approval must be submitted as prescribed in Chapter 1, paragraph 1.4. Tank cars must not be returned to service until approval has been granted and repairs have been made.

3.2 Currently Approved Procedures and Materials

3.2.1 Alterations, conversions or accident-related repairs to tank car tanks must be made using current AAR approved procedures and materials as well as car owner's instructions. An Exhibit R-1 report, in compliance with this appendix, must be submitted by the certified or registered facility performing the work to the car owner and to the AAR Executive Director-Tank Car Safety (Director).

The purpose of Exhibit R-1 is to

- Amend the approved Certificate of Construction for each tank car and certify that all alterations, conversions, and accident-related repairs were made in accordance with AAR-approved procedures, materials, and owners' instructions.
- Provide traceability to the original and subsequent 3.2 or Appendix R procedures.
- Provide a historical record of changes to the tank car.

3.2.2 Tank cars must not be returned to service until submission of Exhibit R-1. Failure to submit the required Exhibit R-1 may be cause for action by the AAR.

3.2.3 By signing Exhibit R-1, the certified or registered facility's management representative shall be understood to certify that the work was performed in accordance with AAR-approved procedures and materials as well as with car owner's instructions.

3.2.4 If drawings depicting the previously approved procedures and materials have not been submitted for approval within the last 10 years, then such drawings must be resubmitted for approval on Form AAR 4-2, 4-3, 4-5, or 4-7.

3.3 Exhibit R-1 Report of Tank Repairs, Alterations, or Conversions

Exhibit R-1 is required for reporting the following:

- Accident damage repairs to tank shell, heads, sumps, nozzles, and pads welded directly to the tank
- Alterations that affect the Certificate of Construction, such as changes to valves or fittings
- Conversions (changes in tank or fittings that change the specification)
- Changes in reporting mark and/or car number
- Changes in authorized commodities (listed on the original Certificate of Construction or subsequent Exhibit R-1)

3.3.1 Until September 1, 2014, the owner or, by agreement, the facility's management representative is responsible for providing all requested information, via hard copy or e-mail, in a format approved by the AAR, to the AAR Executive Director—Tank Car Safety, Association of American Railroads, 425 Third Street SW, Suite 1000, Washington, DC 20024. Other methods of transmission are acceptable if agreed to by the AAR. Exhibit R-1 reports must be typed or hand-written legibly or, if transmitted electronically, in a format that the AAR can view. A copy also must be sent to the car owner.

3.3.2 A separate Exhibit R-1 must be prepared for each tank car, except that with the car owner's permission, multiple identical cars receiving identical work may be reported on a single Exhibit R-1. When multiple cars are reported on a single Exhibit R-1, a separate copy must be retained by the car owner for each car listed.

3.3.3 The information from the completed Exhibit R-1 must be retained in such a way that a printable electronic copy or paper copy can be obtained and that changes to the original information can be detected by the car owner or owner's representative^{1/} as back-up documentation of the work performed. The form used by the repair facility to provide information as to the work performed should be as agreed upon by the two parties and need not be the Exhibit R-1 provided in this manual.

^{1/}The term representative does not automatically mean the shop performing the work. It is intended to mean an entity legally contracted to represent the owner, which may or may not be the shop performing the work.

3.3.4 The following instructions corresponding to the line numbers and field name in the database must be followed in filling out the report:

Line	Instruction
1.	The report is the responsibility of the certified or registered facility performing the work.
2.	Car reporting mark(s) and number(s). ^{a/}
3.	The name of the management representative of the facility performing the work.
4.	Date that the work was performed (MM/DD/YYYY).
5.	Name and location of the company or station symbol of where the work was performed.
6.	Enter X in boxes as applicable for all types of work performed on the car.
7.	Enter original date built of the tank car (MM/YYYY). If there is a different date built between the tank and the underframe, indicate the underframe date.
8.	Enter the name of the car manufacturer.
9.	Enter the original AAR certificate number under which the tank car was built.
10.	Identify the commodity to be transported after the work is completed. If unknown, indicate last contents. When listing a regulated commodity, use the DOT/TC proper shipping name.
11.	Enter the as-built car specification. ^{b/} If the car was converted by Form AAR 4-2, or if Exhibit R-1 (for a conversion) was issued prior to the work, enter the conversion specification. ^{b/}
12.	Indicate the car specification following the work. ^{b/}
13.	Indicate the stenciled car specification following the work ^{b/}
14.	For repairs: <ul style="list-style-type: none"> a. Describe the damage using Appendix R terminology (crack, fracture, dent, gouge, etc.) and indicate the affected area (reference Fig. R.2, Tank location chart) and dimensions (e.g., 10 in. crack at ABS). When repairs are required due to an accident, list the railroad involved, the date of the accident, and the location of the accident, if the information is available. b. Describe the repair performed. List appropriate Appendix R references or previously approved procedures. List material specification (e.g., A516 gr. 70 plate, E7018 rod, etc.).
15.	For alteration, conversion, pressure relief device change, or other work, describe the work performed. List appropriate Appendix R references or previously approved procedures. List material specification (e.g., A516 gr. 70 plate, E7018 rod, CS valve body, SS valve trim, Neoprene gasket, etc.). If material is shown on the drawings listed on line 16, indicate "Materials: See 16." ^{a/}
16.	List Tank Car Committee-approved drawings only. Drawings must relate to the work performed. For instance, a drawing representing a crack repair for a DOT-103AW tank cannot be used for a DOT-103CW or DOT-103DW tank that uses different steel. Indicate the approved AAR certificate number (current within 10 years) for each drawing listed. If reference drawings are not in the name of the applicant, the applying facility must state at line 17 "Permission has been granted for use of drawings, by the certificate holder, for this specific car."
17.	If it is necessary to revise a report, a new completed copy must be submitted. Indicate the revision level, the previous date approved by car owner, and the items that were changed.
18.	Print the company name and location of the facility performing the work.
19.	Print the name and title of the facility's management representative.
20.	Management representative's signature and date signed.

^{a/} When changing the reporting mark and/or number, show the new reporting mark and number at line 2. Record the previous mark and number at line 15.

^{b/} Enter a specification without dashes or spaces (e.g. DOT111A100W1).

EXHIBIT R-1 REPORT OF TANK REPAIRS, ALTERATION, OR CONVERSION

1. To AAR Executive Director—Tank Car Safety 2. Reporting mark and number: _____
3. Reported by: _____ 4. Date work performed: _____
5. Work performed at: _____
6. Report of: Tank repairs ◀ Alterations ◀ Conversions ◀ Relief device sizing ◀ Other ◀
7. Built date: _____ 8. Built by: _____
9. Original AAR Certificate No.: _____ 10. Commodity: _____
11. Constructed car spec: _____ 12. Car spec (after this work): _____
13. Stenciled spec (after this work): _____
14. Tank repairs (Reference M-1002 Appendix R, Fig. R2)

A) Nature and location of defect:

B) Procedure and materials:

15. For alterations, conversions, pressure relief devices, or other, list procedure and materials:

16. Pertinent approved drawings:

	DRAWING TITLE	DRAWING NUMBER	AAR CERTIFICATE NUMBER
A.	_____	_____	_____
B.	_____	_____	_____
C.	_____	_____	_____
D.	_____	_____	_____
E.	_____	_____	_____
F.	_____	_____	_____

17. Revisions and notes:

The cars listed above conform to all approvals mentioned and to all applicable DOT and AAR requirements, including specifications, regulations, rules of interchange, and the DOT safety appliance standards.

FACILITY

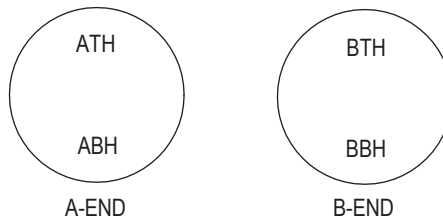
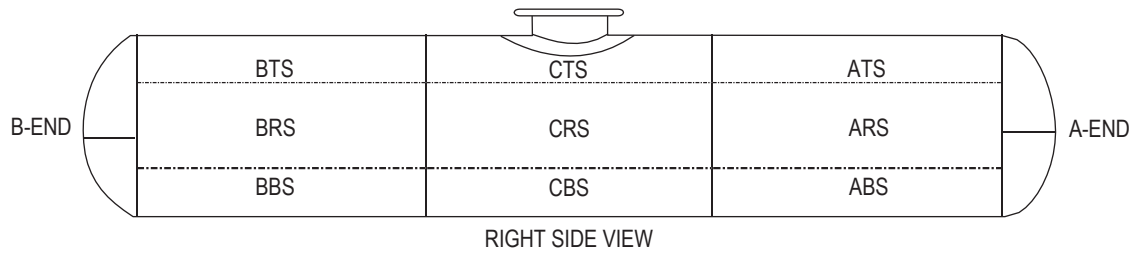
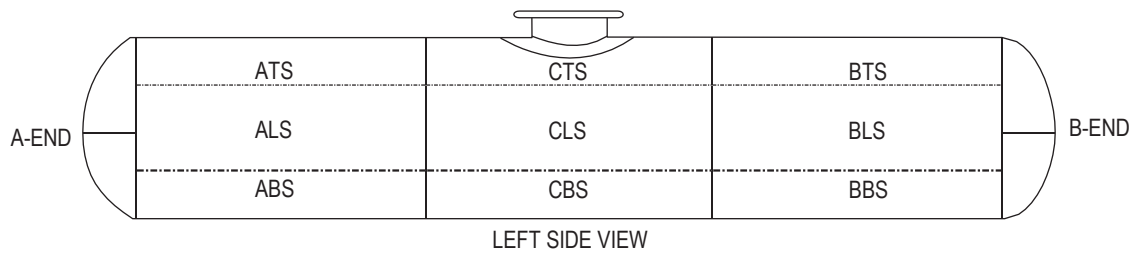
Company name: _____ Location (City/State): _____

Management Representative (Name): _____ Title: _____

Management Representative Signature: _____ Date: _____

Rev. 04/2010

Fig. R.1 Exhibit R-1 Report of Tank Repairs, Alteration, or Conversion



Legend

- | | |
|--------------------------|---------------------------|
| ATS = A-end top shell | BTS = B-end top shell |
| CTS = Center top shell | CBS = Center bottom shell |
| ABS = A-end bottom shell | BBS = B-end bottom shell |
| ARS = A-end right shell | BRS = B-end right shell |
| ALS = A-end left shell | BLS = B-end left shell |
| CRS = Center right shell | CLS = Center left shell |
| ATH = A-end top head | BTH = B-end top head |
| ABH = A-end bottom head | BBH = B-end bottom head |

Note: By convention, "Right" and "Left" sides are relative to a vantage point facing the B-end of the car.

Fig. R.2 Tank location chart

3.4 Exhibit R-2 Report of Nonaccident-Related Buckles, Corrosion, and Crack Repairs

3.4.1 Exhibit R-2 (shown in Fig. R.3) is a means for collecting information pertaining to the following:

- tank buckle repairs
- tank corrosion repairs
- tank crack repairs
- center sill repairs
- repairs to stub sill, bolster, and cradle pad connections to tank

3.4.2 Information supplied will be entered into a database and analyzed in an effort to establish failure trends. The AAR will maintain the database and provide periodic reports.

3.4.2.1 The owner, or owner's designee, is responsible for providing all requested information per paragraph 1.1.1 of this appendix. The AAR is not to receive a hard copy of Exhibit R-2.

3.4.2.2 A separate Exhibit R-2 must be prepared for each car each time nonaccident buckles, cracks, or corrosion repairs are made to it. Up to six repairs per car may be reported on one Exhibit R-2 by inserting information for each in the proper blank, a., b., c., d., e. or f., for each item of information. The Exhibit R-2 software allows entry of up to 26 different repairs per car.

3.4.2.3 The information from completed Exhibit R-2 must be retained, for back-up documentation of the work performed, by the car owner or the car owner's representative in such a way that a printable electronic copy or paper copy can be obtained and that changes can be detected. The Exhibit R-2 at the back of this publication may be used as the hard copy, but is not mandatory. The software is capable of generating a printed record of repairs, which may also serve as the hard copy. The form used by the repair facility to provide repair information to the owner should be as agreed upon by the two parties, and need not be the Exhibit R-2 provided in this manual.

3.4.2.4 Exhibit R-2 data in the software is entered by line number. These line numbers correspond to the entries on the Exhibit R-2 provided in this manual. Each item of the form is to be filled in as described below. Consult the *R-2 Program User's Guide* before attempting to complete Exhibit R-2.

Line	Instruction
1.	Enter the name of the car owner.
2.	Enter the car reporting mark and number.
3.	Enter the name of the company having performed work on the car.
4.	Enter the location of the repair shop or company at which work was performed.
5.	Enter the month, day, and year of repair.
6.	Enter the month and year car was built.
7.	Enter the builder's code as listed in Table R.1.
8.	Enter the original AAR Certificate of Construction number under which the tank car was approved.
9.	Enter the commodity to be transported after the work is completed.
10.	Enter the tank specification, as built.
11.	Enter the tank specification after work is completed.
12.	Enter the specification to be stenciled on the tank car after work is completed.
13.	Enter the manufacturer's stub sill design style designation and corresponding builder code as shown in Table R.1.
14.	Indicate whether or not the car is jacketed.

EXHIBIT R-2 (PAGE 1 OF 3)

REPORT OF NONACCIDENT-RELATED BUCKLES, CORROSION, AND CRACK REPAIRS

- 1. Car Owner _____ 2. Reporting Mark and Number _____
- 3. Reported by _____ 4. Performed at _____
- 5. Date _____ 6. Tank Built Date _____ 7. Built by _____
- 8. Original AAR Cert. of Const. No. _____ 9. Commodity (after this work) _____

Tank spec.: 10. (as const.) _____ 11. (after this work) _____ 12. Stenciled _____

- 13. Stub Sill Design Style _____ 14. Car Jacketed? (Y/N) _____ 15. Head Brace? (Y/N) _____

16. Component Where Failure Occurred:

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(A)-Tank Shell-Interior (B)-Tank Shell—Exterior (C)-Tank Head—Interior (D)-Tank Head—Exterior (E)-Center Sill—Web (F)-Center Sill—Flange (G)-Center Sill—Both (H)-Bolster Pad (Tank Cradle) (J)-Tank Reinforcing Pad (Inboard of Bolster) (M)-Brake Support (N)-Tank Bolster (O)-Other (Explain in Item 24. Comments) (P)-Weld—Bolster Pad to Tank (Q)-Stub Sill Web (R)-Stub Sill Top Flange (S)-Stub Sill Bottom Flange (T)-Head Brace (U)-Head Pad (V)-Top Longitudinal Centerline (W)-Bottom Longitudinal Centerline.

Cracks in Stub Sill Related Welds (See Figs. R3.1 through R3.6):

Transverse Welds: (A1)-Pad to Tank, (B1)-Pad to Sill, (C1)-Brace to Sill, (D1)-Brace to Pad, (E1)-Other. Longitudinal Welds: (A2)-Pad to Tank, (B2)-Pad to Sill, (C2)-Brace to Sill, (D2)-Brace to Pad, (E2)-Other (BF)-Bottom Outlet Flange (MW)-Manway Nozzle (SN)-Safety Device Nozzle.

- 17. Type of Failure: a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(A)-Buckle (B)-Crack in Parent Metal (C)-Crack in Weld (D)-Corrosion—Random Pits (E)-Corrosion—Grouped Pits (F)-Corrosion—Adjacent to Weld (G)-Corrosion—General (H)-Other (Explain in Item 24. Comments) (I)-Corrosion—Bathtub Ring (BL)-Blister.

- 18. Cause of Failure: a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(A)-Fatigue (B)-Workmanship (C)-Missing Weld (D)-Unknown (E)-Overstressed (F)-Abused (G)-Corrosion (BL)-Blister.

- 19. How Repaired: a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(A)-10.2 (B)-10.5 (C)-25.0 (D)-11.1 (E)-13.2 (F)-Replaced in Kind (G)-Precedent Certificate of Construction, Number: a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ (H)-12.2 Buckles (I)-Rule 82 Weld Sill (J)-Rule 57 (K)-Other (Explain in Item 24. Comments).

- 20. Length of Crack: If Item 17 is (B) or (C) [crack], enter length in inches:

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

- 21. Location of Corrosion: If Item 17 is (D), (E), or (F) [corrosion], indicate approximate location on sketches on reverse side of form. Dimensions are not required.

22. Location of Repair on Car:

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(A)-A End (B)-B End (C)-BR Side (D)-BL Side (E)-AR Side (F)-AL Side (P)-Top or Bottom of Transverse Centerline (Q)-Transverse Centerline Left (R)-Transverse Centerline Right (S)-Top Long. Centerline (T)-Bottom Long. Centerline a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(G)-Circumferential Distance on Tank Shell from Bottom Longitudinal Centerline, (xxx) inches

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(H)-Longitudinal Distance on Tank Shell from Head/Shell Seam Along Longitudinal Axis, (xxx) inches

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(J)-Horizontal Curved Distance on Head Shell from Vertical Centerline of Head, (xxx) inches

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(M)-Vertical Curved Distance on Head from Top of Sill, (xxx) inches

a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(N)-Horizontal Distance from Striker, (xxx) inches

- 23. Inspection Method Used to Detect Defect: a. _____ ; b. _____ ; c. _____ ; d. _____ ; e. _____ ; f. _____ .

(AE)-Acoustic (RVT)-Fiber Optic (LP)-Liquid Penetrant (MT)-Magnetic Particle (UT)-Ultrasonics (VT)-Visual (RT)-X-RAY (OT)-Other (Explain in Item 24. Comments)

- 24. Comments: _____

- 25. Completed by: _____ Date: _____ Title: _____ Signature: _____

Distribution: Original—Car owner; Electronic copy—AAR

Fig. R.3 Exhibit R-2 Report of Nonaccident-Related Buckles, Corrosion, and Crack Repairs

EXHIBIT R-2 (PAGE 2 OF 3)
REPORT OF NONACCIDENT-RELATED BUCKLES, CORROSION, AND CRACK REPAIRS

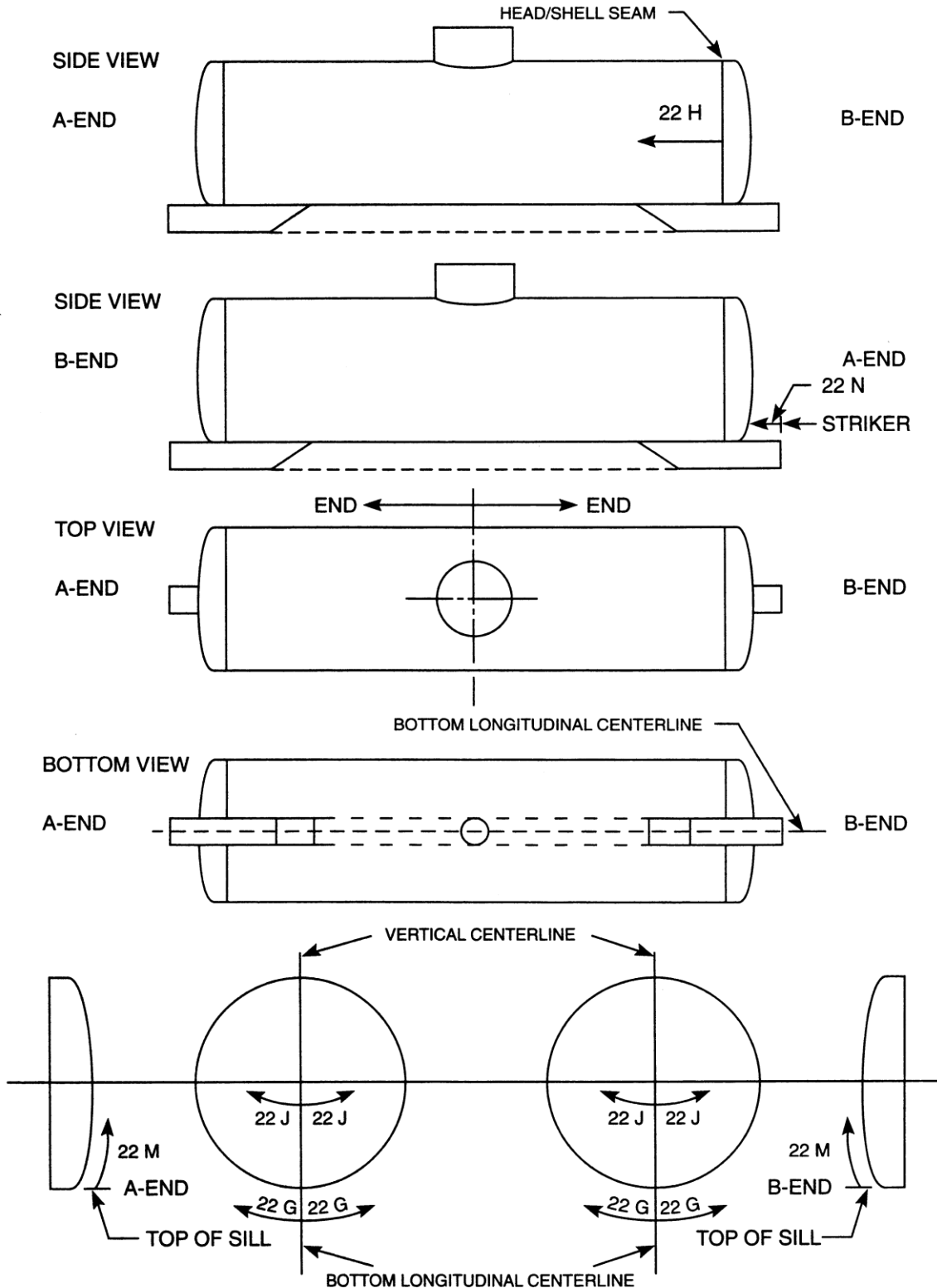


Fig. R.3 Exhibit R-2 Report of Nonaccident-Related Buckles, Corrosion, and Crack Repairs (continued)

EXHIBIT R-2 (PAGE 3 OF 3)
REPORT OF NONACCIDENT-RELATED BUCKLES, CORROSION, AND CRACK REPAIRS

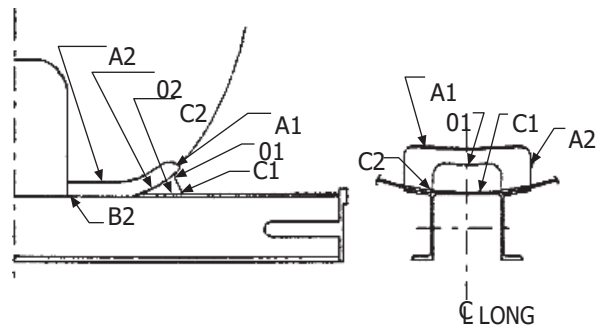


Fig. R3.1

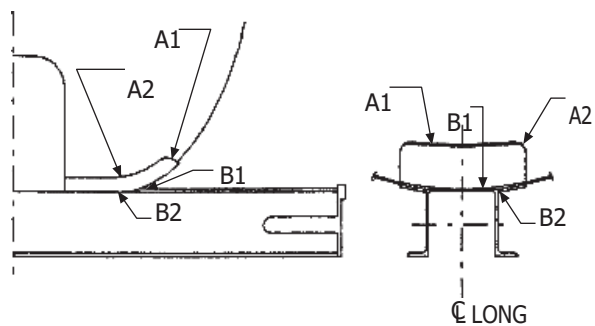


Fig. R3.2

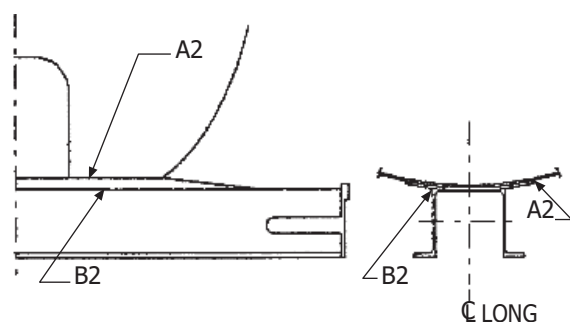


Fig. R3.3

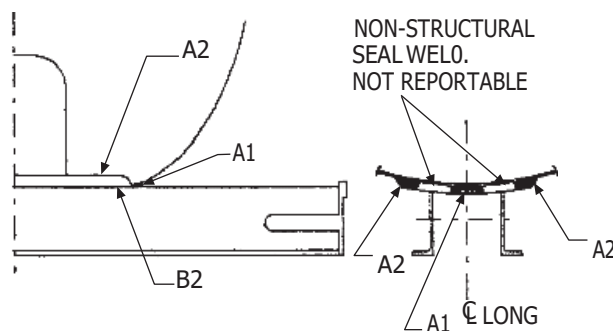


Fig. R3.4

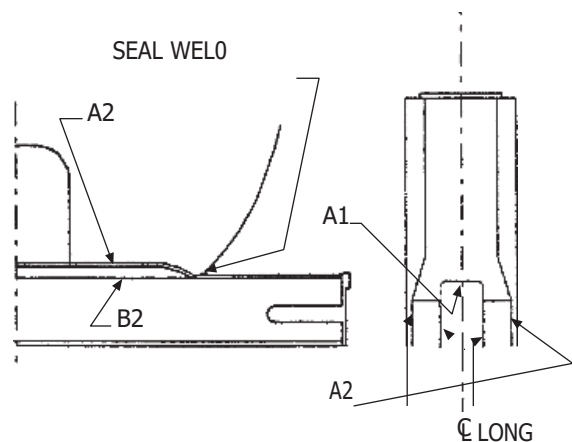


Fig. R3.5

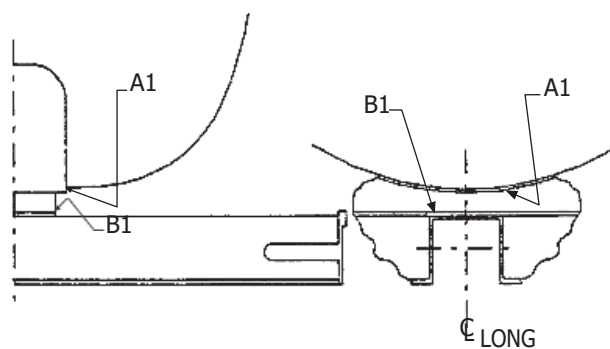


Fig. R3.6

Fig. R.3 Exhibit R-2 Report of Nonaccident-Related Buckles, Corrosion, and Crack Repairs (concluded)

Table R.1 Builder and design style identification (page 1 of 2)

Builder Name	Exhibit R-2 Designation for:	
	Builder	Stub Sill Design Style
ACF Industries, Inc. American Railcar Industries	ACF ARI	100 (Fig. R3.3) 200 (Fig. R3.4) 230 (Fig. R3.4) 270 (Fig. R3.4) 300 (Fig. R3.1)
AMF- Beard design (Built by NACCO, Davie, Hawker Siddeley)	AMF DSL HST NAC	ABC (Fig. R3.5) JKL (Fig. R3.5 w/Hd. Brace) ^{a/}
Constructora	CNC	001 (Fig. R3.2) 002 (Fig. R3.1) ^{a/}
Davie Shipbuilding Ltd. (See AMF-Beard)		
Evans Railcar	EVA	EVA (Fig. R3.2) WBR (Fig. R3.1) ^{a/}
General American Transportation Corporation	GAT	018 (Fig. R3.1) 18A (Fig. R3.1) 18B (Fig. R3.1) 020 (Fig. R3.1) 090 (Fig. R3.6) 095 (Fig. R3.1) 097 (Fig. R3.2) 098 (Fig. R3.1) 102 (Fig. R3.2) as built 102 (Fig. R3.1) ^{a/b/}
Gulf Railcar	GUL	GUL (Fig. R3.4) WBR (Fig. R3.1) ^{a/}
Hargis Railcar	HAR	HAR (Fig. R3.1) 270 (Fig. R3.4)
Hawker Siddeley	HST	080 (Fig. R3.4) 081 (Fig. R3.1) ^{a/} 098 (Fig. R3.1)
Lox Equipment	LOX	LOX
National Steel Car	NSC	001 (Fig. R3.1)
North American Car Corp. (NACCO)	NAC	AB1(Fig. R3.5) DEF (Fig. R3.2) GHI (Fig. R3.1) ^{a/} JK3 (Fig. R3.5) ^{a/} ZBN (Fig. R3.1) 200 (Fig. R3.1) ^{a/}
Process Engineering	PEN	PEN
Procor Limited (See Union Tank Car Co.)		
Richmond Tank Car Company	RIC	RIC (Fig. R3.2) WBR (Fig. R3.1) ^{a/}
Riley-Beard	RIL	RIL (Fig. R3.2) WBR (Fig. R3.1) ^{a/}

Table R.1 Builder and design style identification (page 2 of 2)

Builder Name	Exhibit R-2 Designation for:	
	Builder	Stub Sill Design Style
Texana Tank Car & Mfg.	TEX	TEX (Fig. R3.1)
Trenton Works Lavalin	TWL	TWL (Fig. R3.1)
Trinity Industries	TRN	TYA (Fig. R3.1) TY1 (Fig. R3.2) TY2 (Fig. R3.1) TY3 (Fig. R3.1) 021 (Fig. R3.1) 022 (Fig. R3.1) 023 (Fig. R3.1) 024 (Fig. R3.1)
Union Tank Car Company Procor Limited	UTL PRO	00F CBO (Fig. R3.1) CBR (Fig. R3.1) ^{a/} CWO (Fig. R3.5) FBR (Fig. R3.1) ^{a/} ZBA (Fig. R3.1) ZBB (Fig. R3.1) ZBC (Fig. R3.1) ZBD (Fig. R3.1) ZBE (Fig. R3.1) ZBF (Fig. R3.1) ZBG (Fig. R3.1) ZBH (Fig. R3.1) ZBI (Fig. R3.1) ZBN (Fig. R3.1) ZBR (Fig. R3.1) ^{a/} <u>ZBL (Fig. R3.1)</u> <u>ZBM (Fig. R3.1)</u>

^{a/} Original design modified to include head braces

^{b/} Builder code to be GAX for modified sills for this style only

3.5 Availability of Forms

Reproducible copies of Exhibit R-1 and Exhibit R-2 are located at the back of this publication.

4.0 SPECIAL REQUIREMENTS

For special commodity requirements, see Tariff No. BOE-6000. Also refer to the special commodity requirements in Chapter 2.

4.1 Hydrogen Fluoride, Anhydrous (AHF)

4.1.1 Existing tank cars placed into anhydrous hydrogen fluoride service must conform to Chapter 2, paragraph 2.1.4.

4.1.2 ~~Weld repair of blisters in AHF tank car tanks shall be repaired by insert in accordance with paragraph 12.0 of this appendix R24, Table R2. Weld repair of blisters in AHF tanks shall be repaired by insert. Insert material shall conform to the requirements of Chapter 2, paragraph 2.1.4. Low-hydrogen electrodes must be used. When required, radiography and postweld heat treatment is required for any weld repair made to an AHF tank.~~ radiography or ultrasonic examination must be performed after postweld heat treatment. The tensile strength of the deposited weld material joint tension specimens (as shown on the welding procedure qualification record) must not exceed 85 ksi and must have a carbon equivalent (C.E.) of less than 0.42. ~~Preheat and interpass temperature of 300 °F shall be maintained during welding. The Postweld heat treatment shall be done in accordance with R19.0, and the temperature must be between 1125 °F and 1225 °F. for 1 hour per inch of thickness of material with a 1 hour minimum holding time and must be controlled to prevent a harmful temperature gradient in the welds and the adjacent base metal.~~ The maximum hardness of the weld and heat-affected zone (after PWHT) shall not exceed 248 DPH (Diamond Pyramid Hardness-Vickers) or 20 HRC. Brinell hardness testers are not permitted on repair welds due to the large size of the indenter relative to the features being measured; however, it is common practice to convert hardness measurements to Brinell hardness values using published conversion tables.

4.1.2.1 Portable hardness test methodology and procedures shall conform to the following:

- This procedure provides the techniques to use portable hardness testers to screen the hardness of welds, base metal, and heat-affected zones in tank car construction and repair.
- A microhardness measurement device with a Vickers diamond indenter must be used (e.g., a Krautkramer MIC 10).
- Use a power tool to remove any rust, fine corrosion pits, or other roughness from the surface to be tested. Finish the test surface with a high-speed medium sandpaper disc or a wire wheel to create a suitably smooth surface. The surface finish is satisfactory when the majority readings are consistently within 1 or 2 units of Rockwell C hardness (or 5 units of Brinell hardness).
- At each test location, the hardness of the base metal on each side of the weld, the heat-affected zones immediately adjacent to the toes of the weld, and three readings across the face of the weld deposit itself must be tested and recorded separately on both sides of the plate. Each hardness test location must be spaced 3 in. apart for a repair insert up to 12 ft in circumference. For a repair insert larger than 12 ft in circumference, hardness test locations must be spaced 6 in. apart. When tank repairs are made from one side only, and subsequently covered by attachment fillet welds, hardness readings of the fillet weld metal and tank attachment heat-affected zone may be substituted, provided the same welding procedure specification is used for both tank weld repair and fillet weld application.
- Take five readings at each test location and average them together. If an extremely large or small reading occurs, delete it. Continue taking readings until the average stabilizes by changing less than 1 Rockwell C unit (or less than 5 units of Brinell hardness) with each new reading.

4.1.2.2 ~~Weld repair to cracks and other defects requiring welding on the tank heads or manway nozzle in AHF tank cars shall conform to the requirements of paragraph 4.1.2.1 above.~~

5.0 DAMAGED STUB SILLS (MOVE TO CHAPTER 2 (OR OTHER TBD LOCATION))

5.1 Scope

~~Stub sill tank cars must be home-shopped for stub sill inspection, and the owner must be notified if the car has been damaged to the extent outlined below:~~

- ~~• Stub sill bent, twisted, or bulged in excess of 3/4 in. per 30 in. of sill length~~
- ~~• Bottom tank or stub sill reinforcing plate buckled 1/2 in. in depth or more~~
- ~~• Broken rear draft lug assemblies or attachment welds~~
- ~~• Any cracks in the draft sill inboard of the face of the rear lug assembly~~
- ~~• Any cracks in the area of the head brace~~

5.2 Cleaning for Inspection

~~Welds must be cleaned and made accessible consistent with the inspection technique.~~

5.3 Inspection

~~5.3.1 The following areas must be inspected at a minimum:~~

- ~~• The inboard end of the stub sill reinforcement pad and its welds, for a 12 in. length from the inboard end.~~
- ~~• All welds between sill and head brace (if used), between head brace and head reinforcement pad, and between the tank and reinforcement pad to at least 1 in. inboard of the sill-to-head reinforcement pad connection.~~
- ~~• All parent metal of the stub sill assembly outboard of the bolster.~~

~~5.3.2 The draft gear pocket must be inspected.~~

5.4 Inspection Methods

~~Inspection methods, such as acoustic emission (twist test), fiber optics, or visual techniques may be used. Magnifiers, mirrors, or liquid penetrant may be used to aid in the inspection.~~

5.5 Inspection Reporting

~~When required by car owner, documentation of inspection results should be submitted to the owner using Form SS-1, Report of Tank Car Stub Sill Inspection (see Fig. R.12).~~

5.6 Repairs

~~5.6.1 Repair per owner's instructions or in kind to restore original design.~~

~~5.6.2 Straighten bent sills.~~

~~5.6.3 Reinspect all repairs.~~

~~5.6.4 Repair all cracks, including seal welds.~~

6.0 ACCEPTANCE CRITERIA

6.1 Welding

6.1.1 All welded repairs to tank car tanks must conform to the applicable sections of Appendix W, paragraphs 2.0, 13.0, and 14.0.

~~6.1.2 All welded repairs to related components or assemblies must conform to the applicable sections of AWS D15.1 (latest revision).~~

6.2 NDT

All nondestructive testing results shall meet the requirements of Appendix W, paragraph 10.0.

7.0 MATERIALS

7.1 Specifications

Materials for repairs, alterations, or conversions must comply with the material specification for the original tank, or must have comparable physical and chemical properties and be listed in Appendix M.

7.2 Corrosion Resistance

Procedures and materials used in repairs to high alloy steel tanks must maintain the corrosion resistance capability required for the tanks, as originally built.

7.3 Low Hydrogen Electrodes

When repair welding procedures involve the use of low hydrogen electrodes, they must be handled in accord with the requirements of Appendix W, paragraph 14.12.

~~8.0 HARDNESS TESTS~~

~~Butt-welded repairs in pressure car tanks that are constructed of Table M.10.1 materials must be tested for hardness. Each weld must be checked at one point inside and one point outside the tank at the center line of the weld. Weld hardness must not exceed Brinell 225 (Rc 20) after postweld heat treatment.~~

9.0 REPAIR OF CRACKS

9.1 Methods

Tank cracks may be repaired by one of the following methods:

9.1.1 For cracks determined to progress through the thickness of the tank shell, By preparation and welding of the crack shall be in compliance with Fig. R.5. A interior or exterior reinforcement patch may be applied over the repaired area, if deemed necessary.

9.1.2 By removal of the defective area and application of a welded insert, except as noted in paragraph 13.2.2 below.

9.1.3 On riveted tanks only, by removal of the defective area and application of a riveted patch.

9.1.4 For cracks that do not progress through the thickness of the tank shell, and welding is done from one side only, see R1.3.2, R1.3.3, R1.3.4 and R9.2 as applicable. See R24 for NDE and PWHT requirements.

9.2 Welding of Cracks

9.2.1 When a crack of any size is repaired by welding, the entire discontinuity must be removed by chipping, grinding, or by the air-carbon arc or plasma arc processes. The chipped, ground, air-carbon arc gouged, or plasma arc gouged groove cut into the base metal must be tapered toward the plate surface to provide sound metal for the weld.

9.2.2 On aluminum tanks, flame gouging or air-carbon arc gouging must not be used.

9.3 Reinforcements

Reinforcements may be applied to areas where cracks have occurred; however, cracks must first be repaired in accordance with paragraph 24.0. The reinforcement may then be applied, by welding, to the interior or exterior of the tank. Reinforcements must be of a thickness at least equal to the original tank plate. ~~The area must be postweld heat treated. See R24 for NDE and PWHT requirements.~~

~~9.4 Cracks in Dome Apron~~

~~Cracks in the dome apron of riveted tanks may be repaired by fusion welding. A reinforcement must be applied if the welded area requires postweld heat treating. If a crack extends into the dome flange rivet holes, the joint must be separated to permit weld groove preparation as prescribed in paragraph 9.2.1 above. See Fig. R.7. If it is necessary to remove the tank shell sheet, see paragraph 12.0 or 13.0 below.~~

9.5 Repair of Surface Cracks

For areas on tank car tanks that are allowed reduced thickness in 49 CFR 180.509(g), surface cracks 1/16 in. or less in depth may be removed by grinding to sound metal and blending the ground area smooth with the surrounding plate and/or weld. If the area to be ground is at the toe of a weld, the final surface must be free from undercut and slag. Grinding must be accomplished transverse to crack length unless the crack is along a weld toe, in which case the grinding must be along the length of the crack. Grinding marks and localized frictional heating from grinding must be kept to a minimum. For hand-held disc grinding, the disc should be inclined between 30° and 45°. After grinding repairs, the ground area must be examined by magnetic particle or liquid penetrant method.

10.0 REPAIR OF PITS AND CORROSION

10.1 Repair of pits and corrosion shall be done in accordance with paragraph R24. Welding Purpose Codes A and B apply.

10.2 Patch Plate Repair – AAR Specification Tanks

10.2.1 Repair of corroded areas on AAR-class tank car tanks may be made by application of a patch plate contoured to the shape of the tank and with 1 in. (25.4 mm) minimum corner radii. The minimum patch plate thickness must be equal to the original tank thickness, and the plate material properties must equal or exceed the tank material properties.

10.2.2 The patch plate must be limited to a 24 in. (609.6 mm) circumferential width dimension between longitudinal fillet welds. If welds intermediate to the longitudinal fillet welds are also applied, such as longitudinally spaced slot or plug welds, the maximum plate width is 48 in. (1219.2 mm) between the longitudinal fillet welds.

10.3 Repair of Pressure Car Manway Gasket Grooves

Repair of a gasket groove on a pressure car manway nozzle is to be made by removing corroded or damaged material, applying weld metal, machining the flange face, and recutting the groove. See paragraph 24.0 in this appendix for welding and NDE requirements.

11.0 REPAIR OF DEFORMATION AND SCORING

11.1 Dents or Buckles

Dents or buckles may be repaired, provided the procedure by which the areas are restored to contour does not damage the material or alter the physical properties of the material beyond specification limits.

11.2 Pressing or Jacking

11.2.1 If the sharpest radius formed by dents is at least four times the plate thickness, such dents or buckles may be removed by pressing or jacking to restore original contour to within the limits specified in Appendix W, paragraph 13.5. Excessive heating of the metal shall be avoided. For carbon steel, the maximum temperature is 1250 °F (677°C). If the temperature exceeds 1250 °F (677°C), the affected area shall be repaired by insert.

11.2.2 After complete removal of a deformation, the interior and exterior surfaces of the affected area must be examined for surface cracking, by either liquid penetrant or magnetic particle method, in accord with Appendix W, paragraph 10.0. All weld seams in the deformed area and adjacent within 2 in. (50.8 mm) of the deformed area must be radiographed or ultrasonically examined for the entire weld seam length and 2 in. (50.8 mm) beyond the deformed area.

11.3 Replacement

If the sharpest radius formed by dents or buckles is less than four times the plate thickness, or if material thickness has been reduced, the affected area must be removed and replaced.

11.4 Scores and Gouges

11.4.1 Scores or gouges associated with dents must be prepared first by restoring the dented area to original contour, per paragraph 11.2 above. The score or gouge must then be prepared by grinding or by air-carbon arc or plasma arc gouging, to sound metal, removing all upset metal and ~~injurious defects~~ rejectable discontinuities. The prepared area must have a smooth transition to the surrounding plate. After preparing, the area must be examined by magnetic particle or dye penetrant method, in accord with Appendix W, paragraph 10.0.

11.4.2 If the plate has been reduced below the limitations shown below, it must be restored or replaced in accordance with the applicable reference and paragraph 24.0.

- All DOT specification tanks—49 CFR 180.509
- AAR specification tanks transporting regulated hazardous commodities—49 CFR 180.509
- AAR specification tanks transporting nonregulated commodities—M-1002 Appendix D

11.5 Wheel Burn

11.5.1 A shell damaged as a result of wheel contact (burn) must be repaired by one of the following methods:

11.5.2 Wheel burns that do not exceed 1/16 in. (1.58 mm) in depth and 6 in. (152 mm) in length, width not limited, can be repaired by grinding, provided the shell thickness following grinding is not less than the minimum allowable thickness. The general location must have all upset metal and ~~injurious defects~~ rejectable discontinuities removed, and the repaired area must be examined by magnetic particle or liquid penetrant method, in accord with Appendix W, paragraph 10.0.

11.5.3 Wheel burns that exceed the limitations of paragraph 11.5.2 must be repaired per paragraph 24.0.

12.0 WELDED INSERTS AND TANK SECTIONS

12.1 When Permitted

12.1.1 On riveted tanks, welded inserts and tank sections may be applied if the welding can be locally postweld heat treated.

12.1.2 On fusion-welded tanks, welded inserts and sections may be applied to any part of the tank shell and heads.

12.1.3 On forge-welded tanks, welded inserts and tank sections may be applied to any part of the tank shell and heads, provided the welds of the insert are at no point closer than 12 in. (305 mm) to any forge-welded seam.

12.2 Procedure

12.2.1 The insert or plate must have a double-welded butt joint (DOT-113, DOT-115A, AAR-204W, and AAR-206W specification tanks can be welded from one side using backing strips) with 1 in. (25.4 mm) minimum corner radius. The insert must restore original contour.

12.2.2 The inserted material must be of a thickness equal to or not more than 1/8 in. (3.14 mm) greater than the original material. See Appendix E when the inserted material is thicker than the original material. Inserted material must comply with the material specification for the original tank or must have comparable chemical composition and physical properties equal to or greater than the original material. Materials used for insert material must be listed in Appendix M and in the relevant table for that material type.

12.2.3 Heads repaired by welded inserts are considered to have the same welded joint efficiency as the original head. Head insert welds in the knuckle area, or straight flange, must be ground flush on both sides.

12.3 Inspection of Nonpressure Tanks Inserted in Groups

When uniform inserts, tank sheet sections, or tank heads are being installed in succession on a series of tanks of the same material specification on a production basis, utilizing the same welding procedures and practices employed in the construction of new tanks, the inspection requirements shall comply with Appendix W, paragraph 18.0.

12.4 Welded Inserts in Void Areas

Indentations or cracks in void areas of compartmented tanks may be repaired by application of an insert, per Fig. R.9. The backing strip must be made in one piece, securely clamped and tack-welded before being utilized as a backing.

13.0 RIVETED REPAIRS AND SEAL WELDING

13.1 Requirements

Riveted repairs must be made in compliance with the specification covering original tank construction.

13.2 Riveted Patches

13.2.1 When it is necessary to remove a section of a riveted tank shell because of extensive cracks, reduction in plate thickness, or other defects too large to permit a welded insert from being successfully applied and locally postweld heat treated, a riveted patch must be applied or the defective area replaced in accord with original construction.

13.2.2 Riveted patches may be applied to rubber-lined or elastomeric-lined welded tanks when a welded repair will destroy the lining. A riveted patch must be replaced with a welded repair when the tank is relined.

13.3 Seal Welding

Seal welding inside caulking edges of tank seams and inside rivet heads, attachments, and outside caulking edge of dome flange is permitted, provided the throat thickness does not exceed 3/16 in. (4.76 mm).

14.0 CONNECTIONS ADDED OR RELOCATED

14.1 When Permitted

Additional and relocated connections, such as nozzles, may be added or relocated on dome heads and tank shells, in compliance with Figs. E.20.1 through E.20.12.

14.2 Procedure

Miscellaneous connections through the tank shell or heads, when added, relocated, or eliminated, and closures for openings may be fusion-welded by a double-welded butt joint, or a double full fillet lap joint, or these closures may be riveted. Note that this permits riveted connections on welded tanks. For computing rivet area, the effective diameter of a driven rivet is the diameter of its reamed hole. In no case is the hole to exceed the nominal diameter of the rivet by more than 1/16 in. (1.59 mm). Use of rivets of less than 5/8 in. (15.9 mm) nominal diameter is prohibited.

14.3 Removal of Rivet Holes

When welded inserts are applied to cover riveted nozzle openings, the openings shall preferably be increased in diameter so that the rivet circle is removed and an insert large enough to cover the entire area applied.

14.4 Welding of Rivet Holes

When necessary to close rivet holes, the holes must be plug-welded. See Fig. R.6. The back-up backing strip(s) must be removed after welding and prior to performing any nondestructive examination (NDE). Plug welds must be ground smooth if tanks are to be lined.

14.5 Nozzles and Domes on Welded Tanks

14.5.1 Nozzles and domes attached to a tank shell must be designed to meet the reinforcement requirements of Appendix E.

14.5.2 Approved nozzle and dome designs and welded attachments are shown in Appendix E, Figs. E.20.1 through E.20.12.

14.5.3 Other designs of nozzles and domes and their attachments to tanks may be used, providing reinforcement meets the requirements of Appendix E and welding is equivalent to that shown for designs in Figs. E.20.1 through E.20.12.

14.5.4 When nonpressure tank cars are altered or repaired, or when pressure tank cars are converted to nonpressure status, insert-type nozzle applications may be made, utilizing partial penetration welds per Fig. R.10, subject to the following limitations:

- Applications apply to top fittings only
- Joint gap must not exceed 3/32 in. (2.38 mm) with joint ground smooth or reamed
- Nozzle size must not exceed 10 in. (254 mm) inside diameter
- ~~The welding joint must be preheated to 250 °F (121 °C)~~

14.5.5 When nonpressure cars are altered or repaired, or when pressure cars are converted to nonpressure status, lap joint nozzle applications may be made, in accord with Fig. R.11.

14.6 Permanent Closure of Bottom Outlet or Washout Flange

A bottom outlet or bottom washout flange may be internally sealed by a plate of tank car tank material of the minimum thickness for the car specification that is welded by continuous ~~complete penetration groove welds or combination double full fillet or a combination of full fillet and complete penetration groove welds. Radiography or ultrasonic testing and postweld heat treatment are not required for welding to the flange. See R24.0, Welding Purpose Code I for NDE and PWHT requirements.~~

14.7 Closures for Tongue-and-Groove Fittings Interfaces

When fittings equipped with tongue-and-groove interfaces are removed from a pressure car manway cover plate, they must be replaced using tongued blind flanges that are in accord with Figs. E.27 or E.28. When 3 in. full-ported flanged ball valves equipped with ANSI B16.5 large tongue design are removed from a nonpressure car top fittings cover plate, they must be replaced using 3-in. ANSI Class 300 blind flanges equipped with ANSI B16.5 large tongue design.

15.0 ATTACHMENTS ADDED OR RELOCATED

15.1 Welded Attachments

15.1.1 Exterior or interior brackets, supports, and reinforcement bar pads may be fillet-welded to a tank shell per the requirements of paragraph 24.0.

15.1.2 When adding or relocating reinforcing pads or appurtenances, such as skids, washouts, and sumps, to the bottoms of stub sill tank cars, the requirements of Appendix E, paragraph 15.0, must be met. The fillet welds must meet Appendix W, paragraph 14.10, and the circumferential portions of the fillet welds must be examined by magnetic particle or liquid penetrant, including the corner and at least 3 in. of the weld extending longitudinally beyond the corner.

15.2 Anchor Rivet Caps

One-piece anchor rivet caps may be attached to a tank shell per the requirements of paragraph 24.0. A tapped hole must be provided through the tank shell under each cap to permit making an air test. Each test hole must be tightly closed with an approved plug after completion of the test. Caps must be tested by applying air pressure of 100 psi (689 kPa) and must be tight against leakage.

15.3 Welded Bolster Supports

Welded steel tanks mounted on underframes may be modified by attaching welded bolster supports to tank bottom reinforcement plates or directly to the tank, securely fastened to underframe, with necessary provision for expansion and contraction. Welding must be done in accordance with the requirements of paragraph 24.0.

15.4 Welding Stud Attachments

Stud welding on carbon steel tank car tanks shall be done in accord with Table R.2. Stud welding on tank car tanks made from P-8 (types 304L, 316L), P-22, or P-25 materials shall be done in accord with Table R.3. Welding Purpose Code F applies for both tables.

15.5 Repairs in Kind

Repairs in kind to tank car tanks that have developed service failures in bolster or anchor areas, at the dome-shell interface, or in bottom discontinuity protective devices, must be submitted on Form AAR 4-2 for a review of the adequacy of the original design.

~~16.0 ATTACHMENT OF STUB DRAFT SILL~~

~~16.1 Procedure (MOVE TO CHAPTER 2)~~

~~Stub draft sills may be fusion-welded to bottom reinforcement plates. Tanks mounted on underframes also may be modified by attaching welded stub draft sills.~~

17.0 INSERTION OF INTERIOR TANK HEADS

17.1 Head Requirements

When AAR or DOT tanks are altered by dividing into compartments or by reducing capacity by the insertion of interior heads, interior heads must comply with the requirements specified in DOT 179.200-6.

17.2 Welding

Welding of inserted heads must be performed in accord with Appendix E, paragraph 6.0. Welding of the replaced head must be performed in accord with paragraph 12.0 above.

17.3 Voids Created

A void created by the addition of interior heads must be provided with at least one tapped drain hole at the lowest point and a tapped hole at the top of the tank. The top hole must be closed, and the bottom hole may be closed, with not less than 3/4 in. nor more than 1 1/2 in. solid pipe plugs having NPT threads.

18.0 NONDESTRUCTIVE TESTING

All documents, films, tapes, etc., generated during the NDE process shall be retained for a period as indicated in Appendix Y. All examinations are for the full length and extent of the repair unless otherwise noted.

18.1 Radiographic Examination

Radiographic examination shall be performed in accord with Appendix T. Evaluation and acceptance of indications shall be in accord with Appendix W, paragraph 10.2.2.

18.2 Liquid Penetrant Examination

Liquid penetrant examination shall be performed in accord with Appendix T. Evaluation and acceptance of indications shall be in accord with Appendix W, paragraphs 10.3.2 and 10.3.3.

18.3 Magnetic Particle Examination

Magnetic particle inspection shall be performed in accord with Appendix T. Evaluation and acceptance of indications shall be in accord with Appendix W, paragraphs 10.4.2 and 10.4.3.

18.4 Ultrasonic Examination

Ultrasonic examination shall be performed in accord with Appendix T. Evaluation and acceptance of indications shall be in accord with Appendix W, paragraph 10.5.2.

18.5 Where Appendix R does not specify NDT for welding to the tank, the car owner shall specify a suitable NDT method using personnel and procedures qualified to Appendix T.

19.0 POSTWELD HEAT TREATMENT

19.1 When Required

19.1.1 Postweld heat treatment for tank car tanks steel-stamped to AAR specifications shall be done in accordance with paragraph 24.0.

19.1.2 Any repair or alteration involving welding on a carbon steel pressure car tank must be postweld heat treated.

19.2 Unit Postweld Heat Treatment

After all welding is complete, postweld heat treatment of the tank, as a unit or by the double-ended method, is preferable for carbon steel tanks. Postweld heat treatment of the tank as a unit is mandatory for high alloy steel tanks, except tanks fabricated from Types 304L or 316L materials. Postweld heat treatment ~~must~~ shall be performed in accord with Appendix W, paragraph 16.0.

19.3 Local Postweld Heat Treatment

19.3.1 In lieu of unit postweld heat treatment for carbon steel tanks, local postweld heat treatment (LPWHT) per requirements below may be employed by certified facilities or ~~contracted out to~~ approved subcontractors. If subcontractors are used, an AAR Exhibit B-1 Subcontractor Evaluation Sheet is to be completed and retained by the certified facility. Approved stress-relieving equipment ~~must~~ shall be used, such as controlled gas heating, induction heating or electrical resistance heating systems that will provide a constant and uniform temperature to the welded area.

- Local postweld heat treatment for cars in hydrogen sulfide service is not permitted. (Refer to Chapter 2, paragraph 2.1.2.2.1.)
- Local postweld heat treatment by a manually held gas torch is not permitted.

19.3.2 Requirements for Local Postweld Heat Treatment (LPWHT)

19.3.2.1 Minimum Equipment Requirements

- Automatic temperature recorder
- Heater control unit
- Heaters and insulation
- ~~Control and monitor~~ Thermocouples and control cables

19.3.2.2 Heat Treating Procedure, Minimum Requirements

19.3.2.2.1 Heaters are to be positioned such that the LPWHT heating soak band (SB) meets the PWHT temperature requirements listed in Table W16.0, and the heated band (HB) extends past the soak band ~~extends past each edge of the weld~~ a distance of ~~six~~ four times the shell thickness minimum. For electrical resistance heating, the spacing between heating elements shall be no more than the nominal tank shell thickness. See figure R.4. Heaters and the opposite side of the heating area are to be covered with thermal insulation to reduce heat loss.

19.3.2.2.2 To avoid ignition and fire, sufficient insulation or lining should be removed from the LPWHT area.

19.3.2.2.3 All thermocouples or insulation pins in the heating area are to be securely attached to the tank shell by capacitance discharge welding. A written welding procedure is required. Neither qualification of the procedure nor performance qualification of the welder is required.

19.3.2.2.4 Each heater circuit or control zone is to have a control thermocouple placed near the geometric center of the ~~heating zone~~ soak band. (See Fig. R.4.)

~~19.3.2.2.5 When required, monitor thermocouples are to be located a distance equal to or less than six times the nominal shell material thickness from the edge of the weld. See Figure R4 for monitor thermocouple requirements. Control and monitor thermocouples are to be located to~~

~~ensure uniform temperature within the heating zone. The number of thermocouples will depend on weld length and material thickness.~~

19.3.2.2.6 Heat sinks, such as pads, brackets, flanges, etc., in the ~~heating area~~ heated band are to be heavily insulated to prevent false temperature readings in the control zone.

19.3.2.2.7 To prevent harmful temperature gradient in the tank shell or adjacent appurtenances, heater control units are to be monitored frequently by the LPWHT technician during the entire heat-treating cycle. ~~A temperature gradient greater than 250 °F throughout the portion of the tank being heated is considered harmful.~~

19.3.2.2.8 LPWHT cycle temperatures and time are to be in accordance with Appendix W, paragraphs 16.3 and 16.4.

19.3.2.2.9 Thermocouples and insulation pins attached by capacitance discharge welding shall be removed and the tank surface restored to original contour.

19.3.2.3 Equipment Calibration

Temperature recorders are to be calibrated and heater controllers aligned annually, per written procedure. Units are to be marked to indicate the date of calibration or alignment status (date of calibration or alignment and due date for the next calibration or alignment), and a certificate is to be available upon request.

19.3.2.4 Documentation

19.3.2.4.1 A written local postweld heat treatment procedure is required. The procedure shall, as a minimum, cover safe use of equipment, equipment calibration, thermocouple, heating pad and insulation placement, remote and on-site process monitoring requirements, and PWHT temperature requirements as specified in W16.

19.3.2.4.2 Temperature time record is to be recorded on a strip chart or record showing thermocouple location, car number, and technician signature.

19.3.2.5 Qualification of Heat Treating Technicians

19.3.2.5.1 LPWHT technicians shall be qualified through a written training program conducted either in-house or by a recognized subcontractor.

19.3.2.5.2 The training program shall, as a minimum, cover the following areas: safe use of equipment, equipment calibration, thermocouple/insulation placement, process monitoring requirements as described in the LPWHT procedure and PWHT temperature requirements as specified in W16.

19.3.2.5.3 Technicians shall demonstrate competence in completing tasks outlined in the company's written LPWHT procedure

Typical heating element (pad) and thermocouple placements
 CT=Control Thermocouple ST=Spare Thermocouple

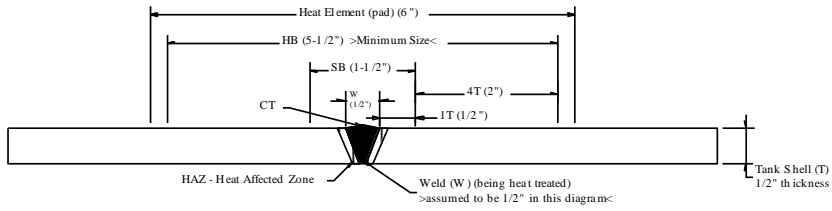
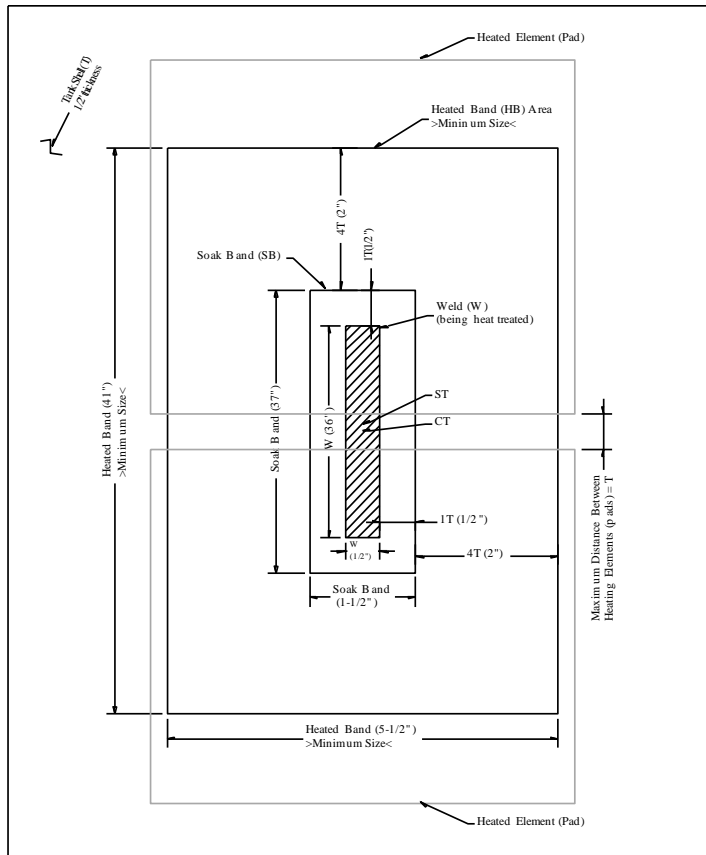


Fig R.4.A POSTWELD HEAT TREATMENT THERMOCOUPLE PLACEMENT AND USE

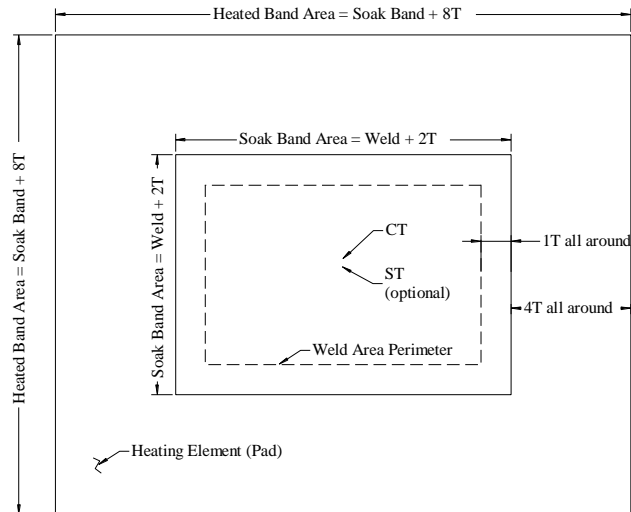


FIG. R.4.B ONE PAD – ONE CONTROL ZONE (CIRCUIT)

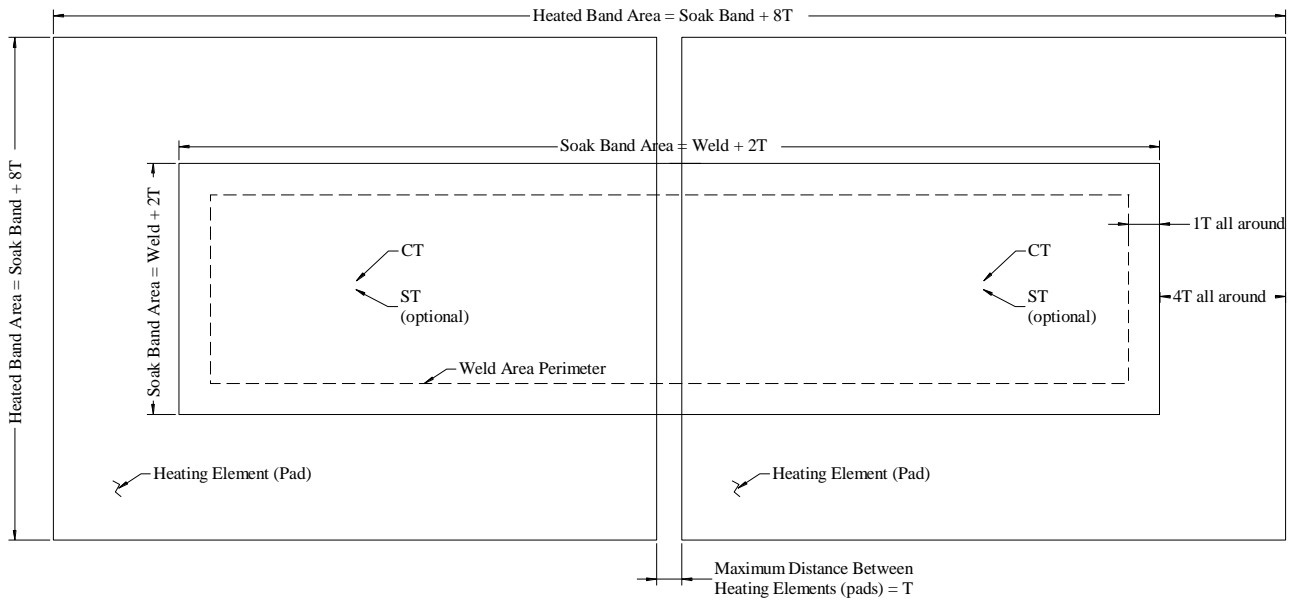


FIG. R.4.C TWO PADS – TWO CONTROL ZONES (CIRCUITS)

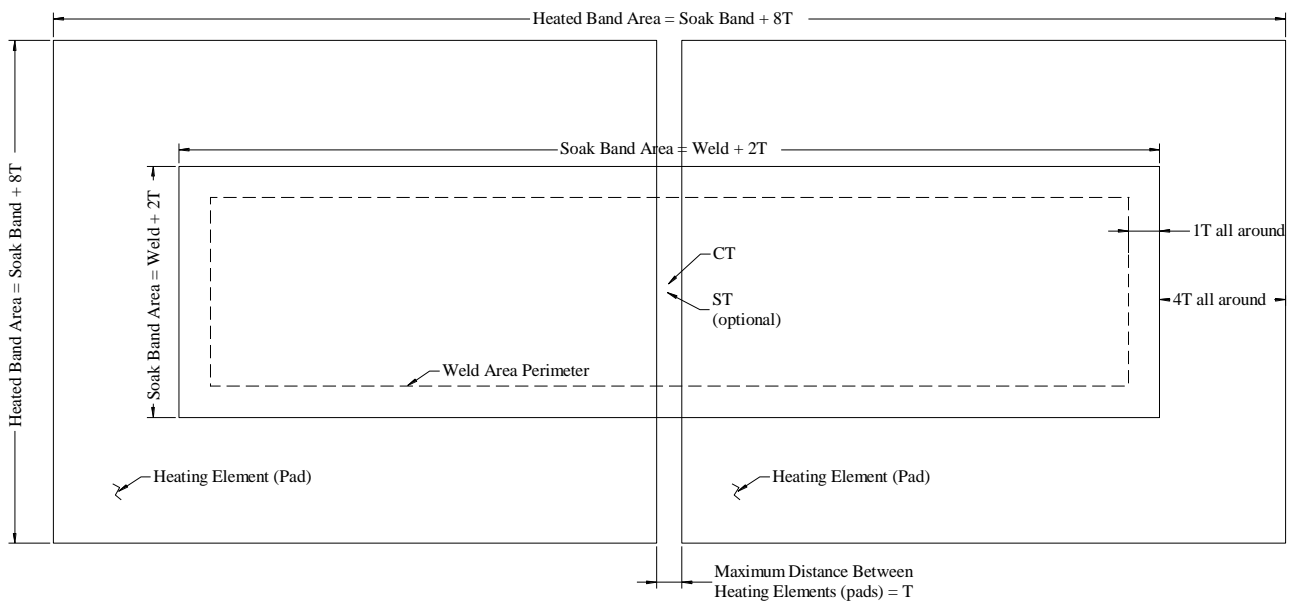


FIG. R.4.D TWO PADS – ONE CONTROL ZONE (CIRCUIT)

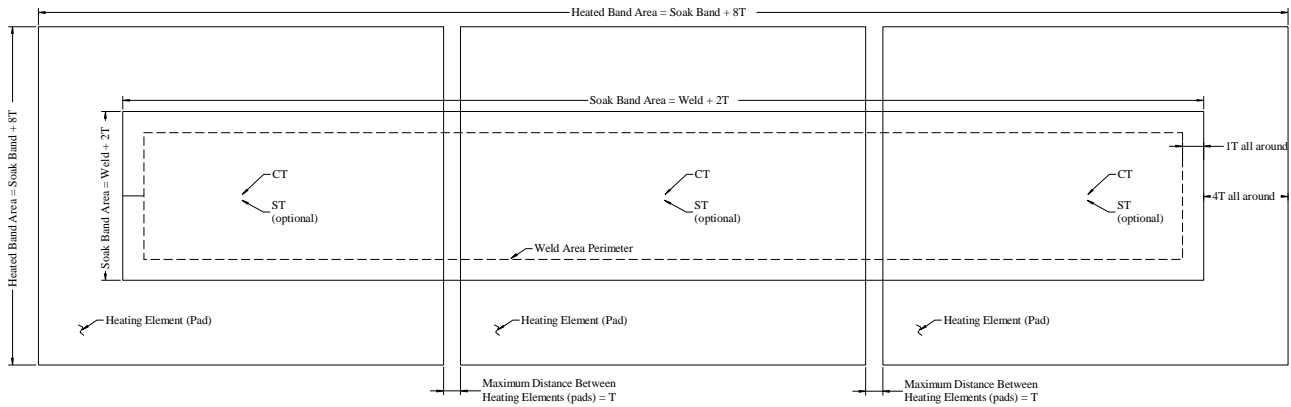


FIG. R.4.E THREE PADS – THREE CONTROL ZONES (CIRCUITS)

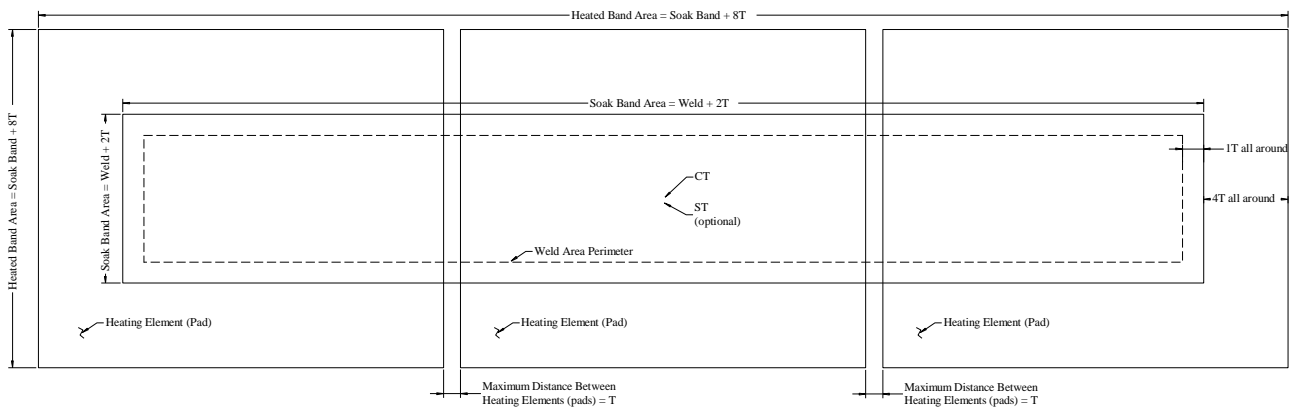


FIG. R.4.F THREE PADS – ONE CONTROL ZONE (CIRCUIT)

CT=Control Thermocouple ST=Spare Thermocouple

Figure R.4 NOTES:

1. Typical heating element and thermocouple placements are shown in the diagrams (Fig. R.4.A, B, C, D, E, F) above. Variations to these placements may be necessary for special control zone requirements on the tank.
2. To avoid problems during the heating cycle, the preferred application is to use one control thermocouple (CT) properly placed directly under each heating element (pad).
3. Spare thermocouples (ST) may be used in the control zone in the case of control thermocouple (CT) malfunction.
4. Thermocouple location is important. If the thermocouple is placed too far from the heating element (pad) or next to a large heat sink, the heating element (pad) can over-heat the tank while the thermocouple records a small temperature increase. Any large mass of steel in direct contact with the tank in the heating area will absorb large amounts of heat. Examples of heat sinks are reinforcement pads, mounting flanges, nozzles, bolsters, draft sill webs and exterior coils. Heavily insulating these areas is critical.
5. It is critical that the heating element be placed directly against the tank shell and the thermocouple attachment be made directly to the tank shell.
6. Pad spacing shall not exceed the tank shell thickness 'T'
7. **Soak Band (SB)**- the volume of metal required to meet the PWHT temperature requirements listed in Table W16.0. As a minimum, the soak band shall contain the weld, heat affected zone, and a portion of the base metal adjacent to the weld being heat treated. The minimum width of this volume is the widest width of the weld plus 1T on each side or end of the weld. The term 'T' is the nominal thickness of the heat treated material.
8. **Heated Band (HB)**- consists of the surface area over which the heater element(s) are applied to achieve the required temperature in the soak band. As a minimum, the heated band area shall contain the soak band plus 4T on each side or end of the soak band. The term 'T' is defined as the nominal thickness of the heat treated material. The heated band must be wider than the required soak band to compensate for conductive heat losses into adjacent unheated sections of the work piece, and convective and radiant heat losses into the workpiece surroundings.

20.0 HYDROSTATIC TESTING

In addition to the nondestructive requirements, hydrostatic testing of pressure car tanks is required for the following repairs or alterations:

- Complete penetration welds of the tank, such as inserts, rings, heads, and through-wall repairs (See D4.0)
- The application, replacement, or relocation of welded components that retain pressure, such as nozzles, flanges, and sumps (See D4.0)

21.0 REPAIRS TO ANCHORS

21.1 Requirements

21.1.1 When necessary to remove fasteners from tank anchors for any reason, the fasteners must not be reused. Fasteners may be replaced in kind, except as otherwise noted in paragraph 15.5 above. Bolts used to replace rivets (or two-piece rivets) must be ASTM A325. Washers, if used, must be hardened steel.

21.1.2 It is permissible to replace discarded fasteners with bolts or two-piece rivets specified by the car owner. The car owner or owner's authorized agent must comply with the following:

21.1.2.1 The ultimate shear strength of the bolts or two-piece rivets securing the anchor to the underframe must not exceed 70% of the ultimate shear strength of the welds used for connecting the anchor to the tank. In anchor designs that utilize more than one mechanically fastened connection in each leg, the 70% requirement need only apply to the connection limited in the original design to not exceed 70% of the shear strength of the welded connection between the tank and the anchor.

21.1.2.2 The shear strength of the connection must be equal to the shear strength of the connection it replaced. Refer to Chapter 5, paragraph 5.2, for design and installation criteria of allowable fasteners. Do not recalculate S_u .

21.1.2.3 If it is necessary to rework the fastener hole, the final diameter must be reamed. In any case, the diameter of the resulting hole must not be greater than 1/16 in. (1.59 mm) larger than the nominal diameter of the fastener.

21.1.2.4 If the resulting connection has unused fastener holes, they must be closed by welding or with cover plates. When choosing holes to eliminate, do not eliminate consecutive holes or end holes.

22.0 REPAIRS TO FIRE-DAMAGED OR HEAT-DAMAGED TANK CAR TANKS

22.1 Requirements

22.1.1 Parts or portions of a tank car tank that have been exposed to fire or heat sufficient to render their performance unsafe must be replaced. See R24 for LPWHT provisions and temperature limitations.

22.1.2 Unsafe parts or portions must be identified by physical testing of removed material or by evaluation of the physical condition of materials on the tank car tank, such as paint film, insulation, gasket materials, surface oxidation film, etc.

22.1.3 Detailed evidence of the safe condition of any part or portion of the tank car tank that is to be retained in service must be submitted for approval using Form AAR 4-2.

22.1.4 All valves and fittings must be removed, overhauled, and tested according to the valve manufacturers' instructions for suspected overheating.

23.0 REPAIRS TO TAPPED HOLES

23.1 Requirements

Tapped holes in flanges or cover plates that are damaged mechanically or by corrosion may be repaired using thread inserts, provided the following conditions are met:

23.1.1 Insert installation is to be in accord with manufacturer's specifications.

23.1.2 Insert material is to be compatible with commodity service.

23.1.3 After drilling out damaged threads, the metal surface is to be free of defects before retapping for the insert.

23.1.4 Nominal thread size of the insert is to match the original size of the existing tapped hole. Oversized holes are not permitted.

23.1.5 Each modified hole must be tested by application of the carbon steel or strain-hardened stainless steel stud, which is to be loaded to the lower of the following:

23.1.5.1 55% of the minimum tensile strength (lb) of the stud, which may be evaluated as either

- the tensile strength of the stud (lb) from the specification for studs/bolts;

or

- the tensile strength of the stud material (psi) from the specification for the stud/bolt material, multiplied by the stress area (i.e., the area corresponding to the minor diameter) of the stud/bolt.

23.1.5.2 The load that results in a shear stress equal to 40% of the yield strength (psi) in tension of the flange/cover parent metal, evaluated at the outside diameter of the insert.

$$P = 0.4\pi DtS_y \text{ or} \\ P = 1.25 DtS_y$$

where

$$P = \text{load (lb)} \\ D = \text{outside diameter of insert (in.)} \\ t = \text{depth of original threads (in.)} \\ S_y = \text{yield strength of flange/cover material}$$

Testing must be done using a direct tension indicator, following manufacturer's specifications for use, or using a calibrated torque wrench.

24.0 WELDING TO TANK CAR TANKS

24.1 Welding to Carbon Steel Tank Car Tanks after Unit PWHT

When additional welding is found necessary following unit postweld heat treatment, the following applies for carbon steel tank car tanks as categorized in Table R.2. See paragraph 4.0 in this appendix for additional AHF tank car tank repair requirements. (Note: hydrostatic testing may be used in addition to NDT methods but not in place of NDT; see paragraph 20.0.)

Table R.2 Processing additional welding to carbon steel tank car tanks

Car Category	Welding Purpose Code	PT or MT after removal of imperfection and prior to welding ^{h/}	PT or MT after welding	RT or UT ^{a/, b/ d/}	PWHT
Pressure cars	A	Yes	Yes ^{c/}	Yes	Yes
	B	Yes	Yes ^{c/}	No	Yes
	C	No	No	No	No
	D	No	No	No	Yes
	E	No	No	No	Yes
	F	No	No	No	Yes
	<u>G</u>	<u>No</u>	<u>No</u>	<u>Yes</u>	<u>Yes</u>
	H	No	No	Yes	<u>Yes</u>
	I	No	No	Yes	Yes
	J	Yes	No	No	Yes
Nonpressure cars or the portions thereof built from carbon steel materials other than TC-128	A	Yes	Yes ^{c/}	Yes ^{e/}	Yes ^{f/}
	B	Yes	Yes ^{c/}	No	Yes ^{f/}
	C	No	No	No	No
	D	No	No	No	No
	E	No	No	No	Yes ^{f/}
	F	No	No	No	Yes ^{e/, f/}
	<u>G</u>	<u>No</u>	<u>No</u>	<u>Yes</u>	<u>Yes^{f/}</u>
	H	No	No	No	Yes ^{f/}
	I	No	No	Yes ^{e/}	Yes ^{f/}
	J	Yes	No	No	Yes ^{f/, g/}
Nonpressure cars, or the portions thereof built from TC-128	A	Yes	Yes ^{c/}	Yes ^{e/}	Yes ^{f/}
	B	Yes	Yes ^{c/}	No	Yes ^{f/}
	C	No	No	No	No
	D	No	No	No	Yes ^{f/}
	E	No	No	No	Yes ^{f/}
	F	No	No	No	Yes ^{f/}
	<u>G</u>	<u>No</u>	<u>No</u>	<u>Yes</u>	<u>Yes^{f/}</u>
	H	No	No	No	Yes ^{f/}
	I	No	No	Yes ^{e/}	Yes ^{f/}
	J	Yes	No	No	Yes ^{f/}

^{a/} If tank material is type 430A, repair welds and intersections of all longitudinal and circumferential ~~double-welded~~ complete penetration butt joints in the tank must be radiographic or ultrasonic tested after postweld heat treatment.

^{b/} When uniform inserts, tank sections, or heads are being welded on a series of tanks of the same material using the same welding procedures and practices as in new construction, the inspection must comply with Appendix W, paragraph 18.0.

- c/ If repair is within 4 ft (1219 mm) of bottom longitudinal centerline
- d/ See Appendix W paragraph 18.0 for inspection requirements
- e/ Not required for tank car tanks steel stamped to AAR specifications ~~unless the steel-stamped AAR tank material is TC-128, then Note f applies.~~
- f/ A welding procedure with a minimum 300 °F (149 °C) preheat ~~and interpass~~ temperature may be used in lieu of postweld heat treatment.
- g/ If fillet weld size exceeds 5/16 in. (8 mm) or length exceeds 24 in. (610 mm), see footnote f/.
- h/ PT or MT required only if defect is a crack.

24.1.1 Welding to Aluminum and Stainless Steel Tank Car Tanks after Hydrostatic Testing

When additional welding is found necessary following hydrostatic testing, the following applies for tank car tanks fabricated from materials listed in Tables M.10.2 and M.10.3.

Table R.3 Processing additional welding to aluminum and stainless steel tank car tanks

Car Category	Welding Purpose Code	PT after removal of imperfection and prior to welding ^{d/}	PT after welding	RT or UT ^{a/ c/}
All cars	A	Yes	Yes ^{b/}	Yes
	B	Yes	Yes ^{b/}	No
	C	No	No	No
	D	No	No	No
	E	No	No	No
	F	No	No	No
	<u>G</u>	<u>No</u>	<u>No</u>	<u>Yes</u>
	H	No	No	<u>Yes</u>
	I	No	No	Yes
	J	Yes	No	No

- a/ When uniform inserts, tank sections, or heads are being welded on a series of tanks of the same material using the same welding procedures and practices as in new construction, the inspection must comply with Appendix W, paragraph 18.0.
- b/ If repair is within 4 ft (1219 mm) of bottom longitudinal centerline
- c/ See Appendix W paragraph 18.0 for inspection requirements
- d/ PT or MT required only if defect is a crack.

24.1.2 Welding Purpose Code

Code	Description
A	Repair defective areas <u>in tank shell, tank heads and nozzles</u> (after preparation for welding) greater than 3/16 in. (5 mm) deep, of any width and length. <u>Repair by weld buildup is included.</u>
B	Repair defective areas <u>in tank shell, tank heads and nozzles</u> (after preparation for welding) equal to or less than 3/16 in. (5 mm) deep, of any width and length. <u>Repair by weld buildup is included.</u>
C	<u>Fillet welding or weld buildup applied to nozzle flanges, or fillet welding applied to nozzles</u> (when welding to the tank shell or tank head is involved, see Welding Purpose Code F and/or H).
D	Repair exterior coil fillet weld with weld length 6 in. (152 mm) or less.
E	Repair exterior coil fillet weld with weld length over 6 in. (152 mm).
F	Add or replace attachments to tank head or tank shell by fillet welding or stud welding (including temporary welds).
G	<u>Complete penetration nozzle butt joint groove welds</u>
H	<u>Attach</u> Add or replace attachments <u>nozzles</u> to tank head or tank shell by groove welding.
I	Groove-welded inserts and closures. See R12.0 and R14.6.
J	Repair of attachment fillet welds.

24.1.3 Local Postweld Heat Treatment

Local postweld heat treatment may be used, provided that the minimum heated area includes ~~at least six times the tank or head plate thickness on each side of the weld.~~ the soak band (SB) and heated band (HB) as defined in Figure R.4. The temperature distribution must be controlled as follows:

24.1.3.1 Above 800 °F (427 °C), the rate of heating shall be no more than 400 °F per hour divided by the tank thickness in inches (5644 °C divided by tank thickness in millimeters), but in no case more than 400 °F (222 °C) per hour.

24.1.3.2 During the heating, holding and cooling periods, ~~there shall be no greater variation in temperature than 250 °F (139 °C) throughout the heated area of the tank~~ the temperature at the edge of the heated band shall be no less than one half the temperature at the edge of the soak band, nor shall any portion exceed 1250 °F (677 °C). If the recorded LPWHT temperature exceeds 1250 °F (677 °C), the affected area shall be repaired by insert. As a minimum, the affected area shall be the same size as the heating pad or pads.

24.1.3.3 ~~During the holding period, there shall be no greater difference than ±50 °F (±28 °C) throughout the heated area of the tank. During the holding period, the minimum temperature throughout the heated band (HB) area shall be not less than 1100 °F (593 °C) or greater than 1250 °F (677 °C).~~

24.1.3.4 Above 800 °F (427 °C), cooling shall be done at a rate not greater than 500 °F per hour divided by the tank thickness in inches, but in no case more than 500 °F (260 °C) per hour. Below 800 °F (427 °C), the tank may be cooled in still air.

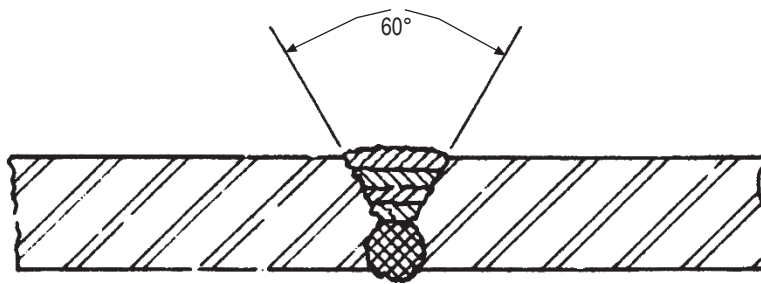


Fig. R.5 Welding fractures

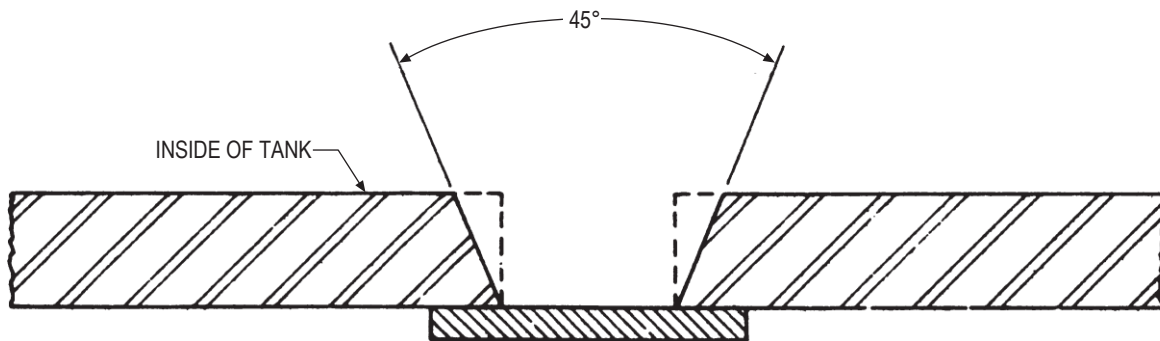


Fig. R.6 Welding rivet holes

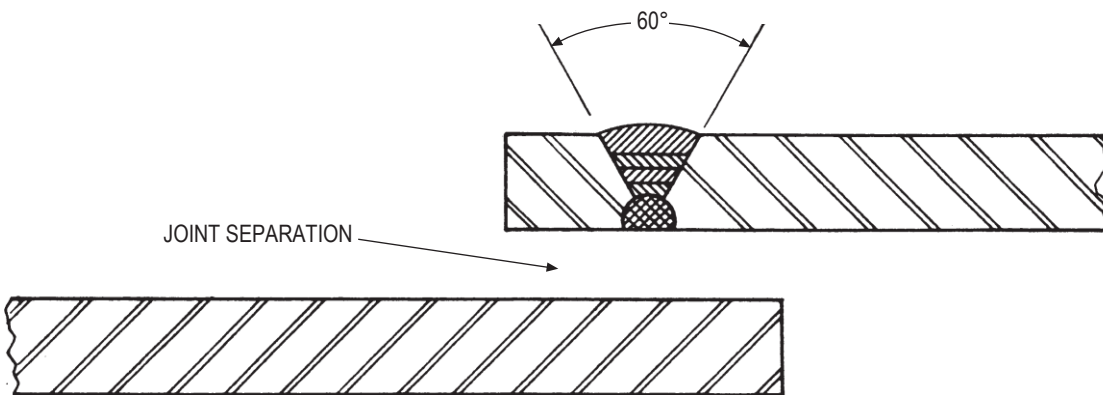


Fig. R.7 Welding fracture that extends into riveted joint

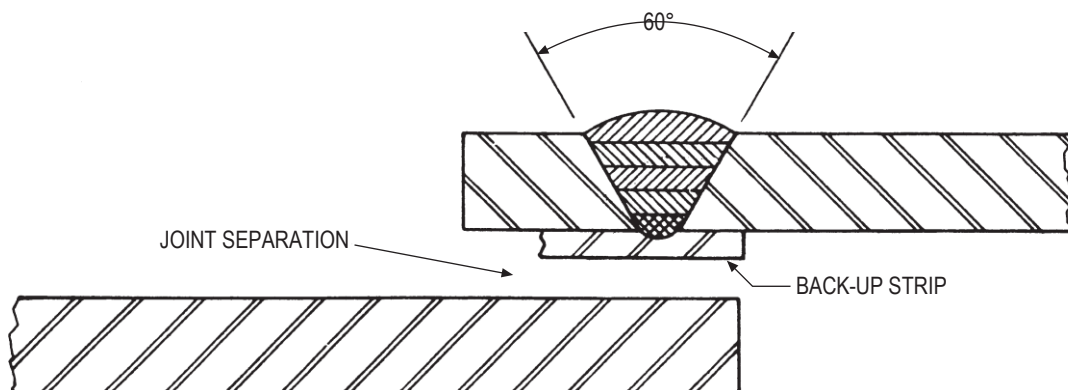


Fig. R.8 Welding fracture that extends into riveted joint (with back-up strip)

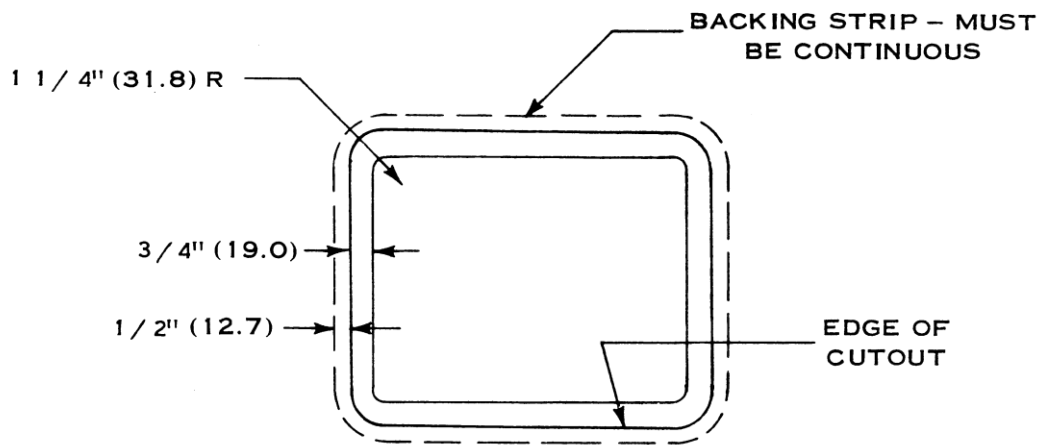
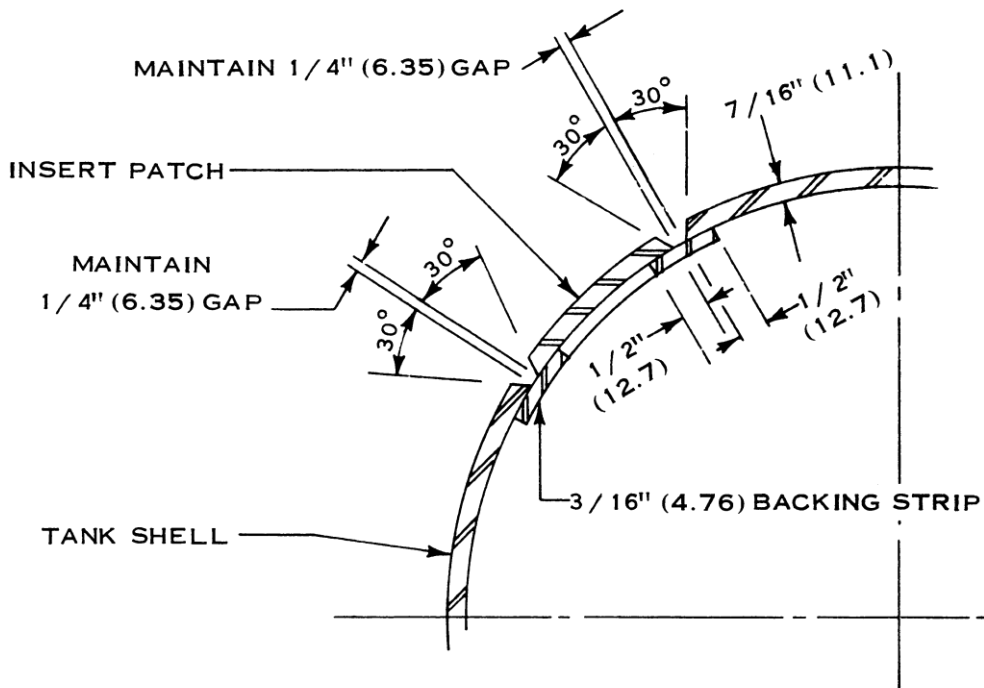


Fig. R.9 Insert application in void area on compartment car

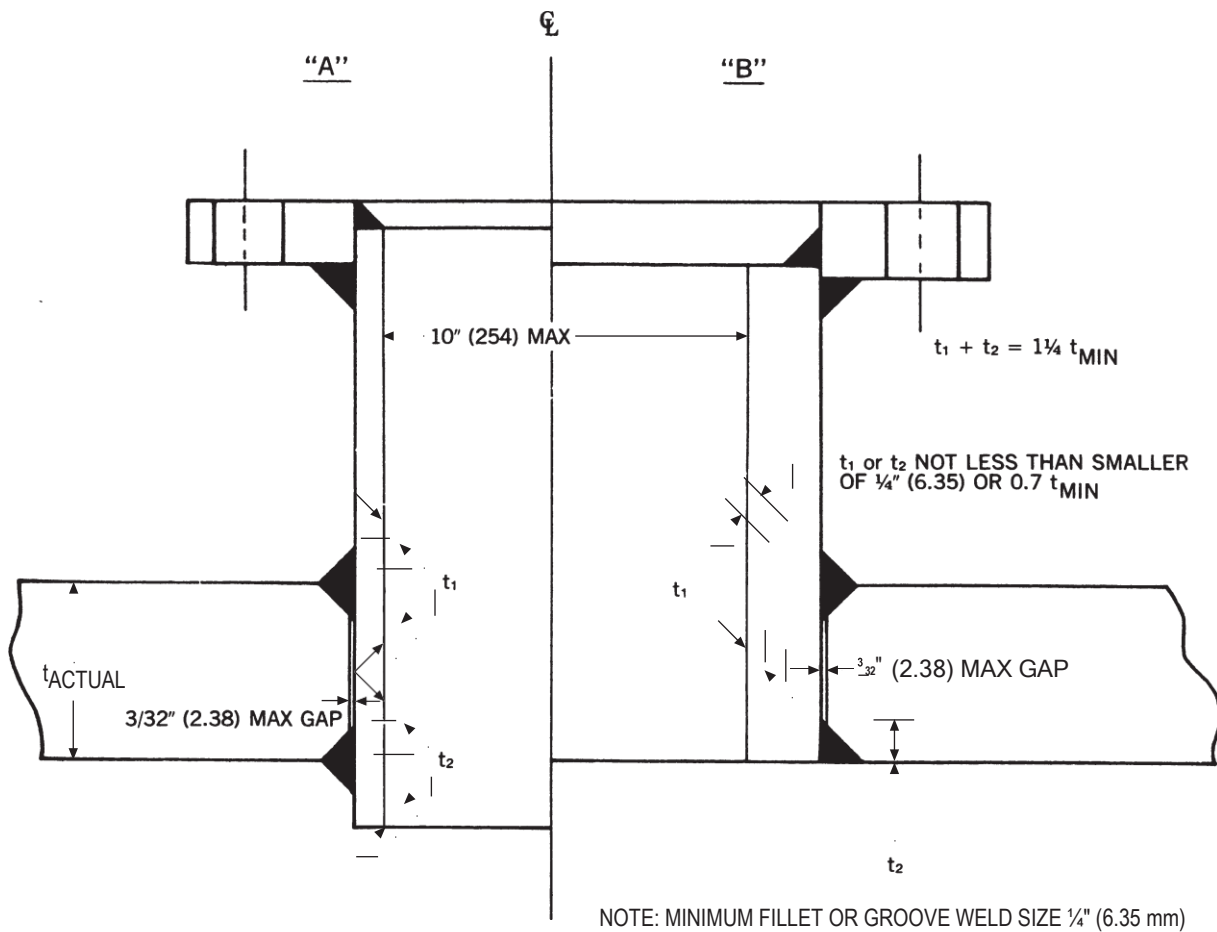
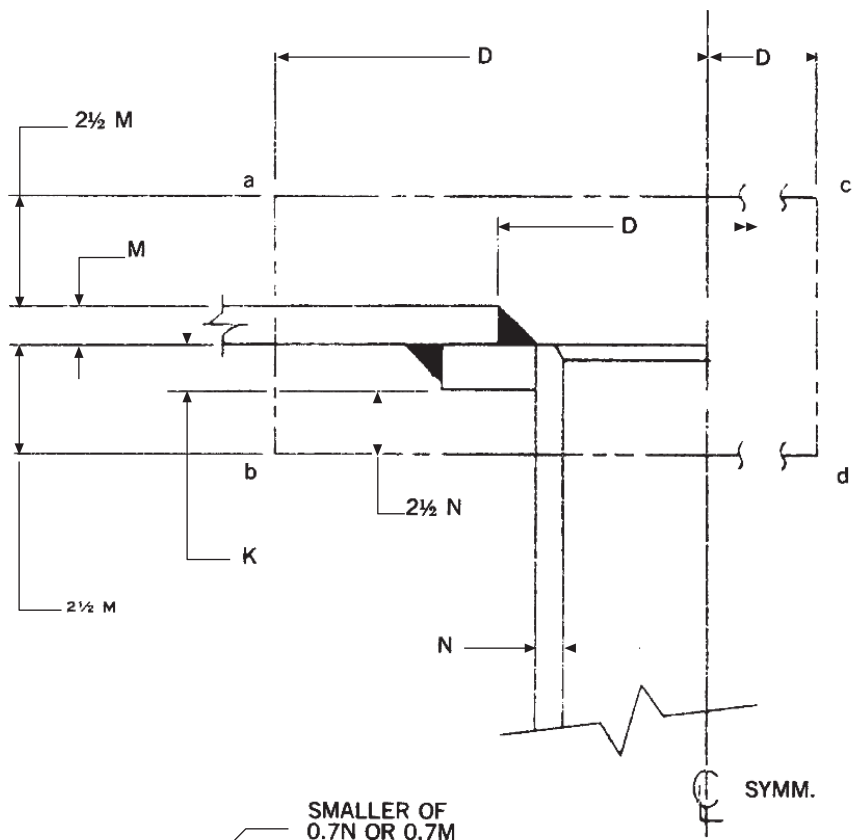


Fig. R.10 Insert-type nozzle application (reference paragraph 14.5.4, this appendix)



SMALLER OF
0.7N OR 0.7M
OR 0.7t MIN.

NOTE: t MIN. TO COMPLY WITH MINIMUMS
SET BY TANK SPECIFICATION.

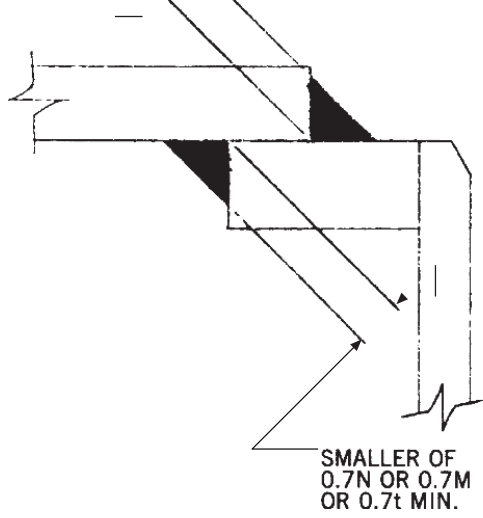


Fig. R.11 Lap joint nozzle application (reference paragraph 14.5.5, this appendix)

FORM SS-1
REPORT OF TANK CAR STUB SILL INSPECTION

- | | |
|---|------------------------------------|
| 1. To: Car Owner _____ | 2. Reporting mark and Number _____ |
| 3. Reported by _____ | |
| 4. Performed at _____ | 5. Date _____ |
| 6. Tank Car Builder _____ | 7. Built Date _____ |
| 8. Current AAR Certificate _____ | 9. Commodity _____ |
| 10. Constructed Tank Spec. _____ | |
| 11. Stenciled Tank Spec. _____ | 12. Car Jacketed (Y/N) _____ |
| 13. Top & Bottom Shelf Couplers (Y/N) _____ | 14. Head Shields (Y/N) _____ |
| 15. Priority Level for This Inspection: _____ | 16. Head Braces (Y/N) _____ |

INSPECTION RESULTS

A-END

B-END

- | | | | | |
|---|-----------|-----------|-----------|-----------|
| 17. Any evidence of striker damage?(Y/N) | _____ | | _____ | |
| | AR | AL | BR | BL |
| 18. Is draft sill bent or warped? (Y/N) | _____ | _____ | _____ | _____ |
| 19. Any evidence of passed couplers?(Y/N) | _____ | _____ | _____ | _____ |
| 20. Any damage to front draft lugs? (Y/N) | _____ | _____ | _____ | _____ |
| 21. Any damage to rear draft lugs? (Y/N) | _____ | _____ | _____ | _____ |
| 22. Describe prior sill repairs _____ | | | | |

23. Inspect for defects at welds. Note inspection method used . . . [AE = Acoustic, F = Fiber Optic, LP = Liquid Penetrant, V=Visual, O=Other (Explain)]

METHOD

A-END

B-END

- | | | | | |
|-------------------------------------|-------|--|-------|--|
| A1 - Pad to Tank (Transverse) | _____ | | _____ | |
| B1 - Pad to Sill (Transverse) | _____ | | _____ | |
| C1 - Brace to Sill (Transverse) | _____ | | _____ | |
| D1 - Brace to Pad (Transverse) | _____ | | _____ | |
| Other Transverse - (Describe) _____ | _____ | | _____ | |

AR

AL

BR

BL

- | | | | | |
|--------------------------------|-------|-------|-------|-------|
| A2 - Pad to Tank (Long.) | _____ | _____ | _____ | _____ |
| B2 - Pad to Sill (Long.) | _____ | _____ | _____ | _____ |
| C2 - Brace to Sill (Long.) | _____ | _____ | _____ | _____ |
| D2 - Brace to Pad (Long.) | _____ | _____ | _____ | _____ |
| Other Long. - (Describe) _____ | _____ | _____ | _____ | _____ |

24. Describe location and nature of defects found (e.g., "C2—3-in. crack in weld")

25. Disposition of Car: _____

Inspected by: _____ Title: _____

Fig. R.12 Form SS-1 Report of Tank Car Stub Sill Inspection

INSTRUCTIONS FOR COMPLETING FORM SS-1

Form SS-1 reports must be typewritten or printed in a legible manner and must be submitted to the car owner. The following instructions must be followed in filling out the report:

Line	Instruction
1.	Enter the company name of the car owner.
2.	Enter the car's reporting mark and number.
3.	List the company reporting the work that was performed.
4.	List the facility and location that performed the work.
5.	The date must be that on which the report was completed.
6.	List manufacturer of tank car.
7.	Enter the original built date of the tank car.
8.	Show the most recent AAR certificate number under which the tank car is currently approved.
9.	Identify the commodity to be transported in this tank car.
10.	Show the tank specification, as built.
11.	Show the stenciled tank specification for the tank car, as operated.
12.	Enter Y (yes) or N (no) to indicate if car is jacketed.
13.	Enter Y (yes) or N (no) to indicate if car is equipped with top and bottom shelf couplers.
14.	Enter Y (yes) or N (no) to indicate whether car is equipped with head shields.
15.	Indicate priority I for inspections required per paragraph 5.0, this appendix.
16.	Enter Y (yes) or N (no) to indicate if car is equipped with head braces.
17.	Enter Y (yes) or N (no) to indicate evidence of striker damage (two places).
18.	Enter Y (yes) or N (no) to indicate if sill is bent or warped (four places).
19.	Enter Y (yes) or N (no) to indicate evidence of sill damage due to passed couplers (four places).
20.	Enter Y (yes) or N (no) to indicate evidence of damage to front lugs (four places).
21.	Enter Y (yes) or N (no) to indicate evidence of damage to rear draft lugs (four places).
22.	Describe prior sill repairs, if present.
23.	Indicate the inspection method that was utilized to examine each weld. Refer to the illustration. Enter Y (yes) or N (no) to indicate evidence of defects in or adjacent to the welds A1, B1, C1, D1 (two places) or A2, B2, C2, D2 (four places). If the design incorporates other welds, describe them and indicate the inspection method and results, as above.
24.	Describe location and nature of defects found, reference lines 17 through 23.
25.	Indicate disposition of car following the inspection (e.g., returned to service, repaired, scrapped, etc.).
Inspector must sign the report.	

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