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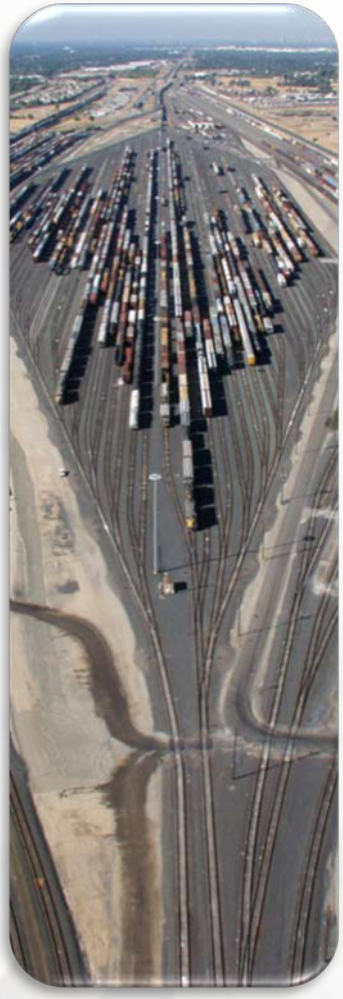

How an Effective Program Prevents NAR's

Welding: Vernon Walker
NDT: James Strong
Coatings/Linings: David Gildea

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Welding Variables that contribute to Prevention of NAR's

Vernon Walker
TCQA Specialist

U.S. Department of Transportation
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Items for Review

- Welding Codes
- PQR
- WPS
- Welder Qualification
- Process Control
- HAZ
- Bad Examples

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WELD CODES FOR TANK CAR INDUSTRY

- AWS D15.1-Other than tank welds
- AAR M1002 APPENDIX W-Tank and tank attachments

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PROCEDURE QUALIFICTION

PQR-A record of a test weld performed and tested (more rigorously) to ensure that the procedure will produce a good weld

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WELDING PROCEDURE SPECIFICATION

WPS-The formal written document describing welding procedures, which provides direction to the welder or welding operators for making sound and quality production welds as per the code requirements. The purpose of the document is to guide welders to the accepted procedures so that repeatable and trusted welding techniques are used. A WPS is developed for each material alloy and for each welding type used. Specific codes and/or engineering societies are often the driving force behind the development of a company's WPS

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WELDER QUALIFICATION

Definition:

Welding qualification are technically a hands-on welder qualification test that is conducted by certified welding inspector that will determine if the person or machine can produce a sound quality weld up to the code or welding procedure needed for a Company, job site or a particular industry standard

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ITEMS AFFECTING WELDER QUALIFICATION

- WELD CODE
- THICKNESS OF TEST SAMPLE
- WELDING PROCESS
- WELDING POSITION
- WELDING PROCEDURE SPECIFICATION (WPS)

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IN PROCESS INSPECTION

Items That Affect Welding Process

(welder qual, wps, metal thickness, calibration, code)

- Joint design (review drawing)
- Joint fit up (review drawing, wps, measure with gage)
- Pre cleaning (process, drawing, wps)
- Pre heating (wps)

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EQUIPMENT

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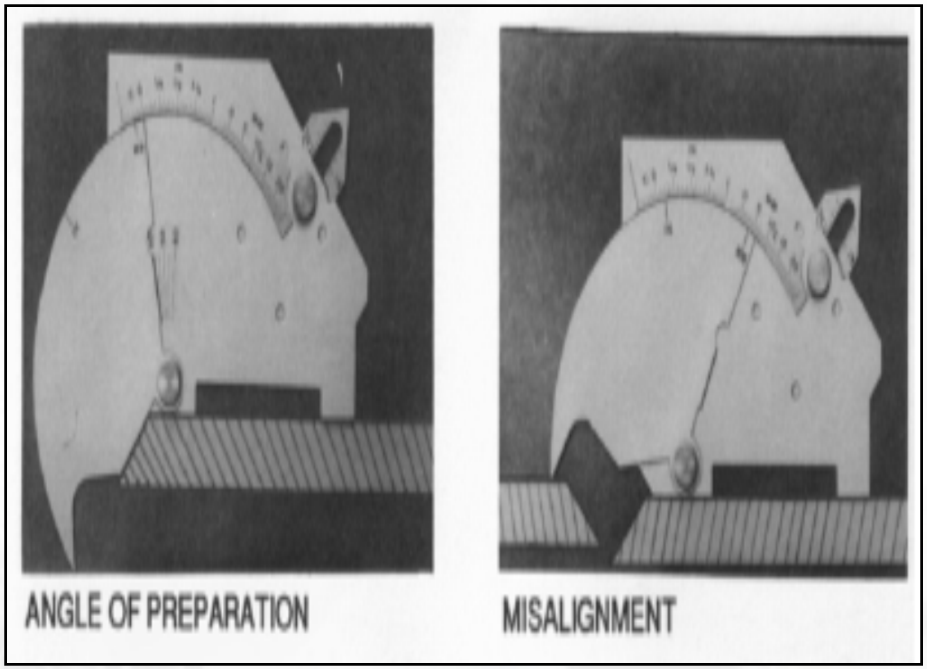
Process Control

BEFORE

- ANGLE OF PREPARATION
- MISALIGNMENT
- WPS PARENT METAL THICKNESS
- WELDER QUAL TO THICKNESS, POSITION AND PROCESS
- MACHINE CALIBRATION
- CODE



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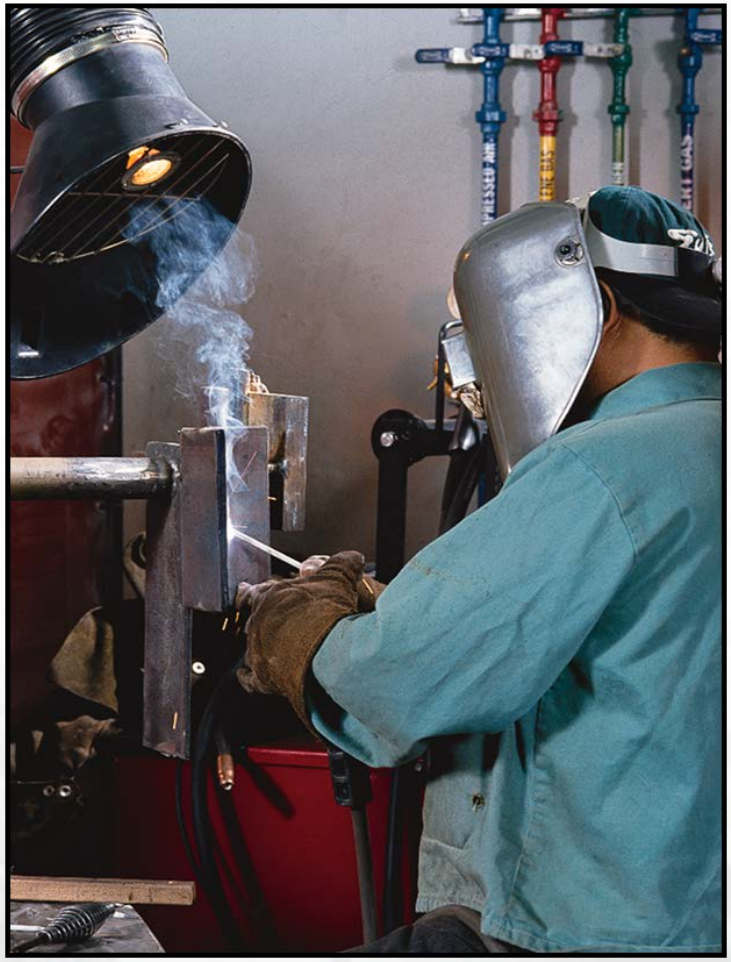
Process Control

During

- Essential variables (WPS)
- Interpass temperatures (WPS, temp device)
- Pre heat maintenance (WPS, temp device)
- Electrode care and selection (WPS)
- Multiple passes (WPS)



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Common Welding Defects

- Porosity
- Slag Inclusions
- Excess Penetration
- Incomplete Fusion
- Under Cut
- Inadequate Joint Penetration
- Cracking
- Welding Debris

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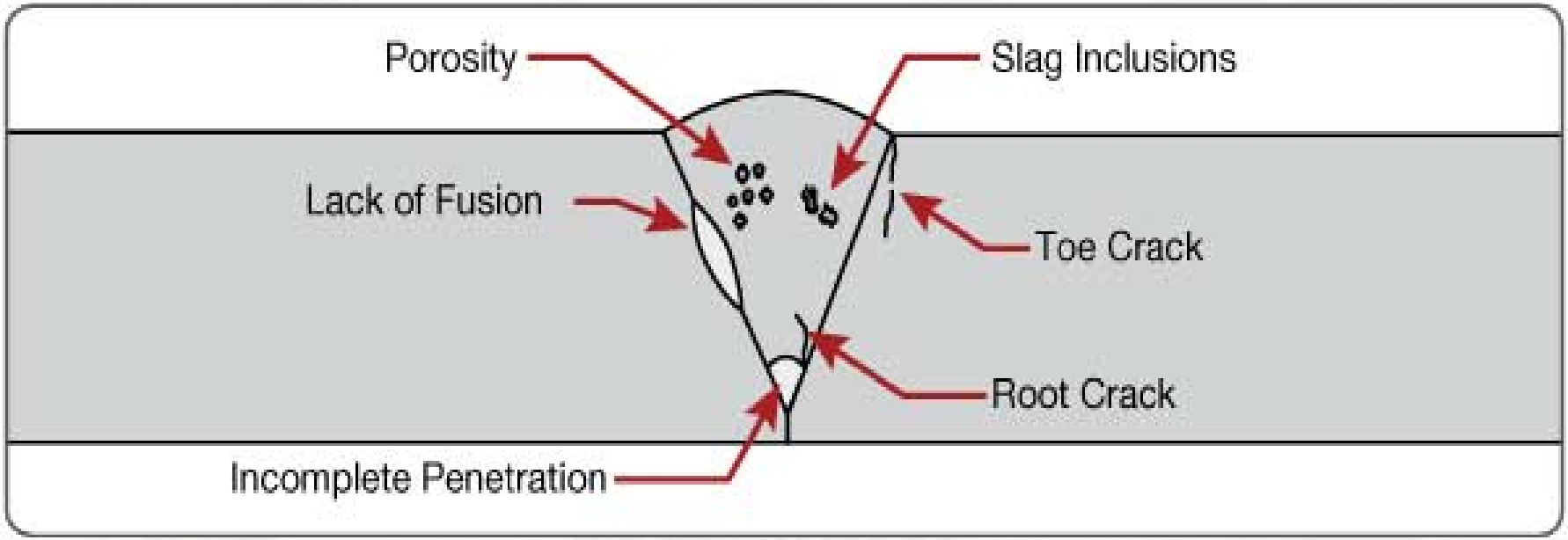
DISCONTINUITIES AND DEFECTS



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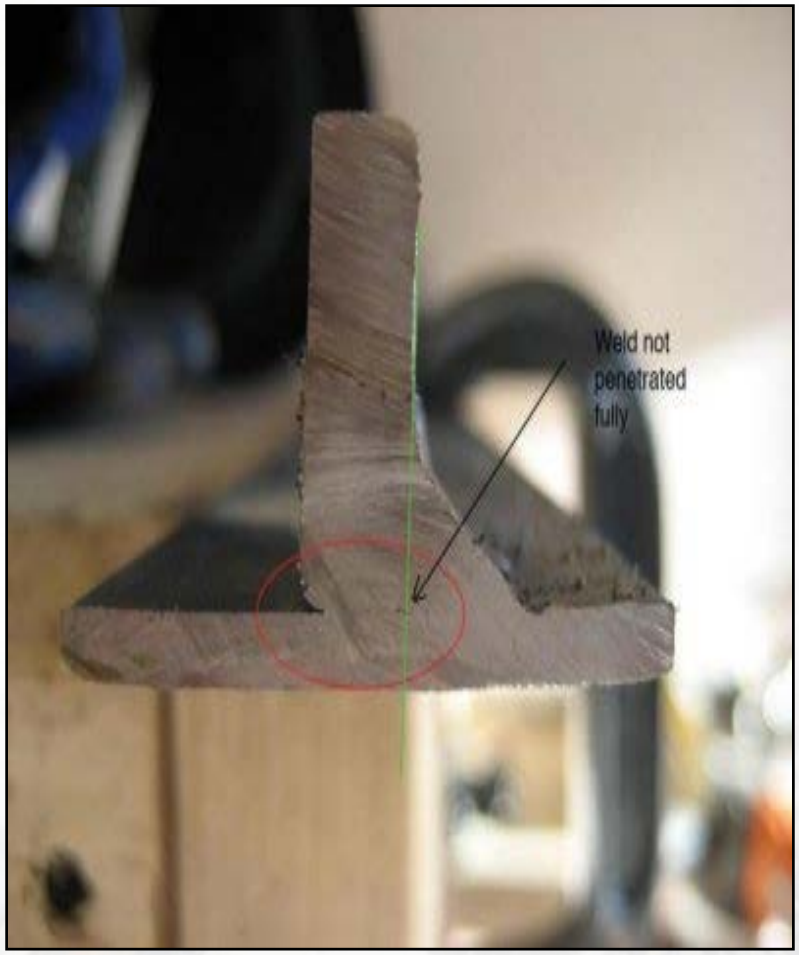
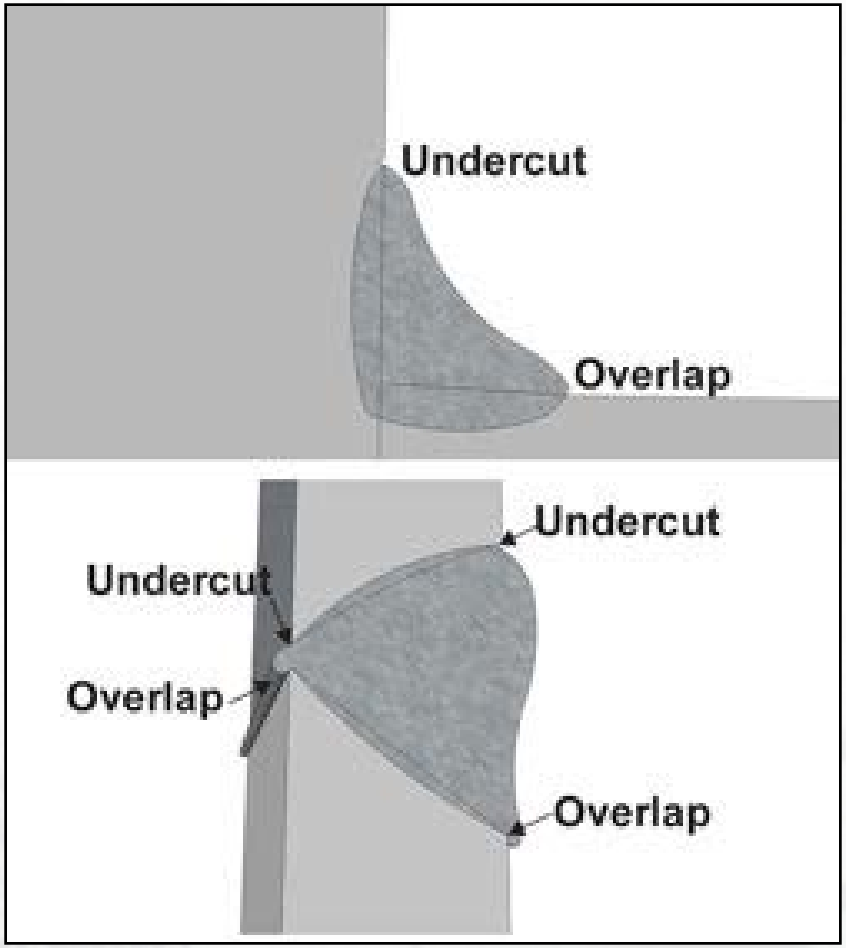
DISCONTINUITIES





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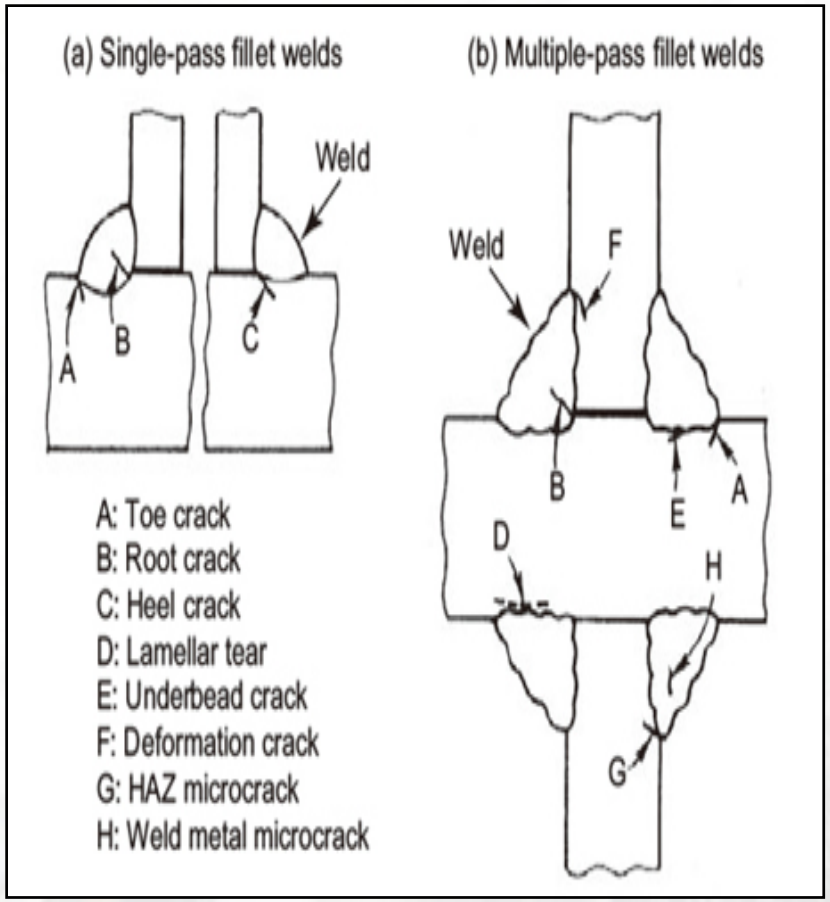
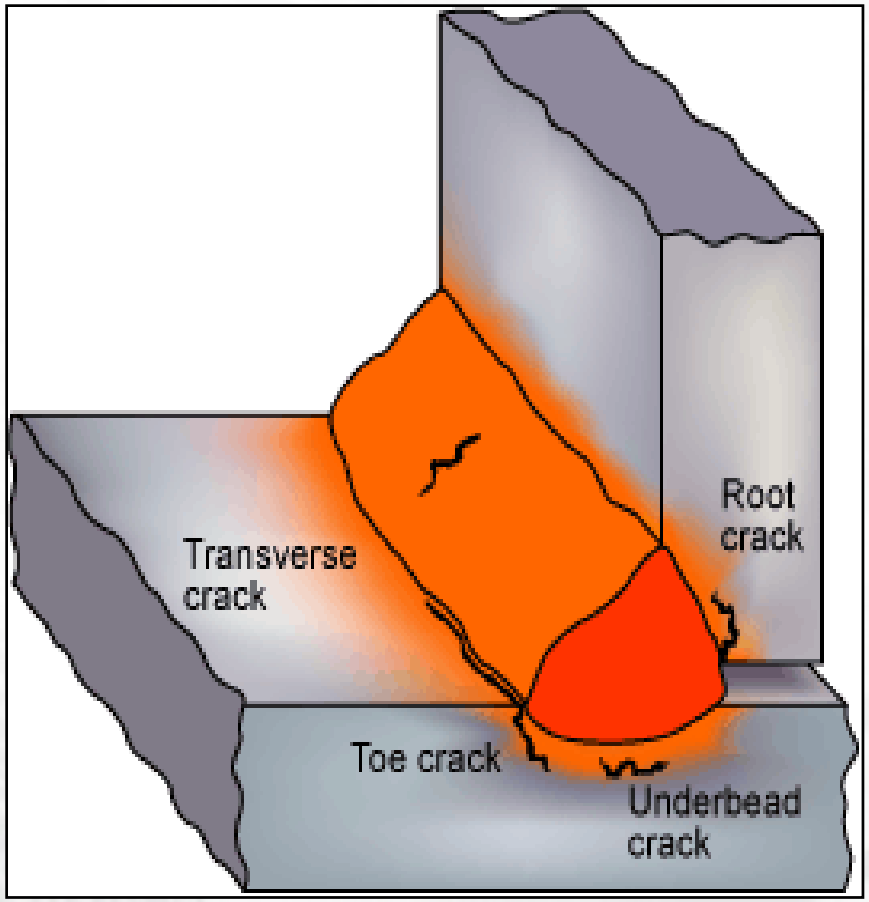
WELD CRACKS





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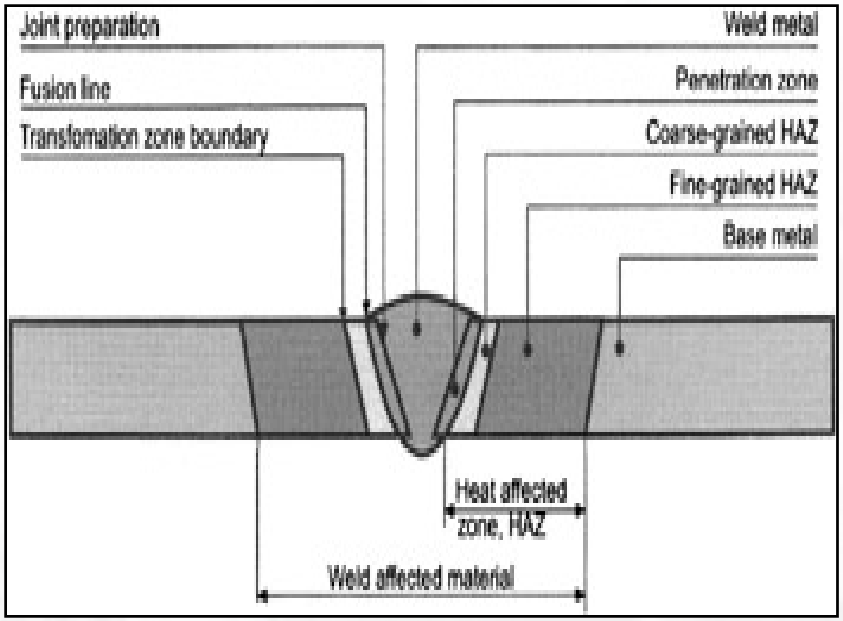
HEAT AFFECTED ZONE (HAZ)

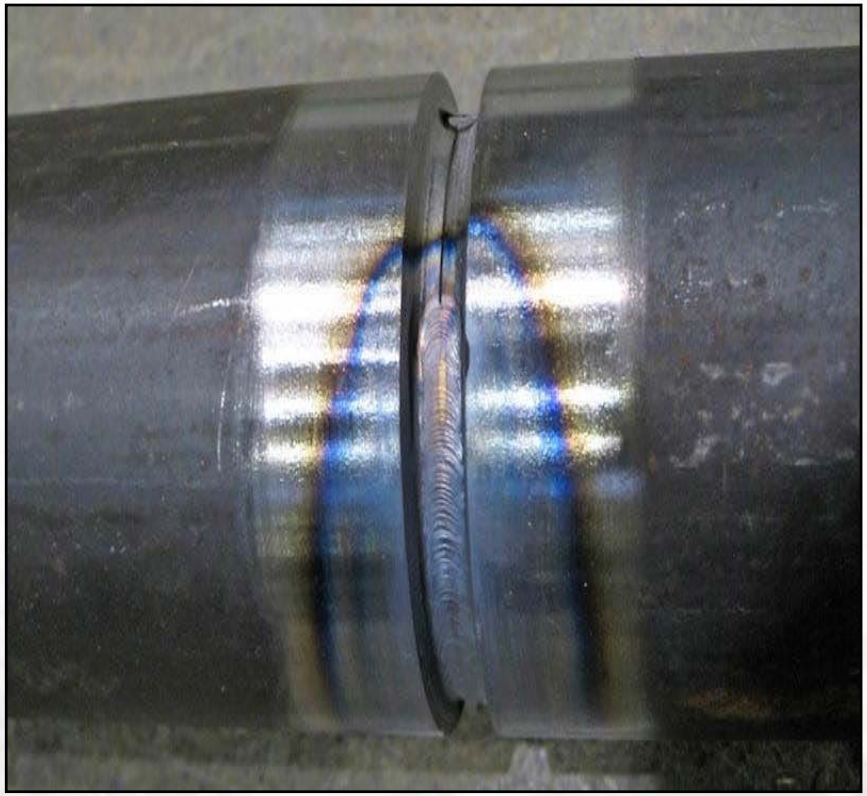
HAZ:

The area of the base metal that was not melted but whose mechanical properties have been changed due to the heat of welding



HAZ

Discoloration of the base metal shows suspect HAZ



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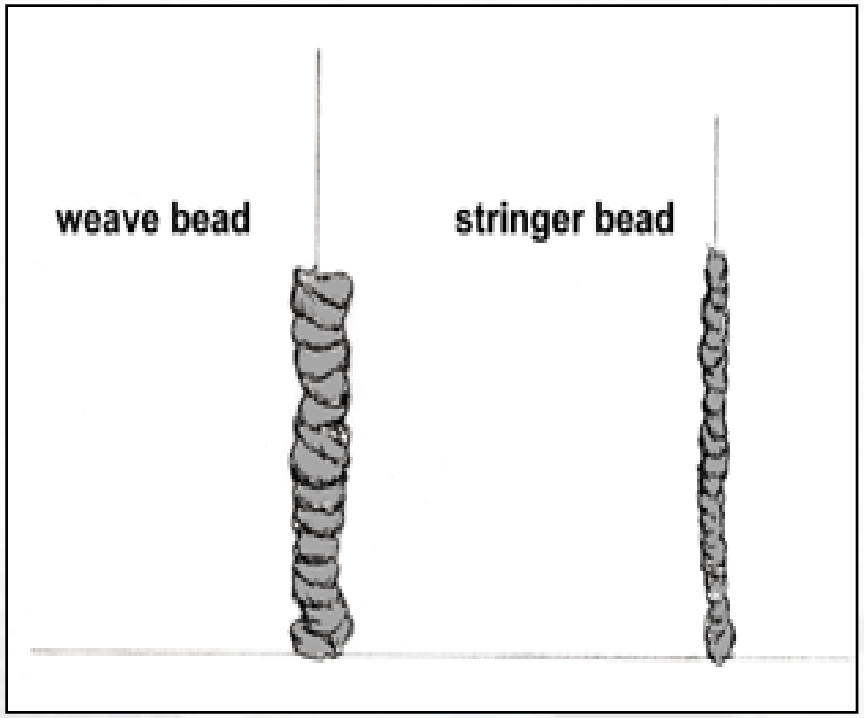
REDUCING HAZ-WELD METHOD

- Stringer bead – a weld bead made with little to no oscillation
- Weave bead – a weld bead made with transverse oscillation



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SUMMARY

- Welding Codes – AWS D15.1 and Appendix W
- Procedure Qualification Record (PQR)
- Welding Procedure Specification (WPS)
- Welder Qualification
- Process Control
- Heat Affected Zone (HAZ)
- All to Prevent the Following…

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YIKES!!!

ALL DEFECTS PRESENT….

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PM CRACKS

Pad PM cracks

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TANK CRACKS

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Great Weld

How does this look?

Final Inspection

Mr. James Strong

U.S. Department of Transportation
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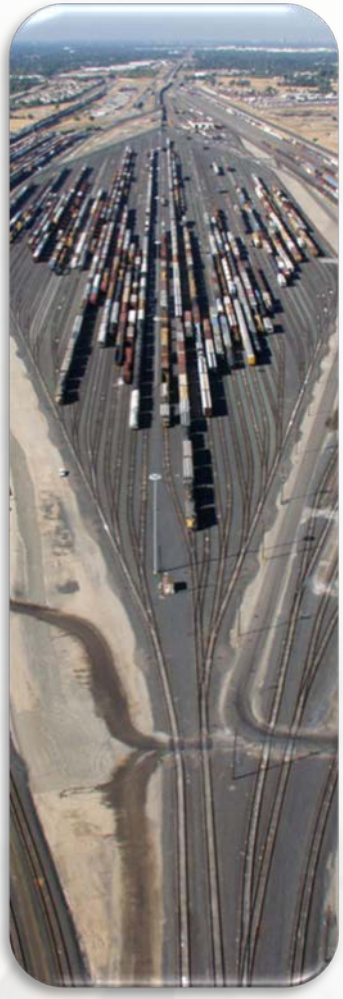
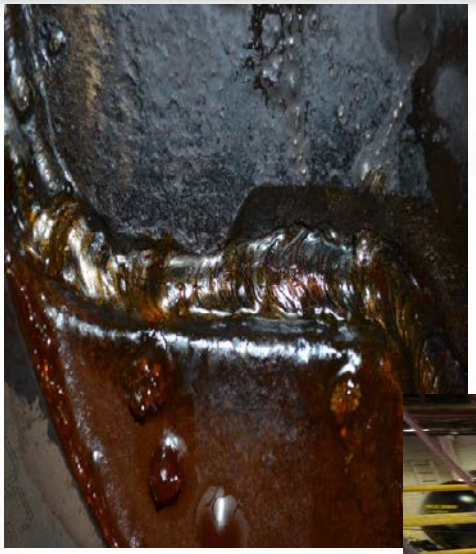
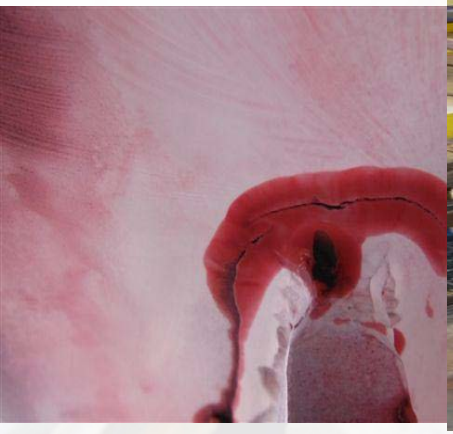


"How an effective NDT Program Prevents NAR's"

James Strong
Tank Car Quality Assurance Specialist
HM Division – Washington, DC





Tank Car Facility – An entity that manufacturers, repairs, inspects, tests, qualifies, maintains, alters, or converts a tank car, ensuring that the tank car conforms to published rules, regulations, and specifications.

49 CFR 180.509 (e)(4)

- Each Tank Car Facility must inspect and test the elements identified in paragraph (e)(1) by one or more of the following methods:
- (i) Dye Penetrant Testing (PT)
- (ii) Radiographic Examination (RT)
- (iii) Magnetic Particle Testing (MT)
- (iv) Ultrasonic Testing (UT)
- (v) Direct, Remote, or Enhanced Visual Inspection, using for example, magnifiers, fiberscopes, borescopes, and or machine vision technology (VT/RVT)

49 CFR 180.509 (e)

(e) *Structural Integrity Inspections and tests*. Each tank car owner must ensure the structural elements on the tank car qualify with the applicable requirements. At a minimum must include

(i) All transverse fillet welds greater than ¼" bottom 4' centerline.

(ii) The termination of longitudinal fillet welds greater than ¼" bottom 4' centerline.

(iii) The tank shell butt welds within 2' bottom centerline, unless tank owner can determine by analysis that the structure will not develop defects that will reduce the design level of safety and reliability or fail within it's operational life or prior to next required inspection (only at the time of lining removal or application for lined cars).

49 CFR 180.511 (b)

Structural Integrity Inspection and test. A tank car successfully passes the structural integrity inspection and test when it shows no defects that may initiate cracks and cause failure of the tank before the next inspection and test interval.

49 CFR 180.509(j):

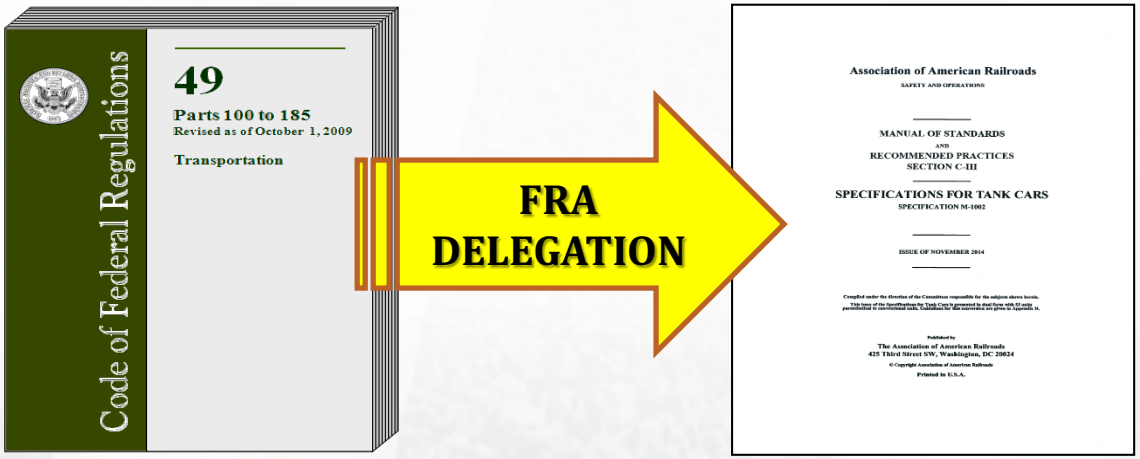
- Leakage Pressure Test. Unless the design of the service equipment arrangement precludes it, each owner of a tank car must ensure that the tank, service equipment, and closures installed, replaced, or reinstalled on the tank car are leak tested.

49 CFR 180.511 (f):

- A Tank Car successfully passes the leakage pressure test when all product piping, fittings and closures show no indication of leaks.

Tank Car Facility:

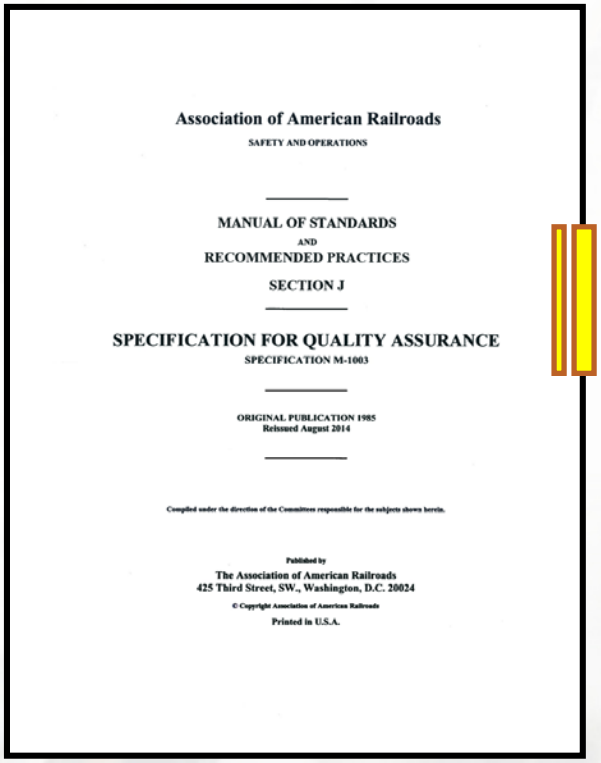
Under the delegated authority of the Department of Transportation, Certification is controlled by the Association of American Railroads (AAR).



What is needed?

AAR Approved Tank Car Facility

AAR Approved Quality Assurance Program (QAP)


Association of American Railroads
SAFETY AND OPERATIONS

MANUAL OF STANDARDS
AND
RECOMMENDED PRACTICES
SECTION J

SPECIFICATION FOR QUALITY ASSURANCE
SPECIFICATION M-1003

ORIGINAL PUBLICATION 1985
Reissued August 2014

Compiled under the direction of the Committees responsible for the subjects shown herein.

Published by
The Association of American Railroads
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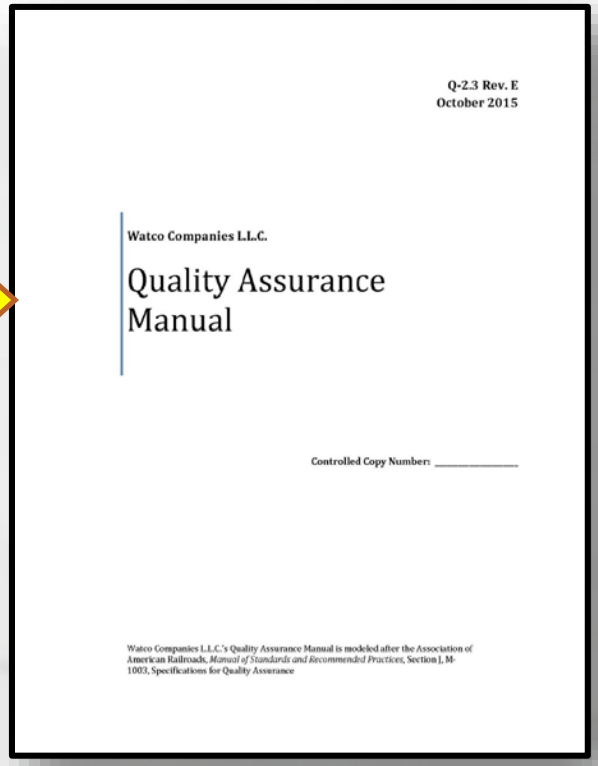
MANUAL DEVELOPMENT


Q-2.3 Rev. E
October 2015

Watco Companies L.L.C.

Quality Assurance Manual

Controlled Copy Number: _____

Watco Companies L.L.C.'s Quality Assurance Manual is modeled after the Association of American Railroads, *Manual of Standards and Recommended Practices*, Section J, M-1003, Specifications for Quality Assurance

QA vs. QC

Quality Assurance is a system of preventative activities that focus on the processes whereas Quality Control is a detection activity that is focused on detecting defects in products that have been produced

49 CFR 180.513(b)

- The facility must incorporate the tank car/equipment owners qualification program into their quality assurance program.

- The facility must obtain the permission of the car/equipment owner before performing any repairs maintenance or qualification of the owners car(s).

- The facility must use the written instructions provided by the car owner or have written confirmation from the owner allowing the use of written instructions provided by another.

49 CFR 179.7 (b)(10)

Procedures for evaluating the inspection and test technique employed, including the accessibility of the area and the sensitivity and reliability of the inspection and test technique and minimum detectable crack length.

- Inspection Reliability and Sensitivity
  - Develop Probability of Detection (POD) experiment for FRA approved NDT Methods
  - Match POD to Critical Flaw size
  - Two chances to detect
  - Generate POD Curve
- Inspection frequency must be driven by supporting data.

Inspection Reliability & Sensitivity for Steel Fillet Weld Panels

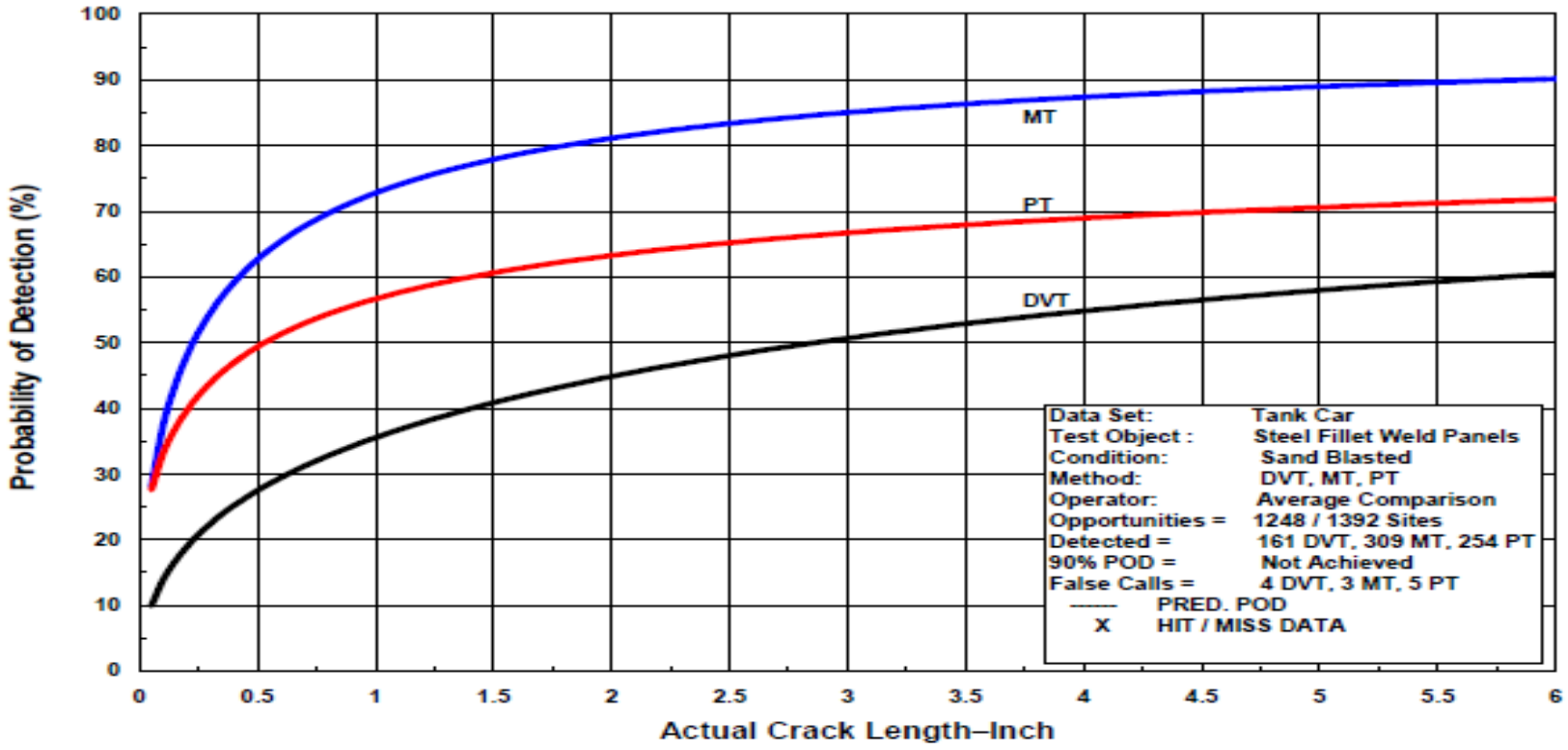


Figure 33. Combined Average POD Comparison for the DVT, MT, and PT Methods

Inspection Reliability & Sensitivity for Tank Car Butt Welds

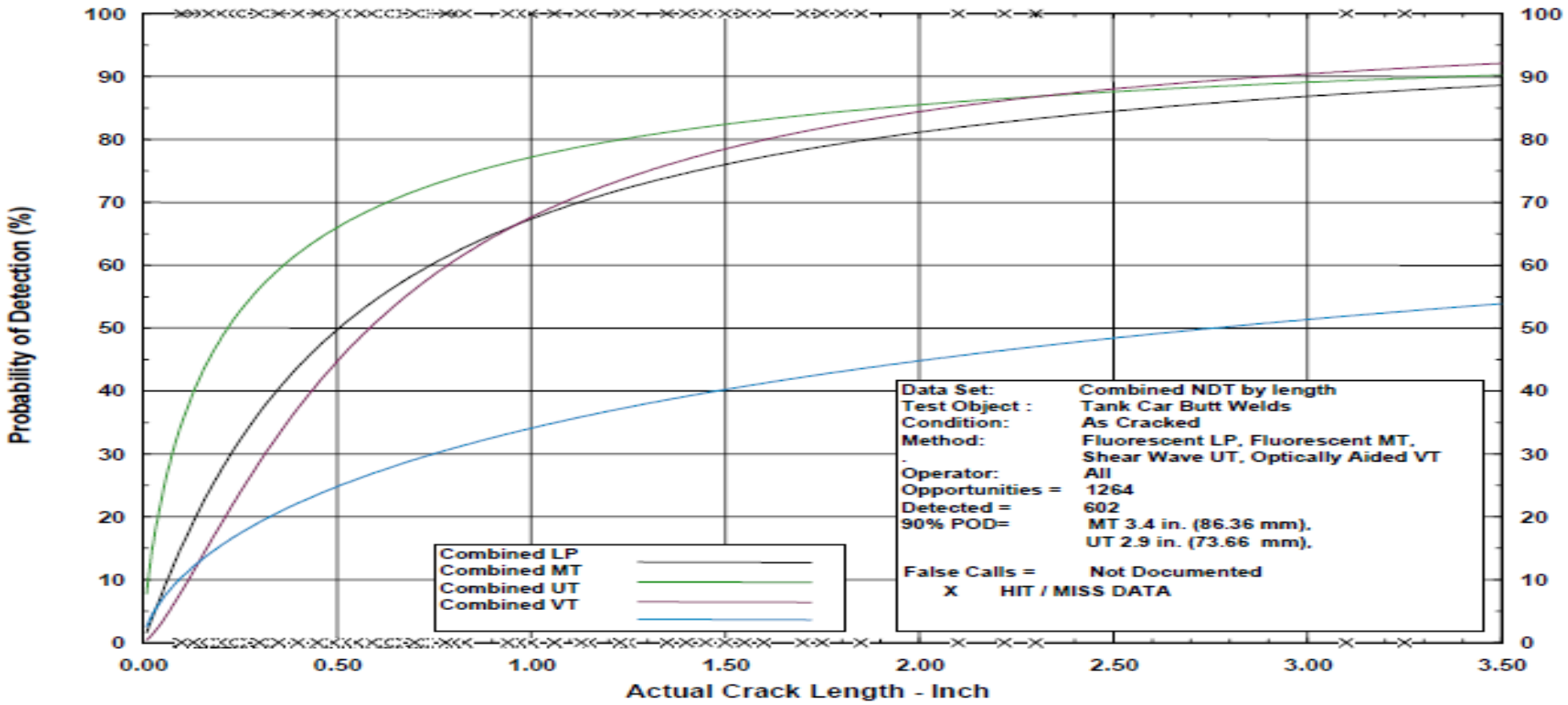


Figure 1. Combined NDT POD Comparison Showing Variability in Test Methods

In accordance to the AAR Manual of Standards and Recommended Practices, Section C-III Appendix T "Nondestructive Examination"

- All nondestructive testing shall be performed by personnel qualified and certified in accordance to a written practice.
- The written Practice shall describe the program for the control and administration of NDT personnel training, examination, and certification modeled.
- The written practice shall be reviewed and approved by an NDT Level III. An AWS CWI, SCWI or CSA 178.2 can function as a level III for visual/remote visual weld inspections.

Procedure Requirements

- All nondestructive testing shall be performed in accordance to a written procedure.
- NDT Procedures shall be approved by a level III certified and qualified in the method.
- The parameters for the essential and nonessential variables shall be stated in the procedure.

  - A change in the essential variable requires a new qualification of procedure
  - a change in a non essential variable doesn't require requalification, only revision to the procedure.

- Essential variables

- Technique on how it is to be performed
- Surface preparation
- Calibration requirements
- Specific equipment requirements
- Temperature constraints
- Procedure qualification requirements, including sensitivity and reliability requirements.
- Method and technique limitations and special requirements.

- Nonessential variables

- Personnel requirements
- Responsibility requirements
- Acceptance criteria
- Report and data requirements, including forms
- Post-examination cleaning requirements

Personnel Certification and Evaluation

- Certification of all levels of NDT personnel is the responsibility of the employer.
- NDT personnel may be reexamined any time at the discretion of the employer and have their certifications extended or revoked
- Periodically, as defined in the employers written practice, the technical performance of the NDT level I and II personnel shall be evaluated and documented by the level III or designee.

Develop a Program

- Management Support
- Develop program using input from all stake holders
- Create ownership
- Challenge on the execution of the program

Implement a Program

- Keep the procedures simple
- Place procedures in the work area
- Control the procedures

Perform Internal Audits

Execution of the NDT process:

Facility must follow the program without deviation.

- Facility must follow the program without deviation:

1. Common Failure areas
   - Misinterpretation of the procedure – Management oversight
   - Execution of the process – Pre-cleaning, hold/soak/observation
   - Final Interpretation – Relevant, nonrelevant or false indications
   - Final Documentation – incomplete forms

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NDT-Bubble Leak Testing (BT)

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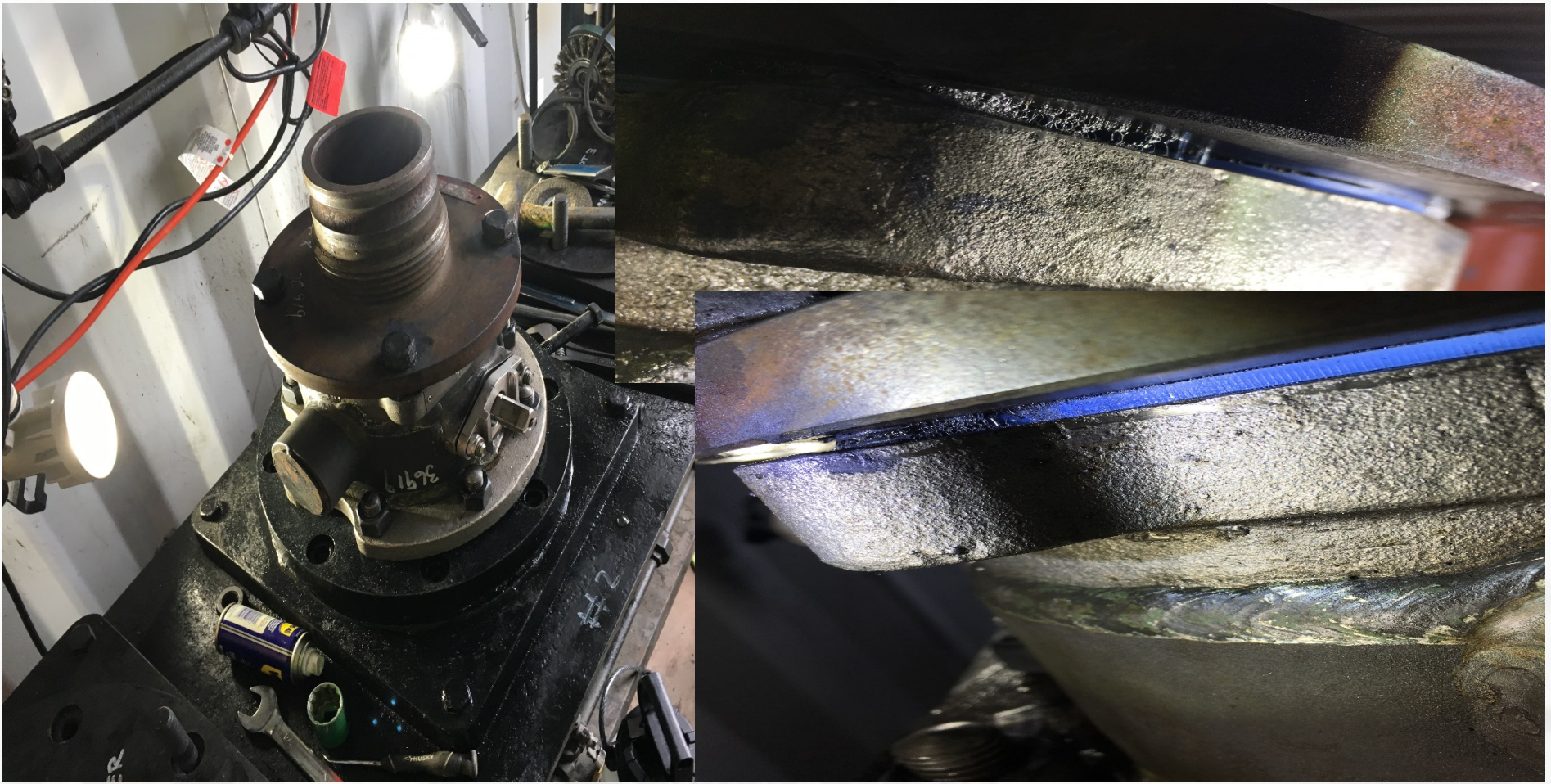
NDT-Bubble Leak Testing (BT)



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NDT-Visual Testing (VT)

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NDT- Visual Testing (VT)

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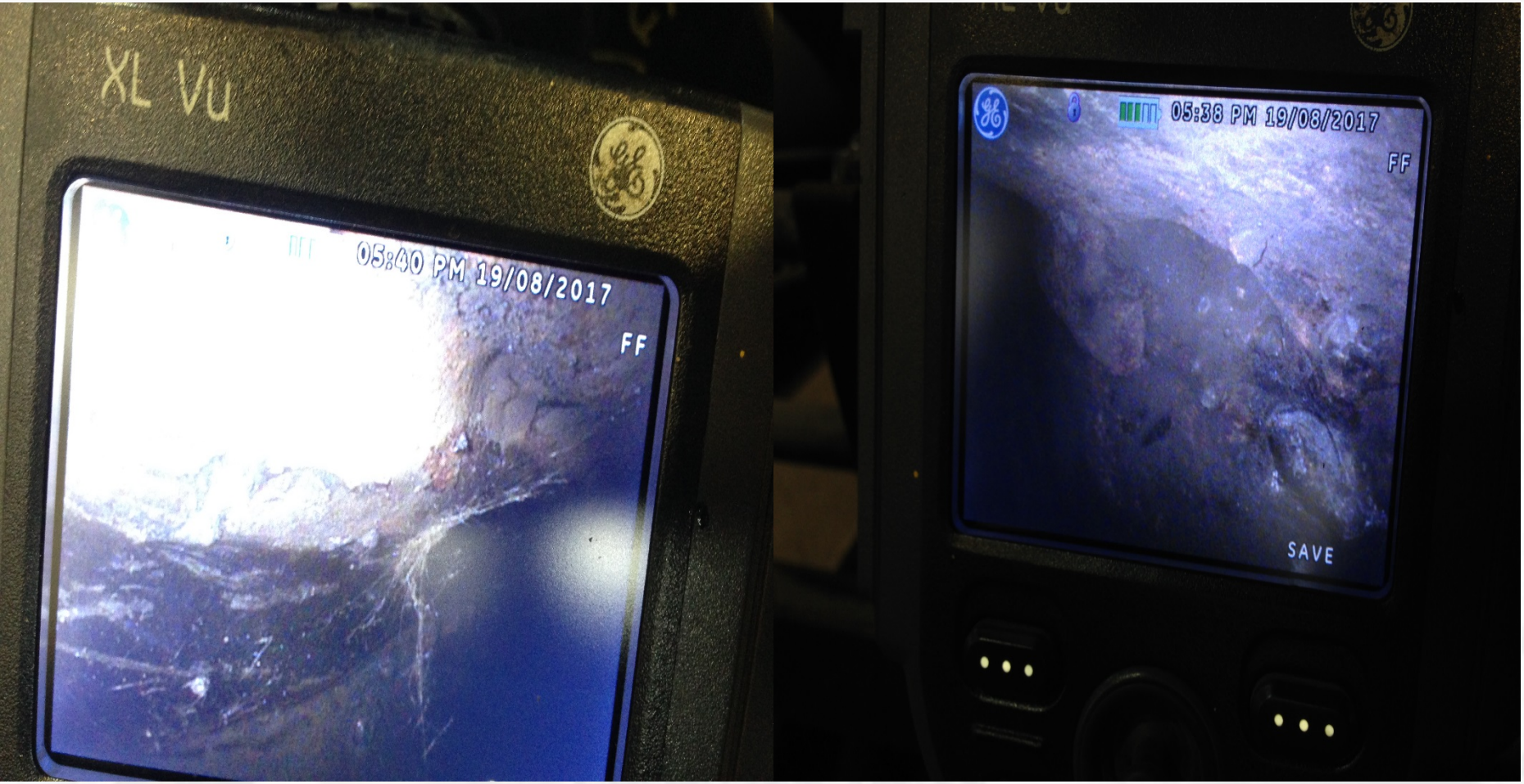
NDT- Remote Visual Testing (RVI)



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NDT-Ultra Sonic Testing (UT)

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NDT-Magnetic Particle Testing (PT)

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NDT- Penetrant Testing (PT)

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Final Documentation

Penetrant Examination Report

QF 804 M

Facility: MRH – Car Number: GATX – 58711 Stencil Class: DOT 112J340W Customer: GATX

GAGE INFORMATION

Thermometer Type: (Analog) / IR Range: 0-500
Thermometer S/N: 144601 Calibration Due Date: 9-29-18
Surface Temperature: 55 (°F) °C (circle one)

Penetrate Manufacturer: Magna Flux Type: SKL-NF2
Developer Manufacturer: Magna Flux Type: SKD – S2
Cleaner Manufacturer: Magna Flux Type: SKC – S
Visible Penetrate Used: Solvent-Removable / (Water-washable)

EXAMINATION REPORT Procedure: NDT-PT Use Current Revision, NDT-VT Use Current Revision

Exam Type: Initial / After Defect Removal / (After Repair)

Component	Location and Identification	VT Accept	VT Reject	PT Accept	PT Reject	Remarks
B-R	in board reinforcement Bar	X		X		after repair & stress
B-R	Termination plate AT Bar	X		X		after repair & stress

Notes/Sketch if needed see page 2

N/A

VT Technician: [Print Name] Signature: Date: 10-28-17 NDT Level: II Trainee

PT Technician: [Print Name] Tim Wilt Signature: Date: 10-28-17 NDT Level: II Trainee

Take-aways

- Safety is DOT's first priority.
- Federal Hazmat Regulations require that tank cars be qualified (inspected and tested) using approved nondestructive testing methods at the time of manufacturer and at defined intervals thereafter based on data collection/analysis.
- NDT methods must be able to reliably detect defects which could initiate or propagate cracks.
- NDT process must be completed by qualified personnel.
- NDT Process must be completed with qualified procedures.
- Facilities and technicians must follow the program without deviation.

How an Effective Coating and Linings Program Prevents NARS

David P. Gildea

Coatings and Linings are Different

Coating

Any paint type protective covering applied in one or more layers to the interior of a tank car to act as a barrier between the base metal and the commodity.

Lining

Any sheet or laminated type material, glass or fused metal applied to the interior of a tank car to act as a barrier between the base metal and the commodity.

Coating/Lining Owner Requirements

49 CFR 180.509(i)(2) & (3)

- Establish and maintain records for the service life of the coating or lining and commodity combination
- Establish an appropriate inspection interval for that coating or lining and commodity combination
- Use a written procedure for collecting and documenting the performance of the coating or lining applied within the tank car for its service life
- Provide the test method and acceptance criteria to the tank car owner and to the person responsible for qualifying the coating or lining.

Tank Car Facility Requirements

- Must have a quality assurance program approved by the AAR. This program must be in accordance with the requirements of 49 CFR 179.7
- Must follow the inspection and test procedure, including the acceptance requirements, established by the internal coating or lining owner per 49 CFR 180.509(i)(3)
- Must obtain the permission of the car/equipment owner before performing any maintenance, repair or qualification per 49 CFR 180.509(b)
- Must use the written instructions furnished by the car/equipment owner or have written confirmation from the owner allowing the use of written instructions furnished by another per 49 CFR 180.513(b)

Tank Car Facility Requirements

- Must not use, copy distribute, forward or provide to another person the owner's written instructions, procedures, manuals, and records without owner's permission per 49 CFR 180.513(b)
- Must report all work performed to the owner per 49 CFR 180.513(b)
- Must report observed damage, deterioration, failed components, or non-compliant parts to the owner per 49 CFR 180.513(b)
- Must incorporate the car/equipment owner's qualification program into their own quality assurance program 49 CFR 180.513(b)

Inspection Requirements

- Internal Coating and Lining Inspection and Test
  - The owner of an internal coating or lining applied to protect a tank used to transport a material that is corrosive or reactive to the tank must ensure an inspection adequate enough to detect defects or other conditions that could reduce the design level of reliability and safety of the tank is performed per 49 CFR 180.509(i)(1)

- Alternative Inspection and Test Procedures
  - A coating or lining owner may request for the use of an alternative inspection program (e.g. extended inspection interval, relief from inspection, etc,). This request must be submitted and approved by the DOT and include a supporting damage tolerance analysis or service reliability assessment per 49 CFR 180.509(l)

AAR MSRP Section C-III Specification For Tank Cars M-1002 Appendix L

- **3.0 PERSONNEL, TRAINING, AND QUALIFICATION**
- **3.1** Facilities that perform stripping, cleaning, and repair and/or apply interior protective coatings and/or linings activities regulated by 49 CFR 180 must have available a coatings inspector capable of establishing techniques and procedures and interpreting codes, standards, and specifications who has been qualified in-house on the basis of demonstrated ability, achievement, experience, and training, in accordance with a written company practice.
- **3.2** Interior surfaces of tank cars subject to activities covered in paragraph 3.1 above shall be prepared by personnel trained and qualified in accordance with a written company practice.
- **3.3** Protective interior coatings and/or linings shall be applied in accordance with the material manufacturer's application procedure and/or the contracting authority's requirements by personnel qualified in accordance with a written company practice.

AAR MSRP Section C-III Specification For Tank Cars M-1002 Appendix L

- **5.0 COMPLIANCE**
- **5.1** All interior cleaning, lining, or coating applications or stripping must be performed in accord with the provisions of this specification.
- **5.2** Facilities that apply, inspect, strip, or repair interior protective coatings and/or linings for protection of tank car tanks against corrosion must maintain applicable standards, guidelines, and procedures covering application, testing, and removal of interior protective coatings and/or linings.
- **5.3** Facilities that apply, inspect, qualify, or repair interior protective coatings and/or linings for the purpose of tank protection shall develop and implement a quality assurance program in compliance with all requirements of 49 CFR 179.7, this appendix, AAR specifications or rules, and DOT/TC regulations.
- **5.4** The interior surface, prime coat, or adhesive layer and all subsequent coats of interior protective coatings and linings shall meet conditions of acceptance as agreed upon by the contracting authority and the applicator, with consideration of the material manufacturer's recommendations.
- **5.5** The contracting authority shall prepare an inspection and test plan per 49 CFR 180.509.

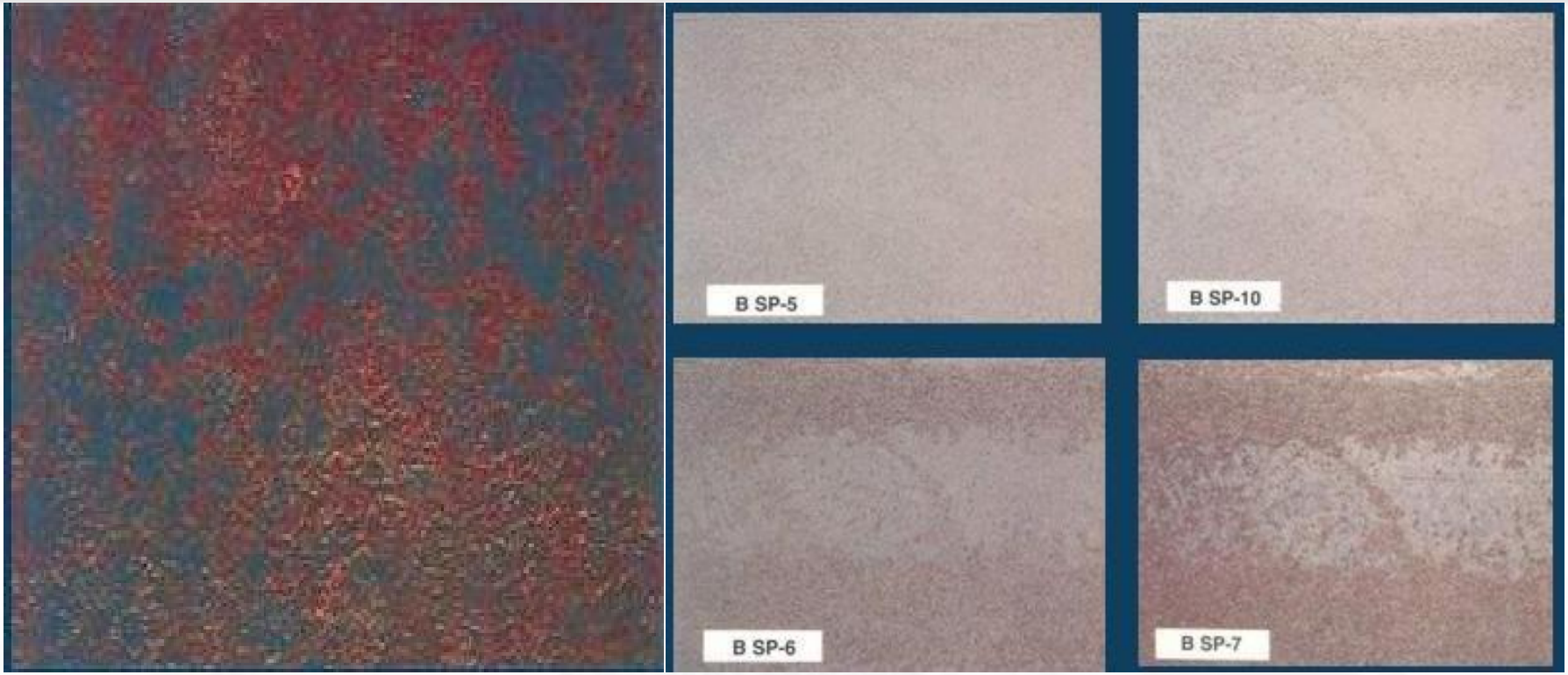
Key Points

- Program must be developed and implemented by car/equipment owner
- Car/equipment owner must ensure that facility operates in accordance with the program
- Facility must follow the program without deviation
- Inspection frequency must be driven by supporting data
- All maintenance and repair functions must be qualified
- Personnel must be trained and qualified in accordance with a written company practice.

Coatings and Linings

- Surface Preparation:
  - Testing – Surface contamination
  - Grinding – Metal Preparation
  - Blasting – Profile
  - Vacuum – Removal of blast media/dust
- Coating Application:
  - Single or Multiple Coats
  - Cure – Intermediate and Final
  - Inspection – Intermediate and Final
- Lining Application:
  - Adhesive System – primer, sealer, cement
  - Rubber Application
  - Cure - Steam
  - Inspection – Before cure and final

Note: all processes are procedure driven



Starting Condition – Grade B: Mill Scale & Rust Blast Cleaning Standards

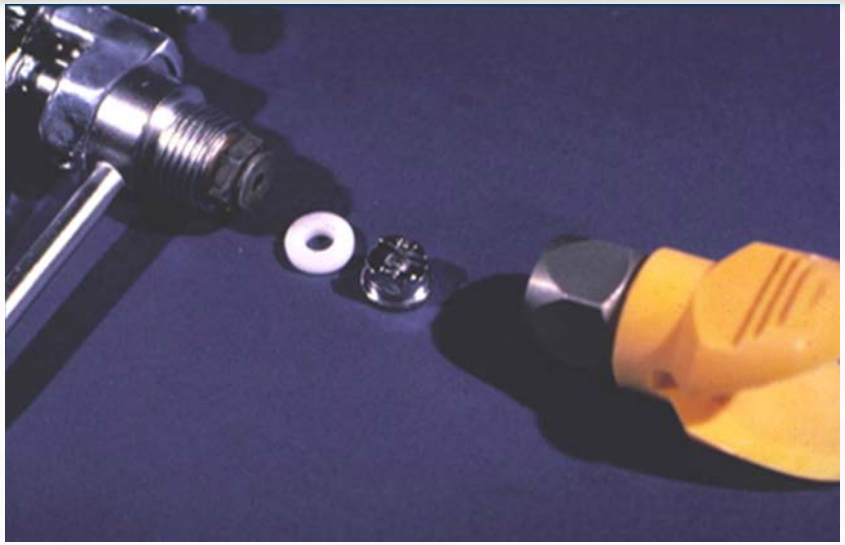
NACE	SSPC	Blast	% of Stain or Shadowing
No. 1	SP 5	White Metal	0%
No. 2	SP 10	Near White	5%
No.3	SP 6	Commercial	33%
No.4	SP 7	Brush-Off	Loose removal only

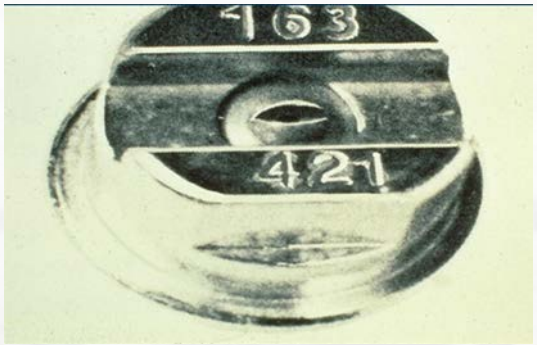
BLAST CLEANING STANDARDS

BLAST MEDIA

SAE Size No.	SAE J444 GRIT Tolerances	Screen Opening In-mm
G10	All Pass No. 7 Screen 80% Min on No. 10 Screen 90% Min on No. 12 Screen	.1110 - 2.80 .0787 - 2.00 .0661 - 1.70
G12	All Pass No. 8 Screen 80% Min on No. 12 Screen 90% Min on No. 14 Screen	.0937 - 2.36 .0661 - 1.70 .0555 - 1.40
G14	All Pass No. 10 Screen 80% Min on No. 14 Screen 90% Min on No. 16 Screen	.0787 - 2.00 .0555 - 1.40 .0469 - 1.18
G16	All Pass No. 12 Screen 75% Min on No. 16 Screen 85% Min on No. 18 Screen	.0661 - 1.70 .0469 - 1.18 .0394 - 1.00
G18	All Pass No. 14 Screen 75% Min on No. 18 Screen 85% Min on No. 25 Screen	.0555 - 1.40 .0394 - 1.00 .0278 - 0.710
G25	All Pass No. 16 Screen 70% Min on No. 25 Screen 80% Min on No. 40 Screen	.0469 - 1.18 .0278 - 0.710 .0165 - 0.425
G40	All Pass No. 18 Screen 70% Min on No. 40 Screen 80% Min on No. 50 Screen	.0394 - 1.00 .0165 - 0.425 .0117 - 0.300
G50	All Pass No. 25 Screen 85% Min on No. 50 Screen 75% Min on No. 80 Screen	.0278 - 0.710 .0117 - 0.300 .0070 - 0.180
G80	All Pass No. 40 Screen 85% Min on No. 80 Screen 75% Min on No. 120 Screen	.0165 - 0.425 .0070 - 0.180 .0049 - 0.125
G120	All Pass No. 50 Screen 80% Min on No. 120 Screen 70% Min on No. 200 Screen	.0117 - 0.300 .0049 - 0.125 .0029 - 0.075

Replica Tape & Micrometer Gage





Spray Gun & Tips

WFT GAGES

DFT Gages – Type I & Type II

SPARK TESTER – LOW & HIGH VOLTAGE

Rotary Cut Saw
Rubber Hot Knife
Durometer

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Federal Railroad Administration

Delamination at Substrate– Results of inadequate surface preparation, anchor profile or surface cleanliness. (This case – inadequate anchor profile on SST)

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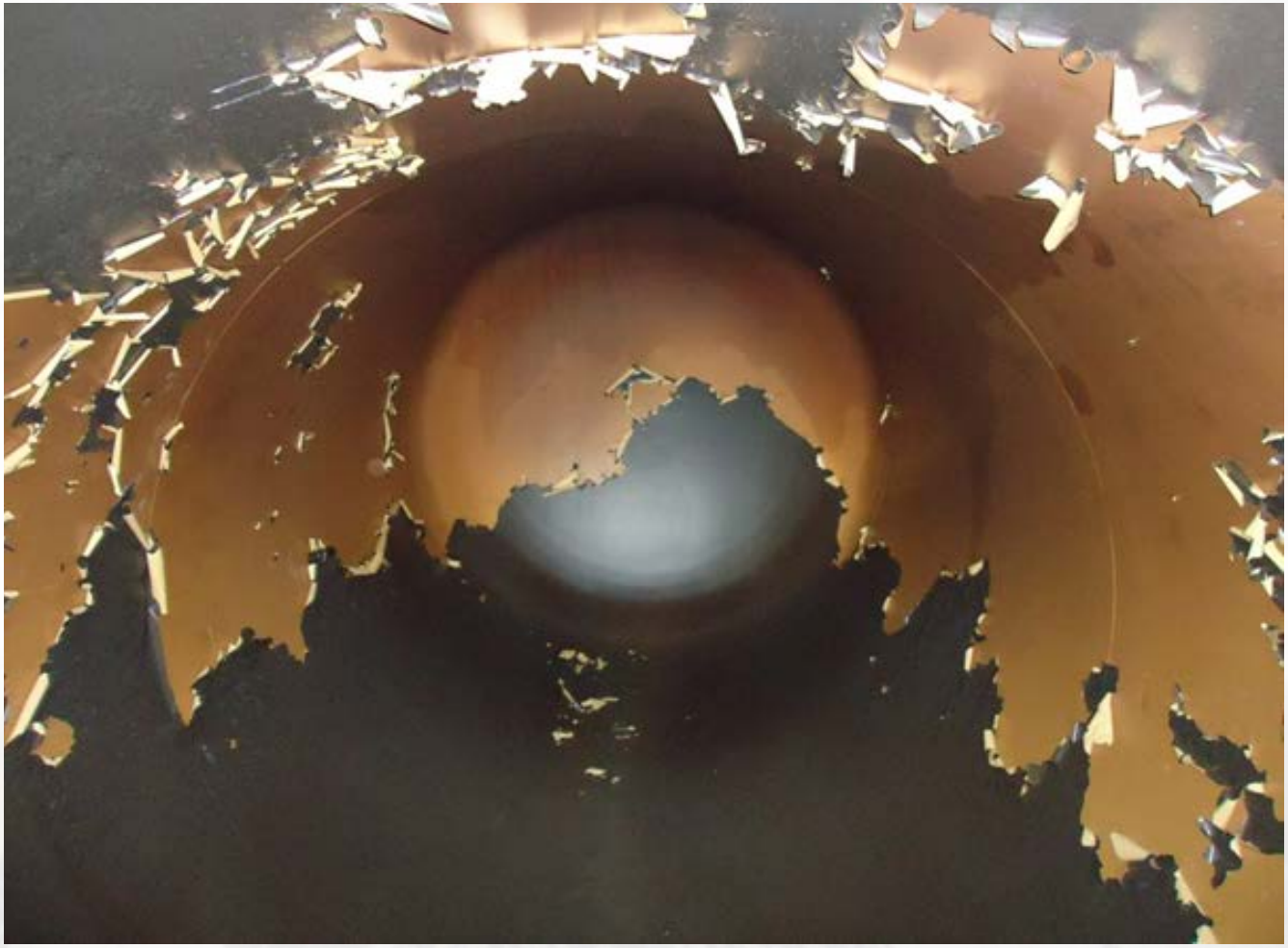
Inter Coat Delamination – Results of contaminates, extensive dry spray, insolubility between coats. (This case – insolubility, undercoat over baked)



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Inter coat Delamination – Results of contaminates, extensive dry spray, insolubility between coats. (This case – insolubility)

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Chemical Attack – Caused by an incompatibility between coating material and product. (This case – mass failure)

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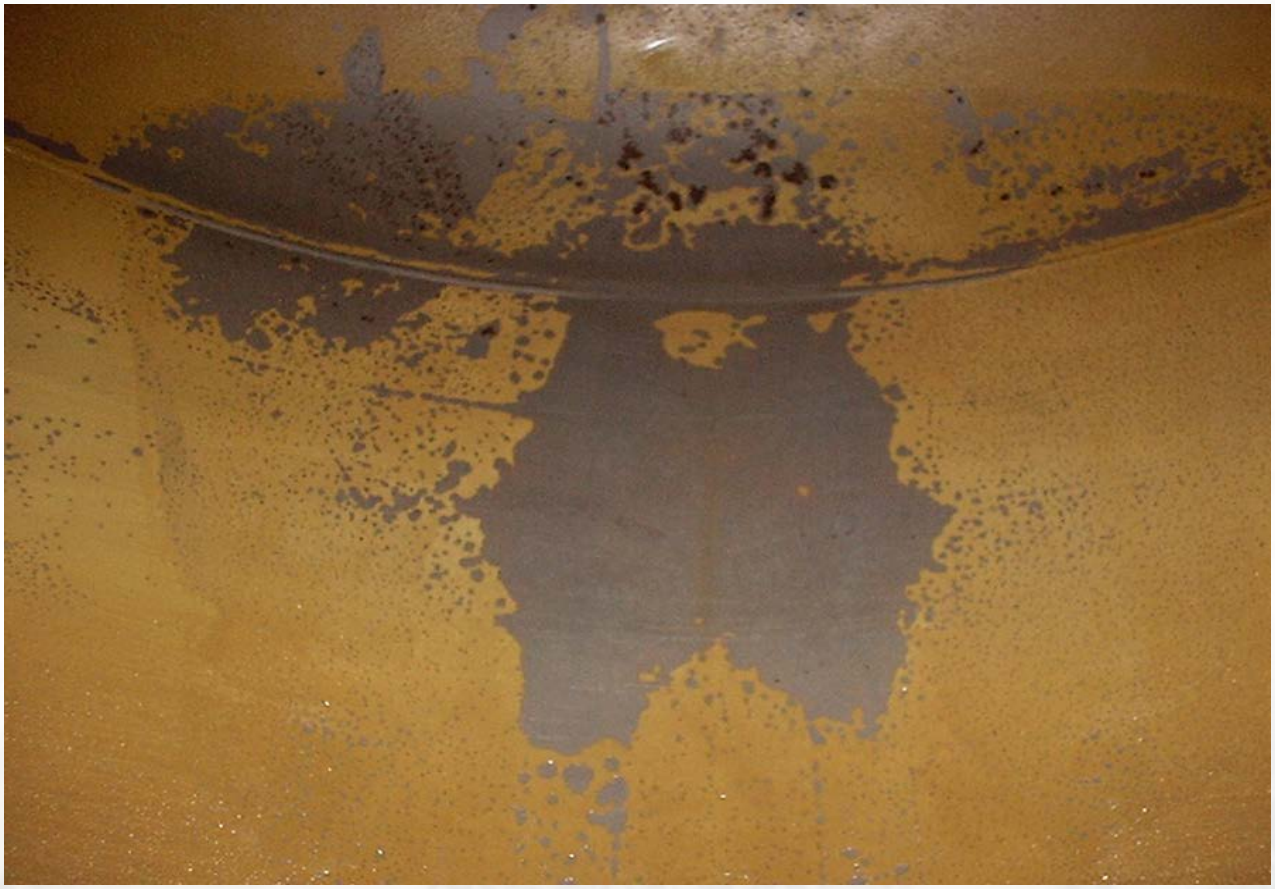
Chemical Attack – Caused by an incompatibility between coating material and product. (This case – caustic soda w/ Plasite 3070)



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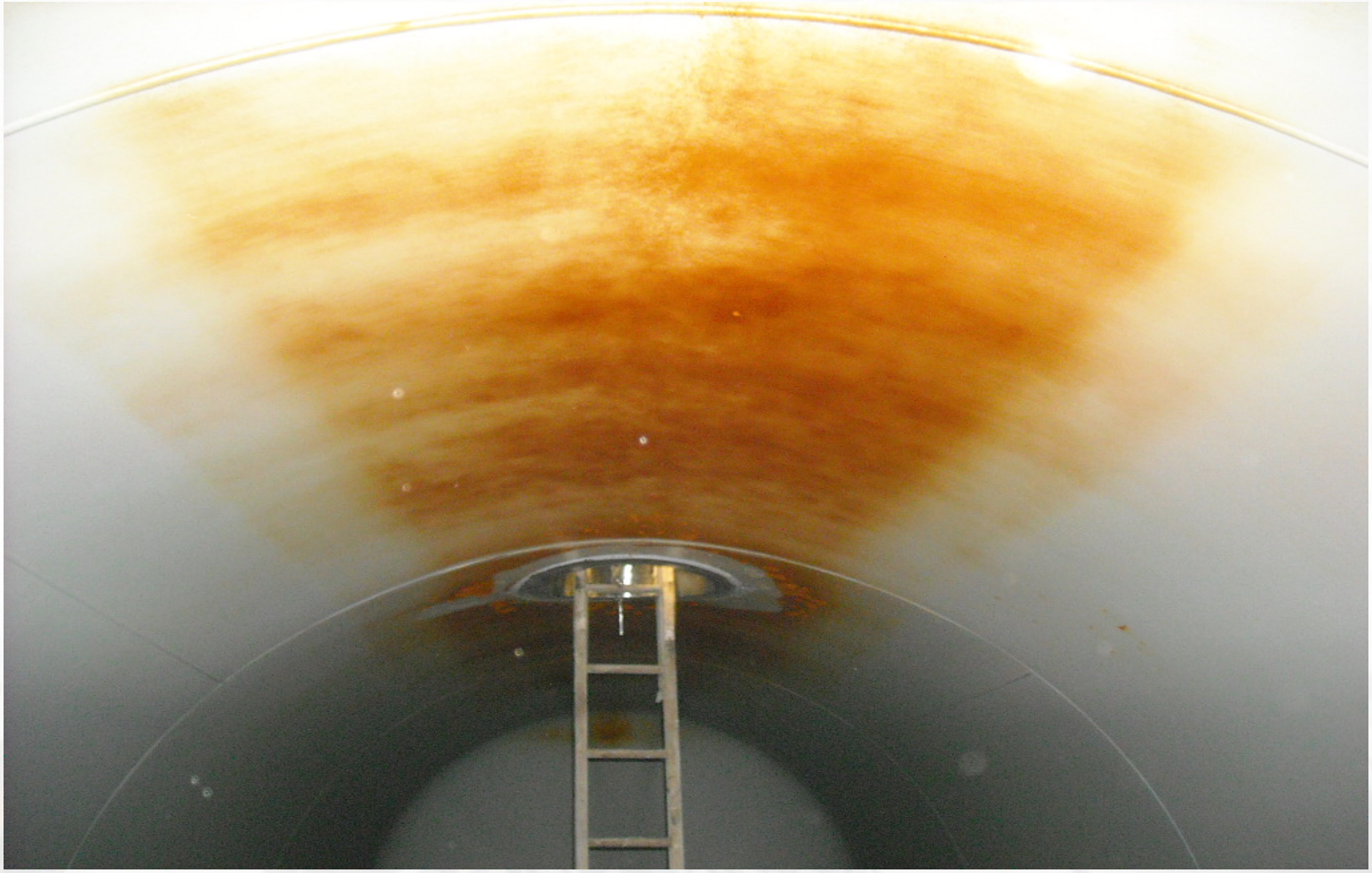
Low Film Build – Result of inadequate WFT build during application process. Allows for rapid permeation to substrate resulting in rust formation.



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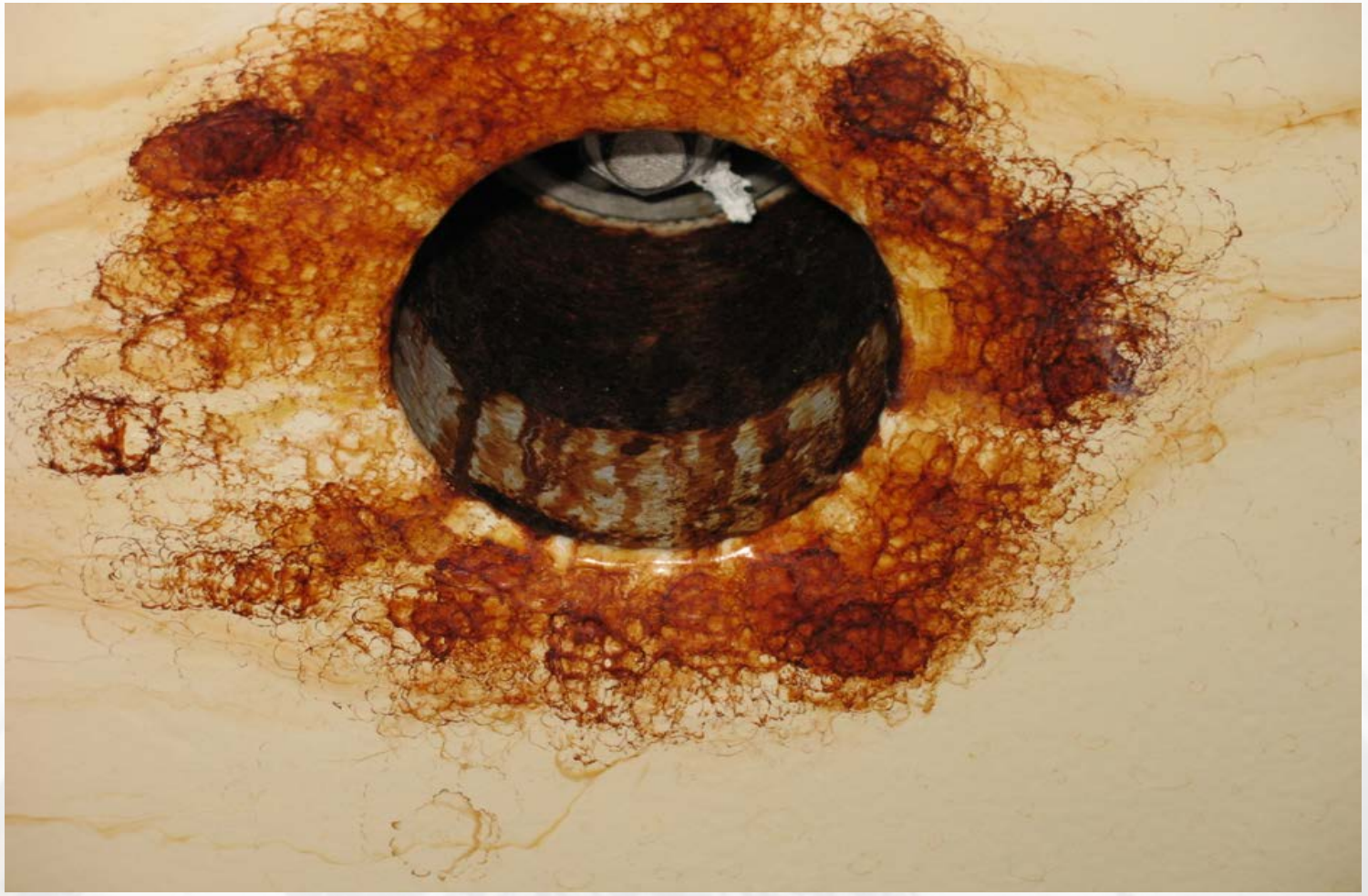
Low Film Build – Result of inadequate WFT build during application process. Allows for rapid permeation to substrate resulting in rust formation.



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Failures in difficult or rough areas – Result of improper substrate preparation or inadequate film build. (This case – difficult area)

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Failures in difficult or rough areas – Result of improper substrate preparation or inadequate film build. (This case – coated over corrosion)

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Failures in difficult or rough areas – Result of improper substrate preparation or inadequate film build. (This case – sharp edge at bottom of nozzle)

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DAMAGE AS THE RESULT OF A COATING FAILURE. CORROSION!

Typical Rubber Lining Application

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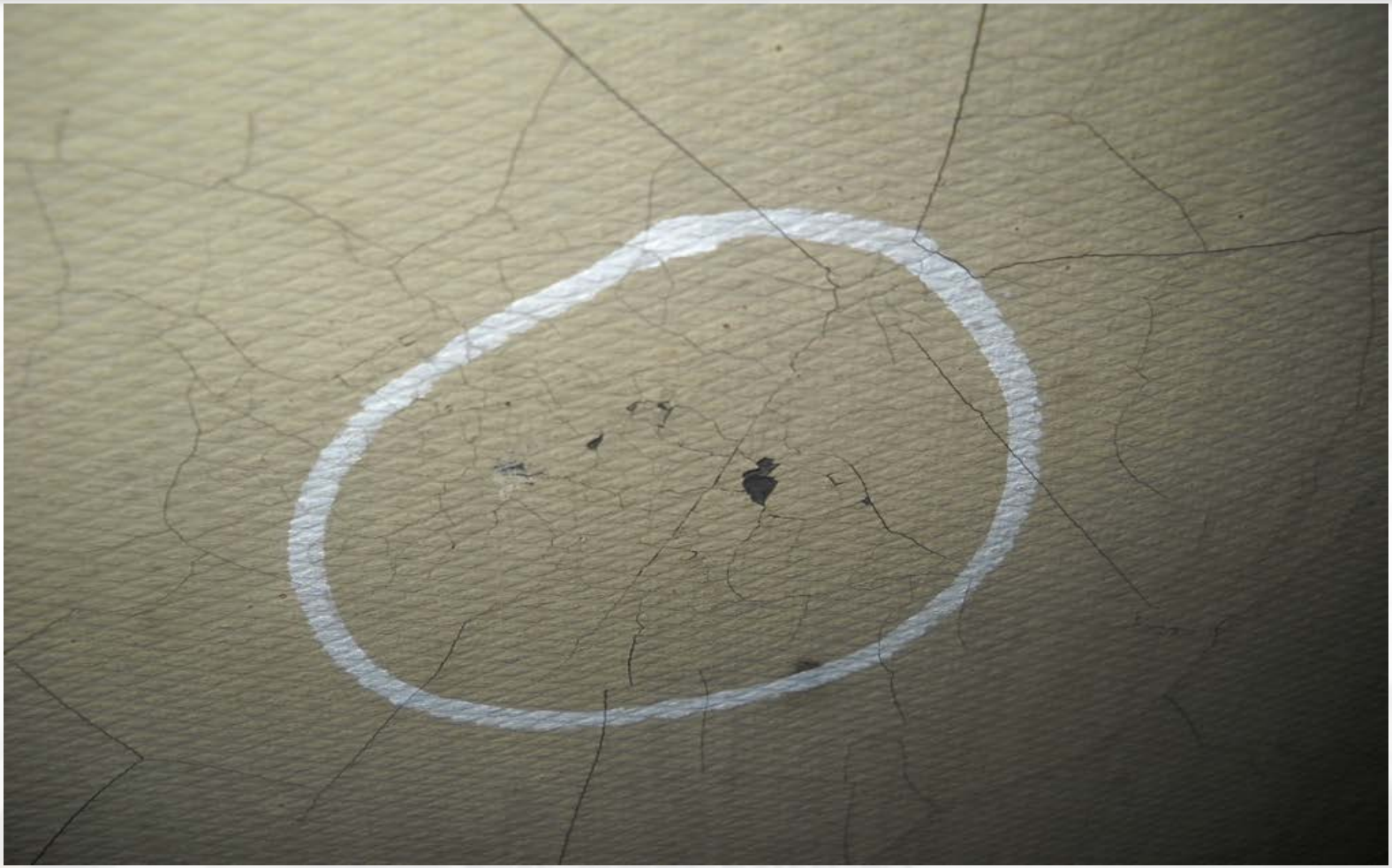
Hardening and Cracking – Result of chemical reaction with product (HCL)



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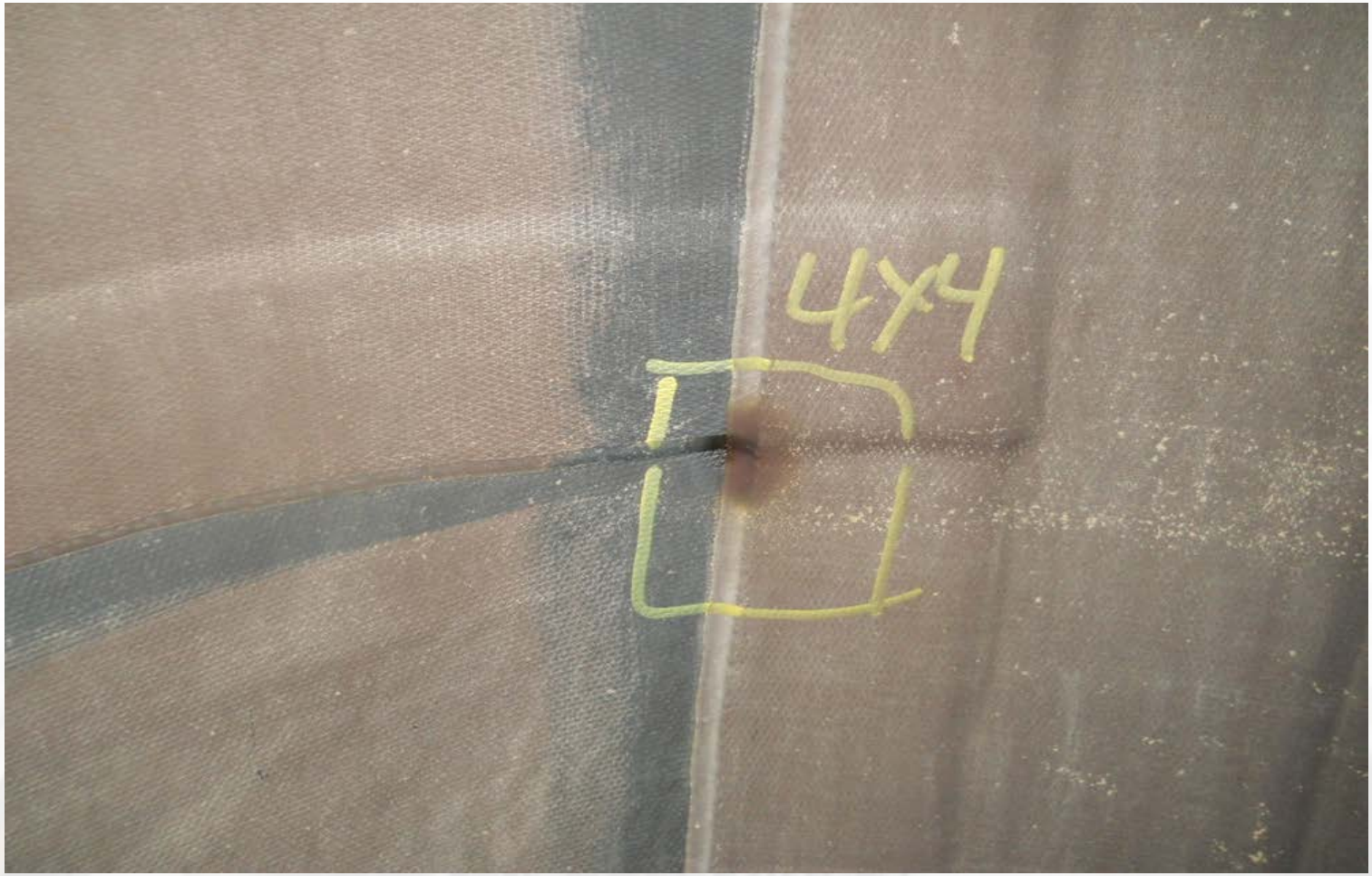
Disbond at Seams – Result of improper seam application.



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Rubber Lined Tank Car
Last Contents – Hydrochloric Acid

Questions