



OFFICE OF RESEARCH & DEVELOPMENT

2012 **R&D**
REVIEW

Non-Destructive Testing (NDT)



U.S. Department
of Transportation

Federal Railroad
Administration

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Program Area & Risk Matrix

Non-Destructive Testing (NDT)

Program Areas	Risk Factors	Trespass	Grade Crossing	Derailment	Train Collision	All Other Safety Hazards
Railroad Systems Issues						
Human Factors						
Track & Structures						
Track & Train Interaction						
Facilities & Equipment						
Rolling Stock & Components						
Hazardous Materials				X		X
Train Occupant Protection						
Train Control & Communications						
Grade Crossings & Trespass						

Acknowledgements & Stakeholders

Acknowledgements

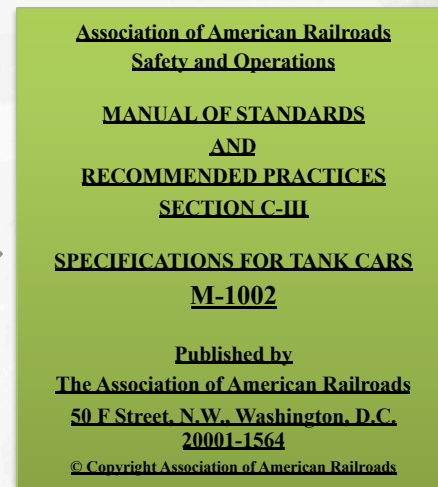
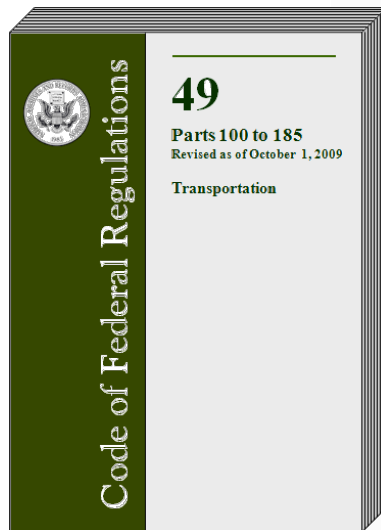
- Greg Garcia, TTCI
- Ward Rummel, D&W Enterprises
- Tank car shops
- Tank car manufacturers
- Association of American Railroads (AAR) Non-Destructive Testing (NDT) Task Force

Stakeholders & Project Partner

- Tank car shops
- Tank car manufacturers
- Transportation Technology Center, Inc. (TTCI)
- Office of Railroad Safety (RRS)

Description of Project

- Evaluate and quantify the capabilities of non-destructive evaluation (NDE) methods authorized under 49 Code of Federal Regulations Section 180.509 for use in replacing the hydrostatic pressure test in the qualification or re-qualification of railroad tank cars
- Probability of detection (POD) metric



Motivation for Project

- Increased safety through technology development
- Provide general understanding of capabilities of NDE methods
- To be used in conjunction with critical flaw size determined through damage tolerance analysis
- Increased reliability of inspections
- Provides for operator and procedure qualification



Previous Methods

Manufacturing

- Hydrostatic pressure testing
- Radiography

Regular inspections

Structural integrity

- Dye Penetrant
- Radiography
- Magnetic particle test
- Ultrasonic test
- Visual inspection
- Prior to HM-201 testing for crack on tank cars done by hydrostatic testing

Technology Background

- A tank car failing a hydrostatic pressure test means that a crack has already propagated through the entire thickness of the tank
- Structural integrity is monitored by other industries (aerospace, automobile, petrochemical, etc.) using NDE
- Methods of evaluation and probability of detection were developed
- Primary method for quantifying NDT was sponsored by NASA in the 1970's and uses the probability of detection (POD) approach

1996

- Process to incorporate more stringent NDE requirements are introduced to increase "Safety" of railroad tank car operations
- Major rule changes for inspecting and testing tank cars (HM-201)

CFR Allowed NDT methods for replacing hydrostatic testing:

- Magnetic Particle Testing (MT)
- Liquid Penetrant Testing (PT)
- Radiographic Testing (RT)
- Ultrasonic Testing (UT)
- Visual Testing (VT)

Benefits & Disadvantages

Benefits

- Techniques discover more defects
- Techniques do not damage the tank
- The POD curves can be used to determine appropriate inspection intervals

Disadvantages

- Cost of NDT methods evaluation
- False positives
- Time for inspection
- Certification of technicians



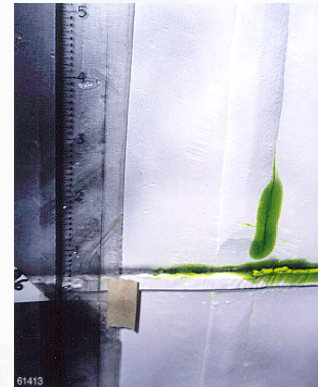
Types of Technologies

MT



Butt Weld

PT



RVT



Fillet Weld

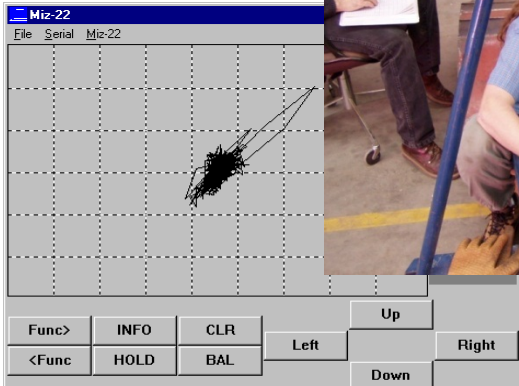


VT



Types of Technologies

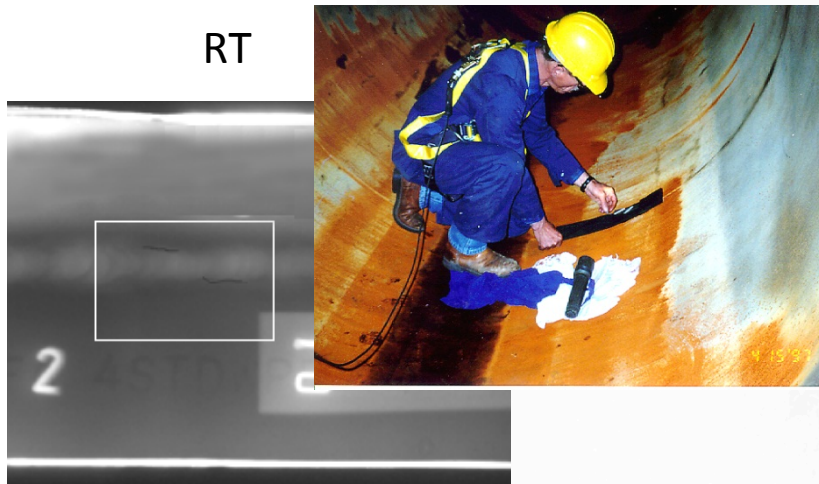
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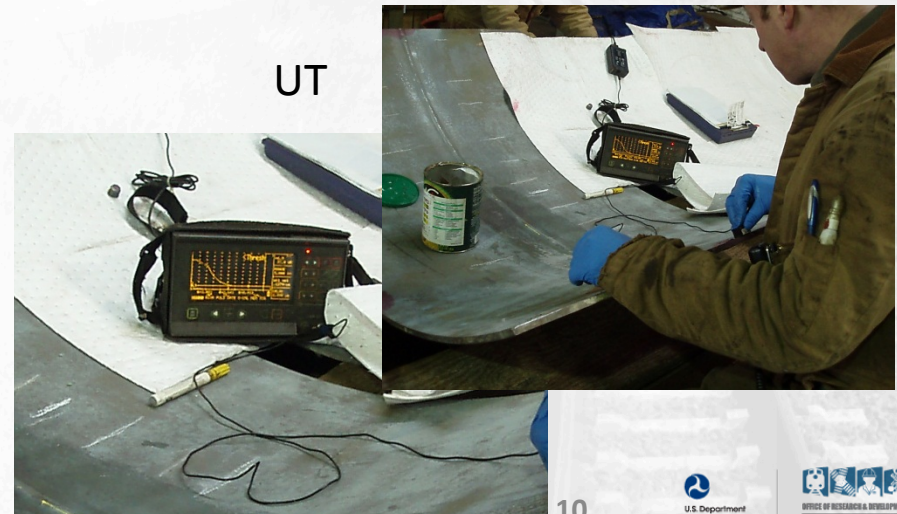
LT



RT



UT



Positive project support

- Tank car shops send their technicians and share the information
- Provides opportunity for technicians to improve understanding of tank car fatigue cracks on tank cars
- Technicians provide insight to industry improvements in detection
- Office of Railroad Safety inspectors share information of inspections to continually include real world situations



USDOT FRA R&D: Non Destructive Evaluation of Tank Cars

Goals

- Fewer spills, releases from tank cars; Less damage, loss, Greater reliability of tank cars and service equipment

Other Interventions

- Other competing technologies
- R&D by other companies
- FRA regulation and recommended practices

Legend

- Happened or in process
- Planned or emerging

R&D Activities & Output

Develop Knowledge

- Evaluate reliability of approved NDT methods relative to tank car qualification (testing and inspection)

- Update the probability of detection graphs to include small shops

Develop + Test Technology/ Solutions(s)

- Test specimens with known flaws to determine the probability of detection of different size flaws.

- Provide data for different NDT methods
- Determine a reliability method for inspection intervals

Partners, Target Users

- Tank car repair and manufacturers
- FRA &R&D
- TTCI/AAR
- Railway Supply Institute

- FRA R&D
- TTCI/AAR
- Office of Safety

Use of Outputs (Outcomes)

Develop Structures to Speed/Expand Adoption

- Testing reliability of inspection methods (choice, use) in different tank car inspection areas and situations

- Develop & maintain Tank Re-qualification and Inspection Center
- Commercial support available for widespread use
- OS agreement on quality assurance for crack detection

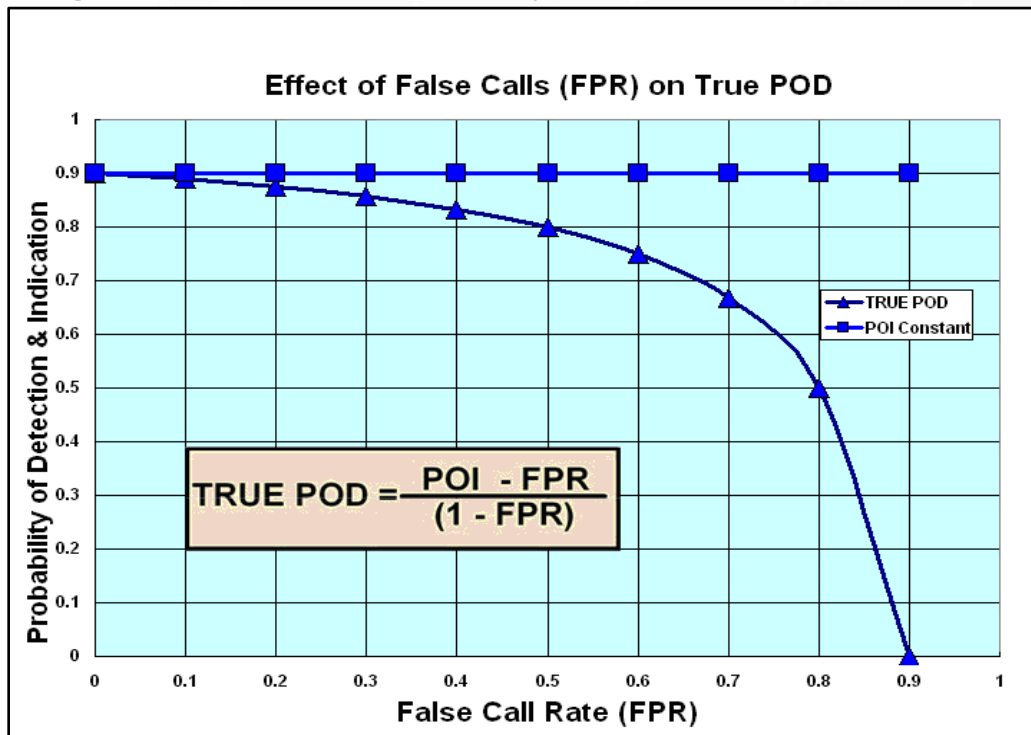
Use Technology/ Solutions

- Ability to detect cracks with greater reliability
- Allow tank car owners to select NDT method that is appropriate for critical size and location

- Use of appropriate reliable NDT method
- Selection of appropriate inspection interval

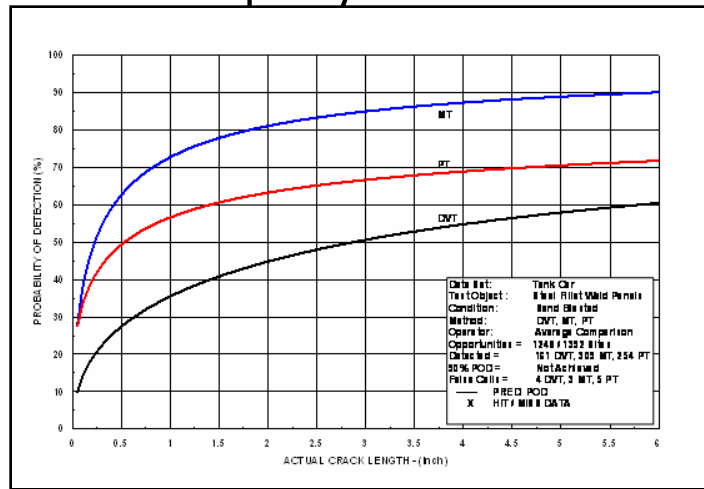
Project Complications

- Scheduling the visits
- False positives and how to handle
- Sharing the information generically
- Developing regulation and reliability

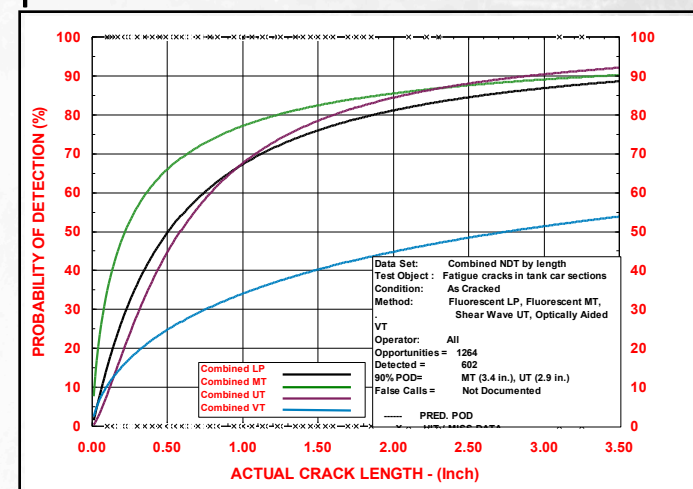


Lessons Learned

- Identified ways to generate more participation from smaller tank car shops
- Developed procedures for evaluating individual shops
- Addressed the need for calibration in inspection setup
- Identified the need to address false positives
- Provides 3rd party assessment of NDT processes



Fillet Weld POD



Butt Weld POD

Key Success Factors

- Provided base line PODs for the approved NDE methods
- Identified process improvements to increase method sensitivity
- Adopted methodology for addressing the effect of false positives
- Good cooperation from the industry
- Good team to evaluate the results

