



OFFICE OF RESEARCH & DEVELOPMENT

2012 **R&D**
REVIEW

Tank Car Research



U.S. Department
of Transportation

**Federal Railroad
Administration**

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Office of Railroad Policy and Development

Program Area & Risk Matrix

Tank Car Research

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

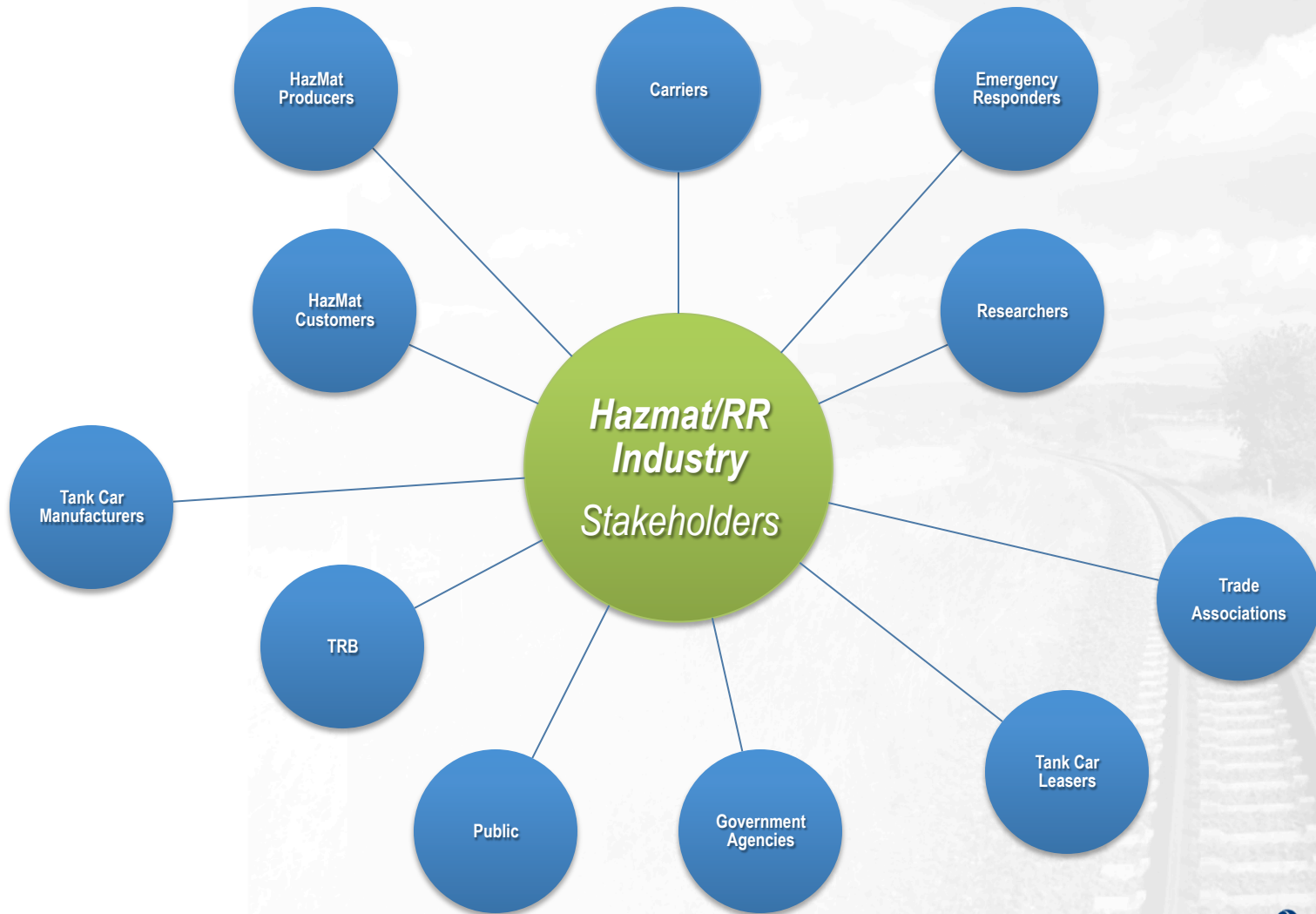
Acknowledgements

- David Jeong, Volpe
- Mike Carolan, Volpe
- Karl Alexy, Office of Railroad Safety (RRS)
- Anand Prabhakaran, Sharma & Associates

Stakeholders & Project Partners

- Railroads
- Tank Car Builders
- Chemical Companies
- Repair Shops
- Transportation Technology Center, Inc. (TTCI)
- VOLPE
- Sharma & associates

Stakeholders for FRA Hazmat Research



Tank Car Research Project Description

Investigate ways to improve the performance of tank cars transporting hazardous materials:

- Quantify “normal” operating environment
- Survivability of tank car tanks and substructures under normal operating environment
- Service equipment in loading and unloading operations
- Survivability of tank cars in derailments and collisions
 - Puncture resistance of tank
 - Integrity of substructures, body bolster and sills
 - Top and bottom fittings

Railroad Hazmat Accidents of Concern

2002

2003

2004

2005

2006

2007

2008

2009

2010

2011



January 18, 2002
Minot, ND



June 29, 2004
Macdona, TX



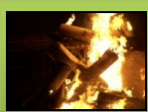
January 6, 2005
Graniteville, SC



July 10, 2005
Anding, MS



October 15, 2005
Texarkana, AR



October 20, 2006
New Brighton, PA



January 16, 2007
Shepherdsville, KY



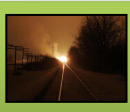
March 12, 2007
Oneida, NY



October 10, 2007
Painesville, OH



June 19, 2009
Cherry Valley, IL



February 6, 2011
Arcadia, OH



October 17, 2011
Tiskilwa, IL

Objectives

- **Reduce the likelihood and severity** of a hazmat release associated with rail transportation
- Provide the **foundation** of facts for industry best practices, FRA rulemaking, and enforcement activities

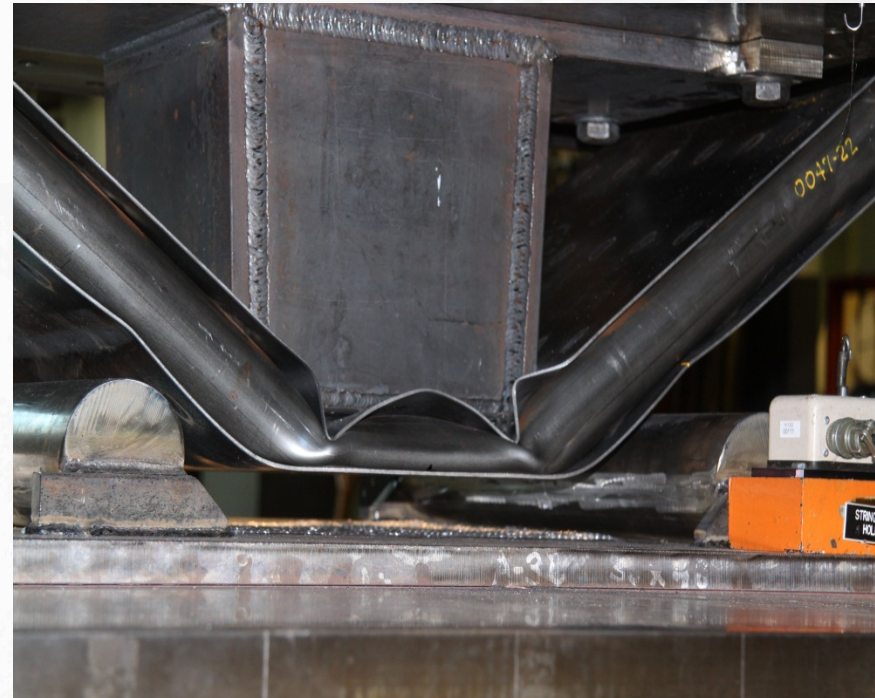
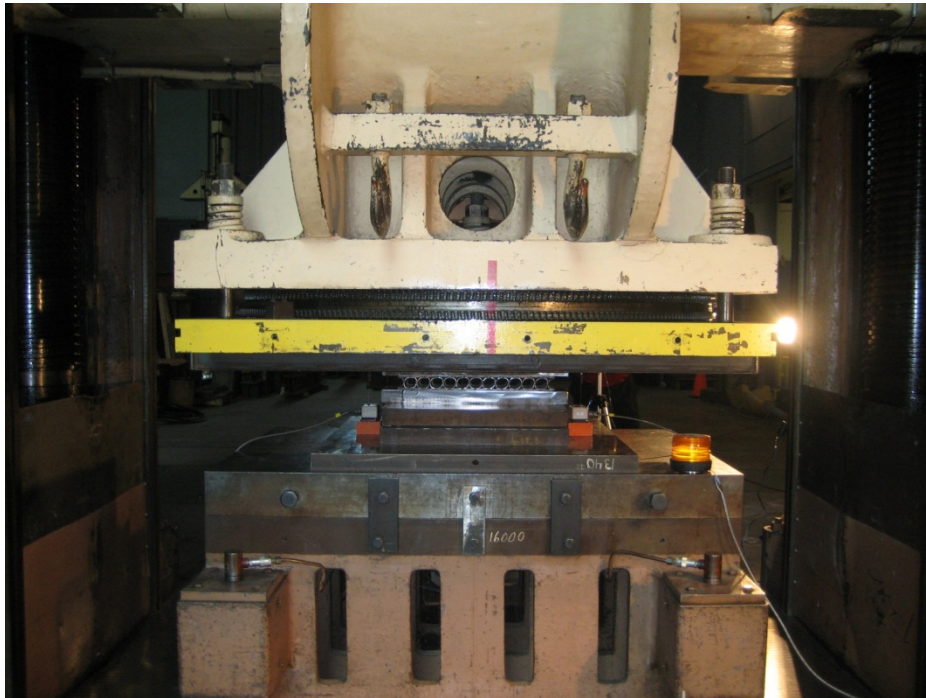


Technology Evolution

- Evaluate the different protection methods
- Choose the ones that provide the best results (optimal cost/benefit)
- Develop testing procedures
- Conduct modeling
- Perform full-scale testing

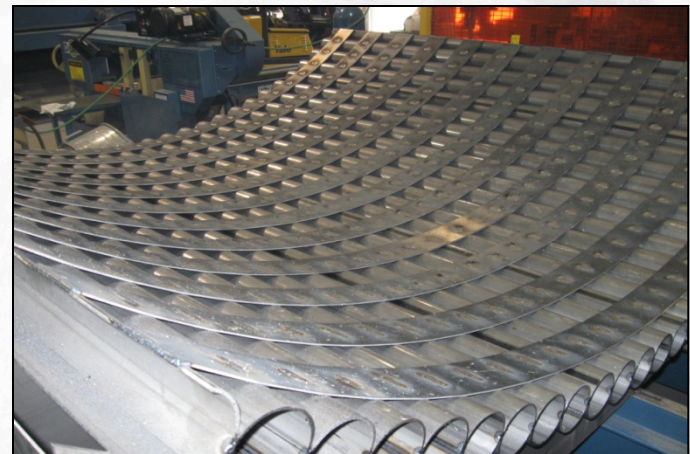
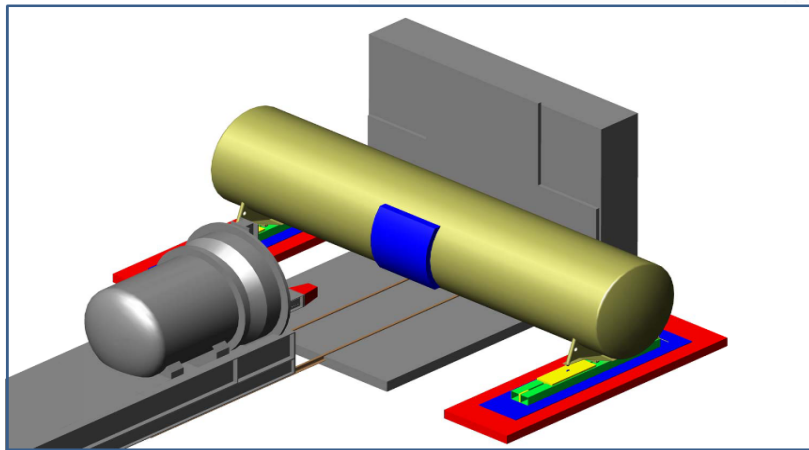
Component Testing

Engineered protective structure intended to spread load of indenter and prevent puncture.



Full –Scale test

- FRA conducted a full scale test using this CEM structure on May 18 at TTC
- This test demonstrated added protection for tank cars to prevent puncture
- The results from this test were compared with previous tests with no protection



Preparation for test



Baseline tests puncture resistance



Baseline tests for top fittings protection

Goal: Develop & demonstrate concepts for tank car top fittings protection

Full scale tests:

- **Base Case:** Demonstrated a repeatable method in which tank car fittings and fittings protection can be impact tested
- **Skid Protection:** Significant structural addition that protected fittings during an 18 mph impact
- **Protective Sleeve/Bonnet with Cone type reinforcement** : Similar to pressure tank cars 12 mph
- Measure forces and deflections seen by the fittings, local tank shell and protective structure



How the technology works

- **Evaluate the different protection methods**
 - Head protection
 - Side protection
 - Top fittings protection
- **Select options that provide the best results**
- **Testing procedures for different specification tank cars**
- **Modeling and simulations**
- **Full-scale testing**

Benefits & Disadvantages

Benefits

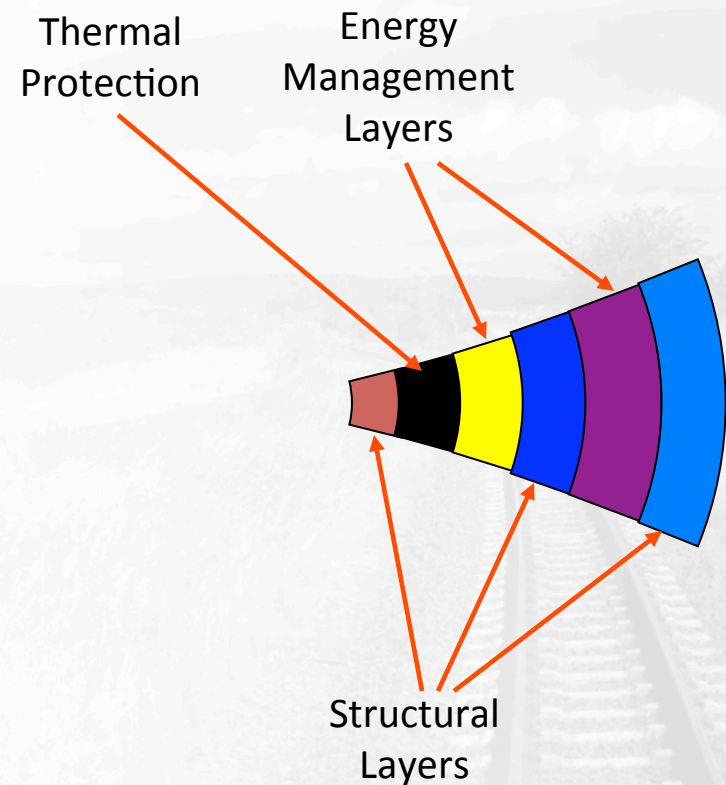
- Evaluation of different protection methods
- Preliminary testing-eliminate choices
- Modeling
- Saves time and money

Disadvantages

- It can eliminate choices
- Some methods can not be finalized

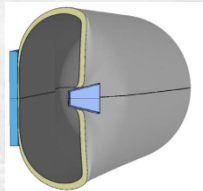
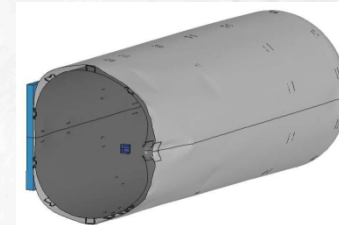
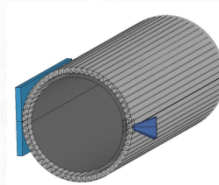
Variations being evaluated in project

- Crush energy managements
- Different steels
- Thickness of steel
- Composite materials
- Sandwich panels
- Different layers of materials
- Stronger materials
- Puncture resistance systems
- Layers of Protection



Examples of positive project support

- Test subjects are donated tank cars
- Tank car manufacturers help evaluate the construction methods
- Stakeholders provide input and comments
- Railroads donated damaged tank cars for future investigation and training
- Formation of the Advance Tank Car Cooperative Research Program (ATCCRP)



Hazardous Materials (HM) Projects

1. Hazmat Risk Assessment
2. Evaluation of HM Program- Impact assessment of Research
3. Post Accident Investigation
4. Loading/unloading Ethanol, reducing NAR's
5. Loading and unloading of Sulphur
6. Improve safety on tank car fittings
7. Top Fitting protection non-pressure and **pressure** tank cars
8. Tank Car Structural Integrity: Impact Resistance, Fracture Toughness
 - a) CMI Sandwich panels
 - b) Stub sills and coupler research
9. Tank Car Operating Spectrum (Valve failures)
10. Liquid Flow test for valves
11. ATCCRP: Evaluation of different impactors on different tank car designs
12. Steel testing (Task force/VOLPE)
13. Non-destructive Evaluation Techniques
14. Valve testing (VOLPE/ Industry) Determining Effect on Environmental Factors in PRV Testing
15. Fire test on small scale container.
16. Test Procedures and evaluating techniques for new tank car designs(White paper)
17. Determine the benefits of stress relief after major welding repair to the tank car and tank car components

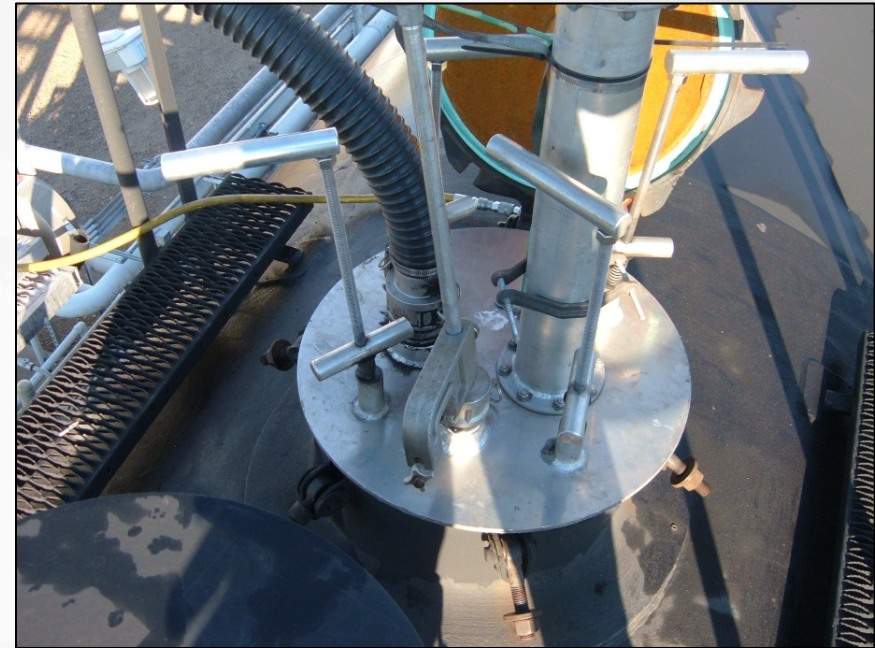
Project Complications

- Fabrication of panels and safety measures
- Test procedures
- Preparations to perform the test
- Weather



Lessons Learned

- Procure more tank cars
- Research new and emerging technologies
- Learn about the loading and unloading procedures for particular materials



Key Success Factors

- The full scale tests were successful
- The actual tests validate the models

