FRA Hazardous Materials Research

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Federal Railroad Administration
U.S. Department of Transportation

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Tank Car Structural Integrity

• Mission…
  – Improve the crashworthiness of tank cars and containers transporting Hazmat

• Goal…
  – Replace existing regulations with performance standards and testing procedures for tank car design
Interaction with VOLPE and Sharma

• **FRA sponsors research**
  • Contracts other entities to conduct the research via:
    • Interagency agreements (IAA)
      – Volpe
      – PHMSA
      – NIST
    • Contracts
      – Sharma & Associates
      – ENSCO
      – TTCI
    • Grants and Cooperative Agreements
      – Renewal Fuels Associations
      – The Sulphur Institute
      – Universities
    • Broad Agency Announcement (BAA)
FRA Sponsored Research

- Damage tolerance analysis
- Mechanical behavior of tank car steels
- Tank car operating environment
- Nondestructive evaluation of tank cars and components
- Rollover derailment dynamics
- Risk analysis
- Requirements for pressure relief valves
- Structural evaluation of stub sill tank cars
- Structural integrity and crashworthiness of tank cars
- Crude oil Classification
- Tank car total containment testing (fire test)
- Objective evaluation of risk reduction from tank car design & operations improvements
Overall Roadmap

**Resources**
- Modeling Software (LS-DYNA ABACUS)
- TTC Crash Wall
- Sharma
- Volpe Center
- Donated Tank Cars

**Program Activities**
- Computer Modeling
- Impact Test
- Model Validation

**Initial Outputs**
- Simulation Results
- Test Results
- Research Reports
- Presentations

**Intermediate Outcomes**
- RSAC Meetings
- Rule Language
- NPRM
- New Regulation

**Long Term Outcomes**
- Industry Input
  - New Tank Car Design
  - Reduction in HAZMAT Releases
  - Industry Implementation
Tank Car Structural Integrity: Current & Next Steps

**Current:**
- Full Scale Side Impact Testing with different type of tank car
  - DOT 111 *(12/2013)*
  - DOT 112 *(02/2014)*
  - DOT 113
  - DOT 105
- Developing Puncture Models with different tank cars
- Verify the models with the actual testing data

**Next Steps:**
- Evaluate the different protection methods
  - Head protection
  - Side protection
- Select options that provide the best results
- Testing procedures for pressure tank cars
- Modeling and simulations
- Continue improvements

**Research Cost:**
- Current: 2.5 Million
- Past: 2 Million

**Project Partners:**
- Sharma
- VOLPE
- TTC
Resources

- **Modeling Software (LS-DYNA ABAQUS)**
  - Using dimensions and measures of the tank car and create simulations of the impact
- **TTC Crash Wall**
  - Use the repeatable testing procedures to perform the crash
- **Sharma**
  - Analyze the model and make an impact speed prediction to puncture
- **Volpe Center**
  - Help develop the testing procedures
- **Donated Tank Cars**
  - Industry providing tank cars to test and obtain the test results
Program Activities

• Computer Modeling
  – Analyzing the problem and making predictions

• Impact Test
  – Perform the side impact and record results

• Model Validation
  – Use the data to validate and calibrate the model for better confidence

Predicted Ram Impact Force
Impact Test of a DOT-112 Tank Car
Impact Speed: 14.7 mph
Tank Integrity Maintained

Impact Test of a DOT-111 Tank Car
Impact Speed: 14.1 mph
Tank Punctured

Tests Performed at Transportation Technology Center
Pueblo, CO
Intermediate Outcomes

- **RSAC Meetings**
  - Input
- **Rule Language**
  - DOT develop
- **NPRM**
  - Receive comments
- **New Regulation**
  - Performance standard and testing procedures
- **Industry Input**
  - Involved

Revised as of October 1, 2010
Questions?

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Published reports website
http://www.fra.dot.gov/Page/P0151
http://www.fra.dot.gov/eLib/Find#p1_z10_IRT_s23
Backup Slides
Photos of Derailment Pile-Ups
Development of Generalized Impact Scenarios

- Based on Results from
  - Train Derailment Dynamics Research
  - Accident Data and Forensic Evidence

- Idealized Impact Condition
  - Repeatable
  - Analyzable
  - Results in Failure Mode(s) Similar to Accidents
  - Represents Essential Accident Characteristics

- Provides Means of Comparing Alternative Designs
- Provides Means for Qualifying Designs
Framework for Comparative Analyses

Load Case → Design “A” → Evaluate → Develop Evaluation Techniques → Compare Effectiveness Of Designs

Design “B” → Revise
Protective Panel

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<th>Material</th>
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Crude oil Classification

• Shippers may not be correctly classifying shipments of crude oil in accordance with the Hazardous Materials Regulations (HMR)

• Intra-Agency Agreement with Pipelines and Hazardous Materials Association to test samples for
  – Vapor Pressure
  – Flammability
  – Flash point
  – Corrosion of metal
  – Hydrogen Sulfide, etc.

• But how many samples are required to be statistically confident?