NTSB Rail Safety Forum
Transportation of Crude Oil and Ethanol by Rail

FRA Hazardous Materials Research

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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

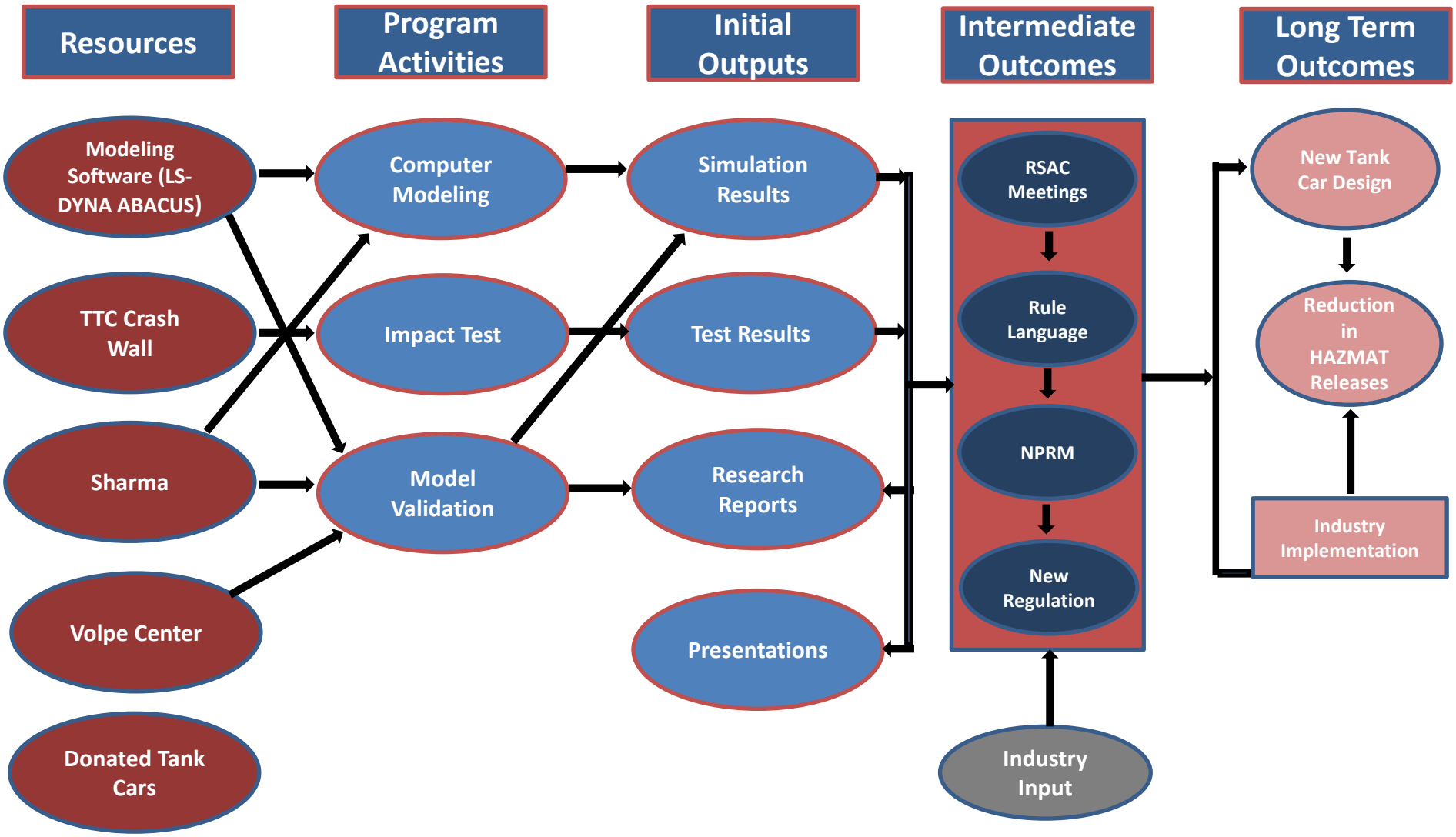
Interaction with VOLPE and Sharma

- 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



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:

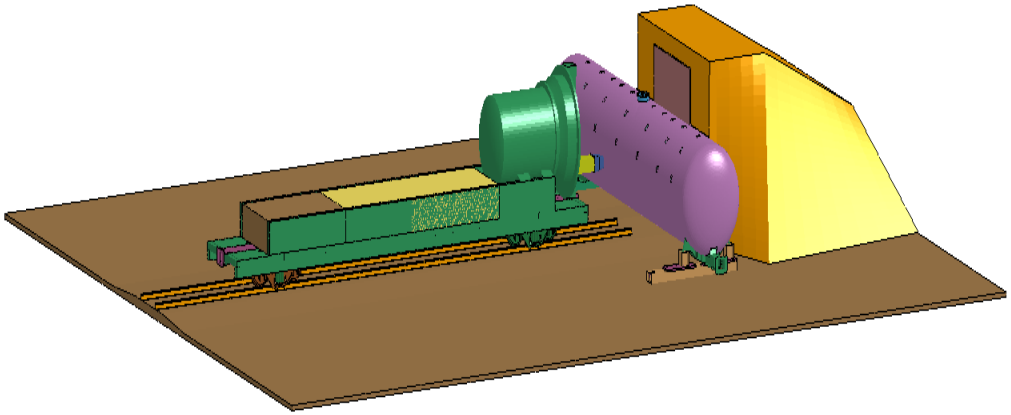
- Sharma
- VOLPE
- TTC

Resources

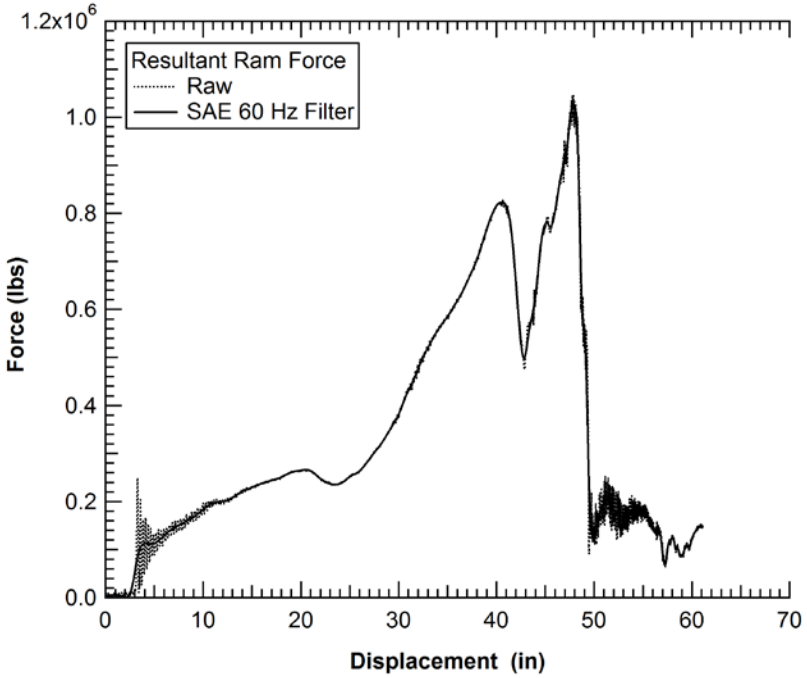
- Modeling Software (LS-DYNA ABAQUS)
  - Using dimensions and measures of the tank car and create simulations of the impact
- TTC Crash Wall
  - Use the repeatable testing procedures to perform the crash
- Sharma
  - Analyze the model and make an impact speed prediction to puncture
- Volpe Center
  -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

Program Activitie

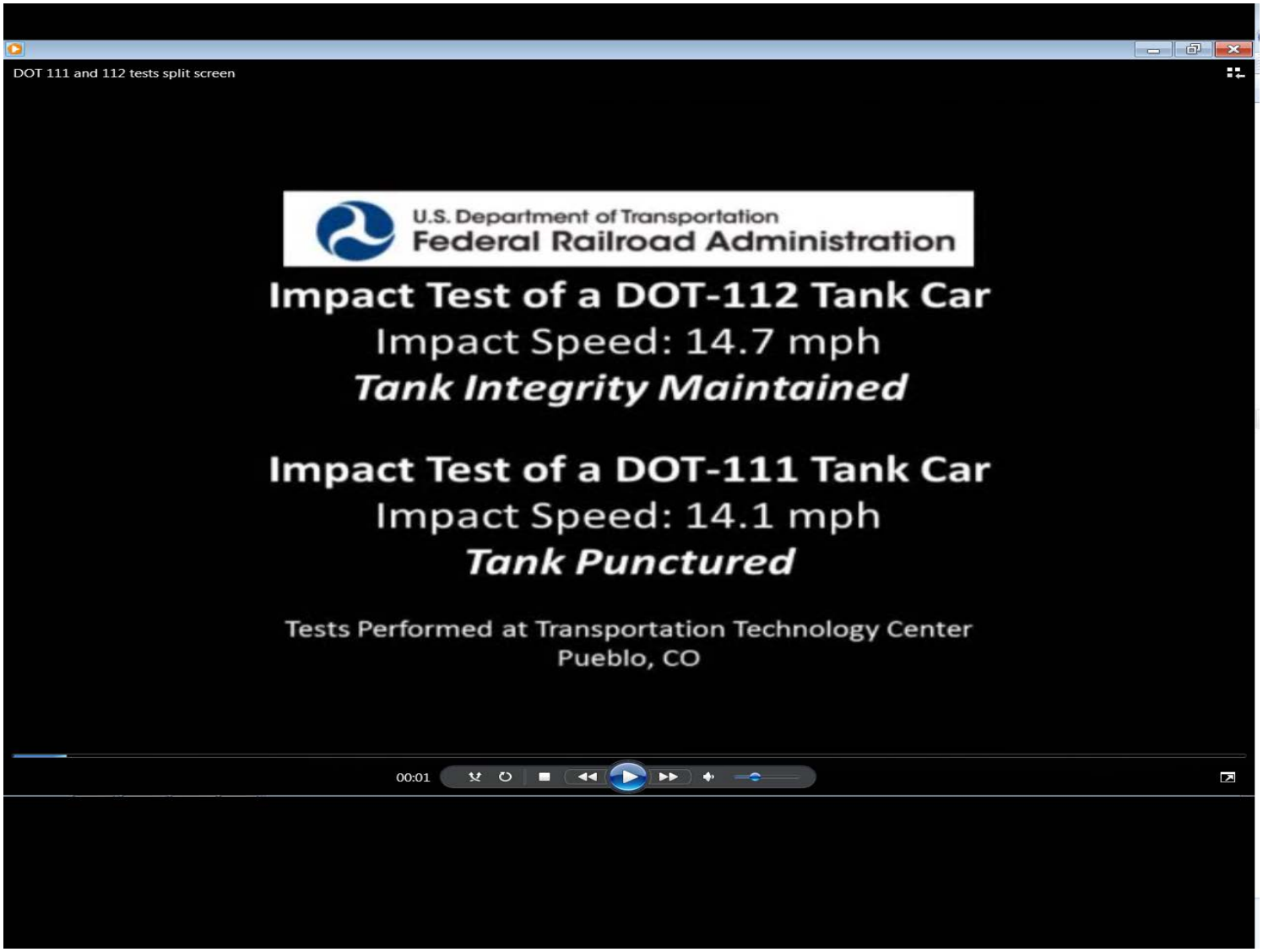
- Computer Modeling
  - Analyzing the problem and making predictions
- Impact Test
  - Perform the side impact and record results
- Model Validation
  - Use the data to validate and calibrate the model for better confidence



Predicted Ram Impact Force

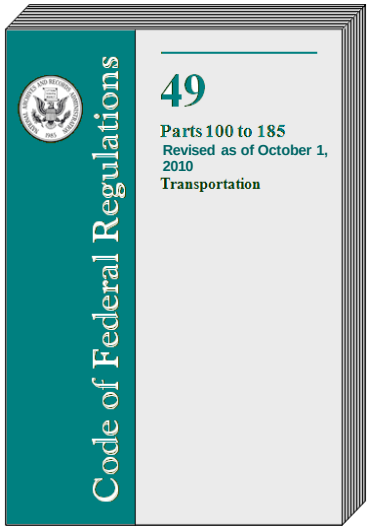


VIDEO


DOT 111 and 112 tests split screen
U.S. Department of Transportation
Federal Railroad Administration
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
00:01

Intermediate Outcomes

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



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

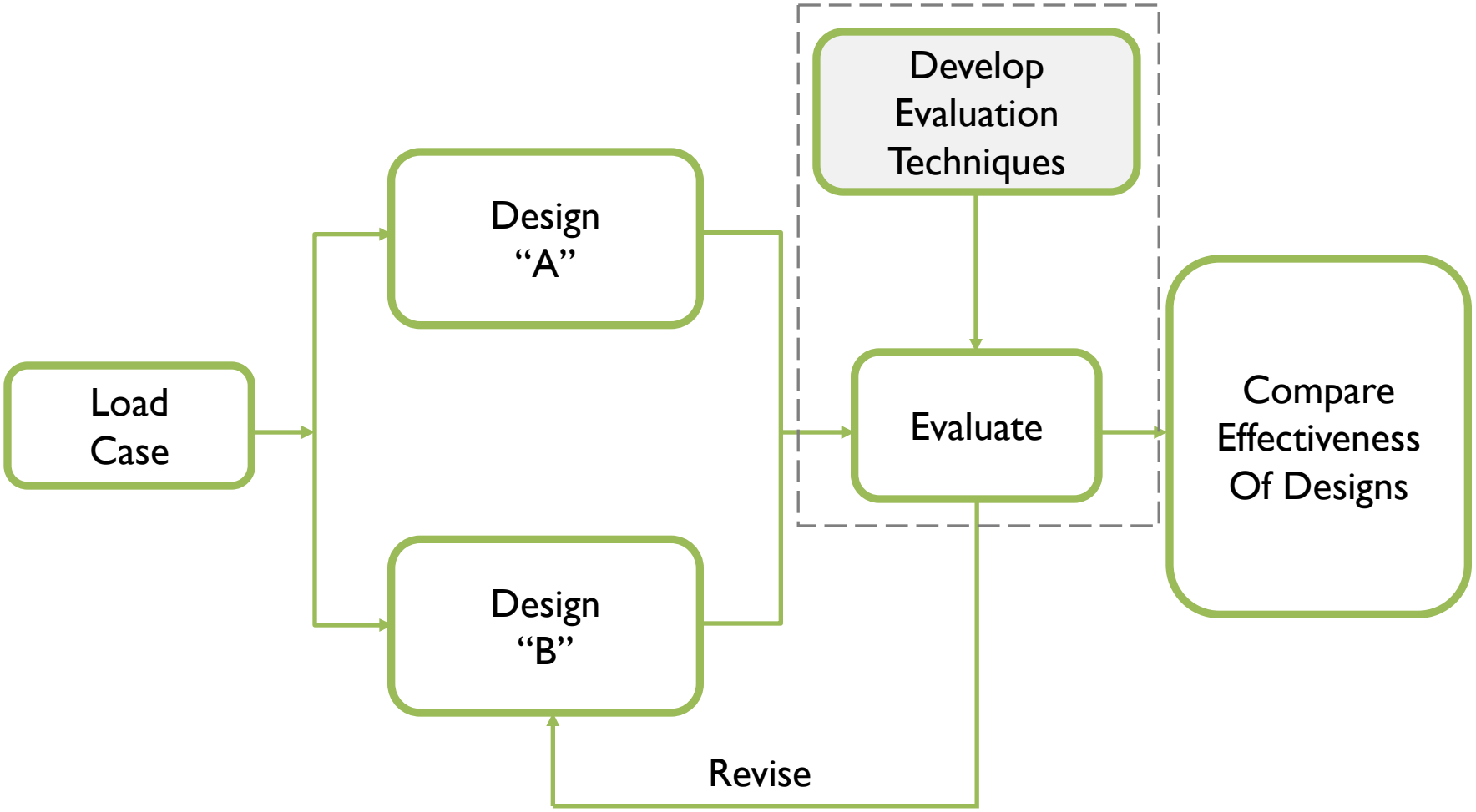
Backup Slides

Photos of Derailment Pile-Ups

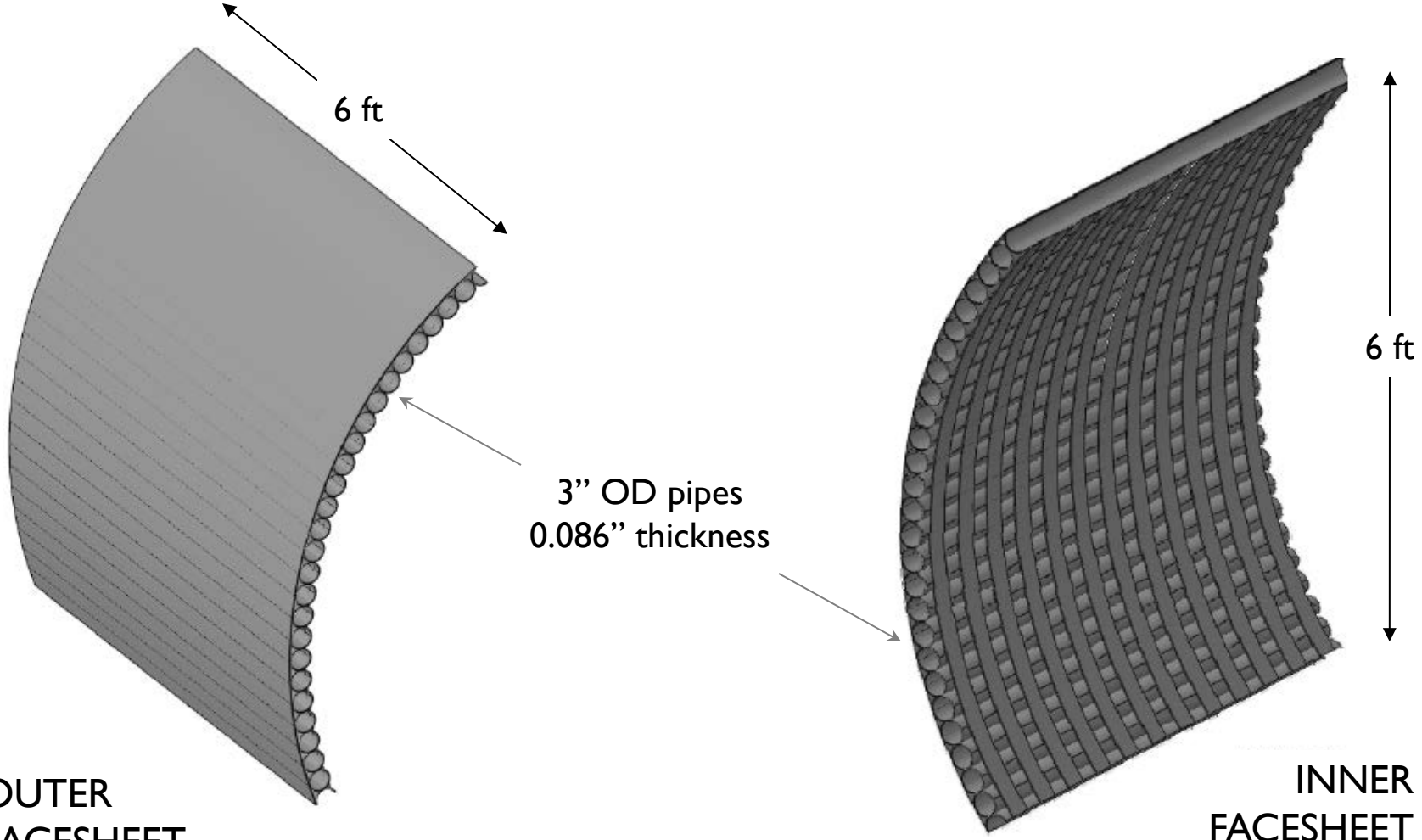
Development of Generalized Impact Scenarios

- 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



Protective Panel



OUTER FACESHEET
0.12” thickness

INNER FACESHEET
0.12” thickness
Strips 3” wide, 3” spacing

Material	AISI 1010
Weight	803 lb (21 psf)

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?