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Tank Car Accident Safety Research for Crude Oil and Ethanol Cars

Rail Safety Forum; Crude Oil and Ethanol in Transportation
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Outline of Presentation

- Protective feature options for tank cars
- Approaches to assessing damage resistance of tank cars in accidents
- RSI-AAR Tank Car Safety Research Project
- RSI-AAR tank car accident data
- Conditional Probabilities of Release (CPRs)
- CPR estimates for selected tank cars
- Other aspects of accident performance
- Other research areas

Four Key Components

Tank Head

Top Fittings

Tank Shell

Bottom Fittings
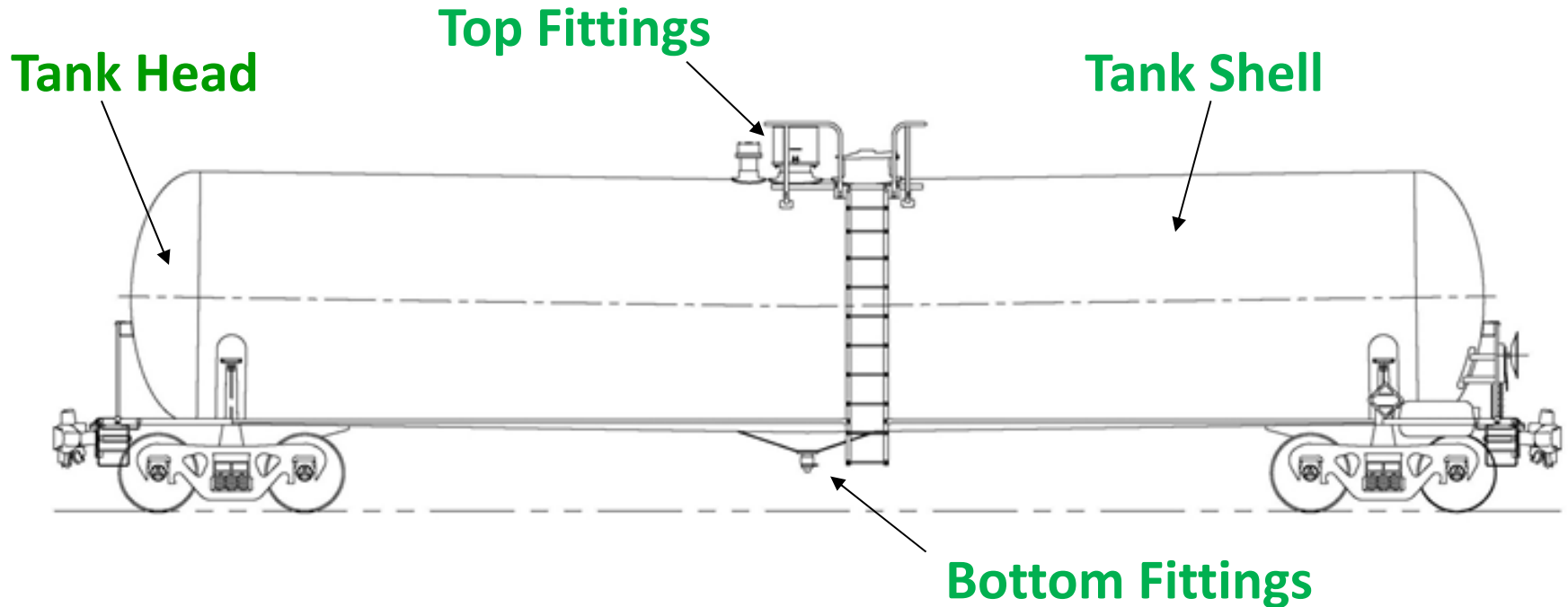
**These are the four components of the car
that can release lading when damaged in an accident**

5/12/2014

Protective Feature Options

- Tank Head
  - Thicker tank
  - Jacket, with or without thermal protection system
  - Head shield
- Tank Shell
  - Thicker tank
  - Jacket, with or without thermal protection system
- Top Fittings
  - Protective housing
- Bottom Fittings
  - Handle securement

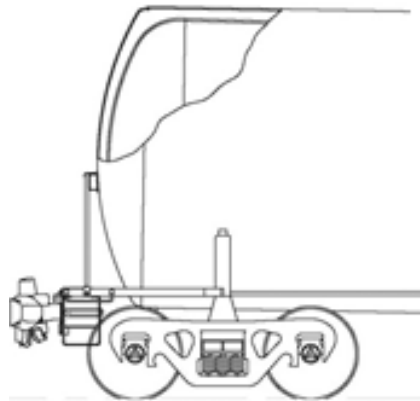# Examples of Protective Systems

Top Fittings Housing
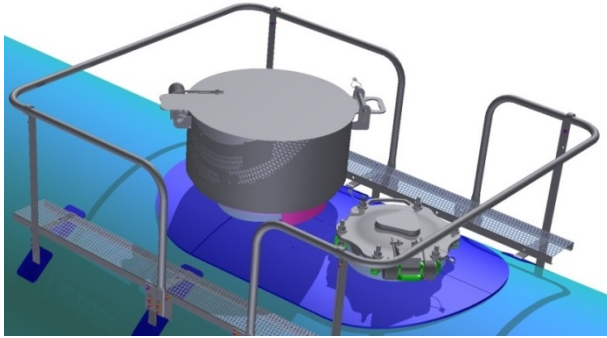
Head Shields

Jacket

Trapezoidal for Non-Jacketed Cars

Incorporated Into Jacket

Approaches to Assessing Damage Resistance

Approach	Accident Scenarios Accounted For	Cost per Analysis	Ability to Analyze New Design Elements Not Already in Fleet	Ability to Quantify Expected Releases in Operation
Testing	One Idealized Scenario per Test	Very High	Good	None*
Modeling	One Idealized Scenario per Run	Moderate, Once Model is Developed	Good	None*
Statistical Analysis of Empirical Data	Entire Spectrum of Actual Scenarios	Low, Once Model is Developed	Limited*	Good

* Project underway to enable this for tank car analyses

RSI-AAR Tank Car Safety Research Project

- ## Origin 1970

  - 1960s flammable gas accidents

  - Collaborative effort led to effective changes implemented in HM-144: head shields, thermal protection, and shelf couplers

  - RSI and AAR saw benefits of continuing the partnership

- ## Co-funded and co-directed by RSI and AAR

- ## Dedicated to producing reliable and objective research for the sponsors and other stakeholders

RSI-AAR Tank Car Accident Data (TCAD)

- Collected since 1970
- 46,400 cars damaged in 29,900 accidents
- Fields
  - 37 describing nature of accident
  - 40 describing car properties
  - 34 describing damage and performance of car
- Used to provide objective, quantitative information on safety options

Conditional Probability of Release (CPR)

- CPR = the probability that a single tank car releases any quantity of lading, given that it is derailed in an FRA-reportable accident

- RSI-AAR Tank Car Accident Data are analyzed with advanced statistical techniques to quantify the CPR performance of each car configuration

CPR Estimates for Selected Tank Cars

Car	Tank (Head & Shell)	Jacket	Head Shield	Top Fittings Protection	Estimated Mainline CPR	Estimated Mainline $CPR_{>100}$*
"Legacy" Bare Tank	7/16"	No	No	No	0.266	0.196
"Legacy" Jacketed	7/16"	Yes	No	No	0.128	0.085
CPC-1232 #1	1/2"	No	Half-height	Yes	0.132	0.103
CPC-1232 #2	7/16"	Yes	Full-height	Yes	0.064	0.046
AAR 2014 Proposal	9/16"	Yes	Full-height	Yes	0.042	0.029

* $CPR_{>100}$ = The CPR for a release of more than 100 gallons

Other Aspects of Accident Performance

- ## Quantity of lading lost, given a release
  - Distributions of quantities lost are different for the four car components
  - Therefore different packaging options affect quantities lost differently

- ## EQR = Expected Quantity Released, given derailment
  - Risk metric combining CPR and quantity lost distributions

- ## Fire survival
  - Fire increases internal pressure, can lead to tank failure
  - AFFTAC fire simulation estimates survival time for combinations of car and commodity properties

Other Research

- Data collection at key accident scenes

- Advanced Tank Car Collaborative Research Program (ATCCRP) developing the future car for Toxic Inhalation Hazard (TIH) materials such as chlorine and anhydrous ammonia

- Tank Car Integrated Database allows tracking and analysis of tank and stub sill inspection records and service damage