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OFFICE OF RESEARCH & DEVELOPMENT

Overview of FRA Research

Operational Enhancements for Tank Car Safety

Presented At the NTSB Rail Safety Forum

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Overview

- Reducing Derailment Severity & Consequences
  - Improving the car design
  - **Reducing the kinetic energy in a derailment**
- Achieved by:
  - Reducing operating speed
  - Implementing advanced braking systems
- **How do we quantify benefits?**
  - New approach to evaluate likelihood of puncture
- Train Operations/Braking Simulations
  - Kinetic energy reductions resulting from implementing advanced braking
- Other Research

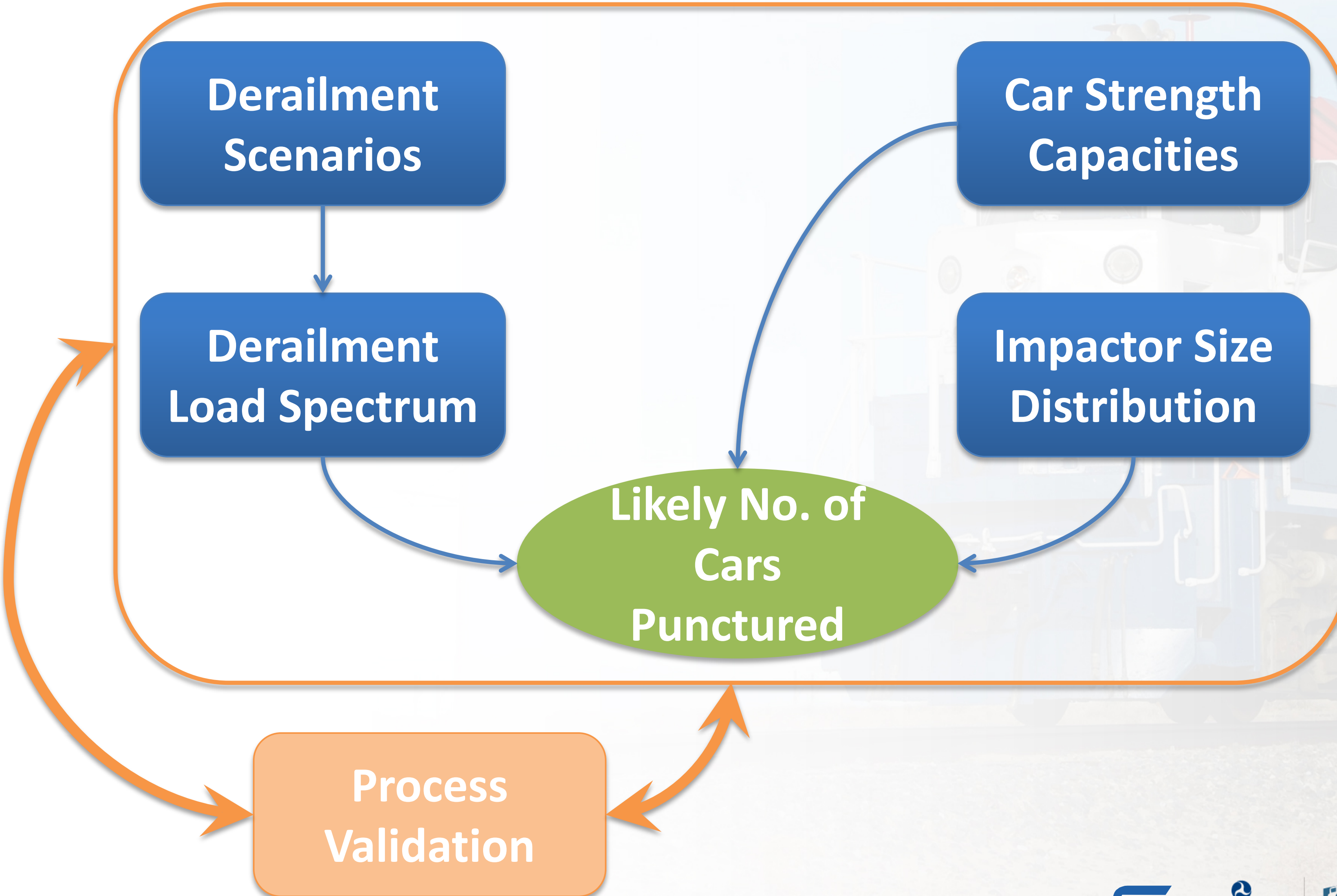
Effectiveness of Mitigation Strategies

- As we review potential mitigating strategies/solutions for implementation, it becomes critical to have an objective measure of the expected improvements that these solutions afford.

- What is the overall reduction in risk afforded by:
  - Increasing the minimum required shell thickness to ‘X’ inches?
  - Making a given operational change, such as a speed restriction?

- While not intended to predict the precise results of a given accident, this methodology will provide a basis for comparing the relative benefits of various mitigation strategies.

Process for Evaluating Likelihood of Puncture



Comparing Puncture Risk Mitigation Strategies

		Most Likely Number of Punctured Cars		% Improvement Compared to Base Case		% Improvement Due to Speed Reduction
	Tank Type	30 mph	40 mph	30 mph	40 mph	40 to 30 mph
Base Case	7/16" A516-70 No Jacket	8	11	~	~	29%
Alternate	5/8" TC128B 11 Gage Jacket	4	6	52%	47%	

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Effectiveness of ECP under Derailment Conditions

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Safety Advantages of ECP Brakes

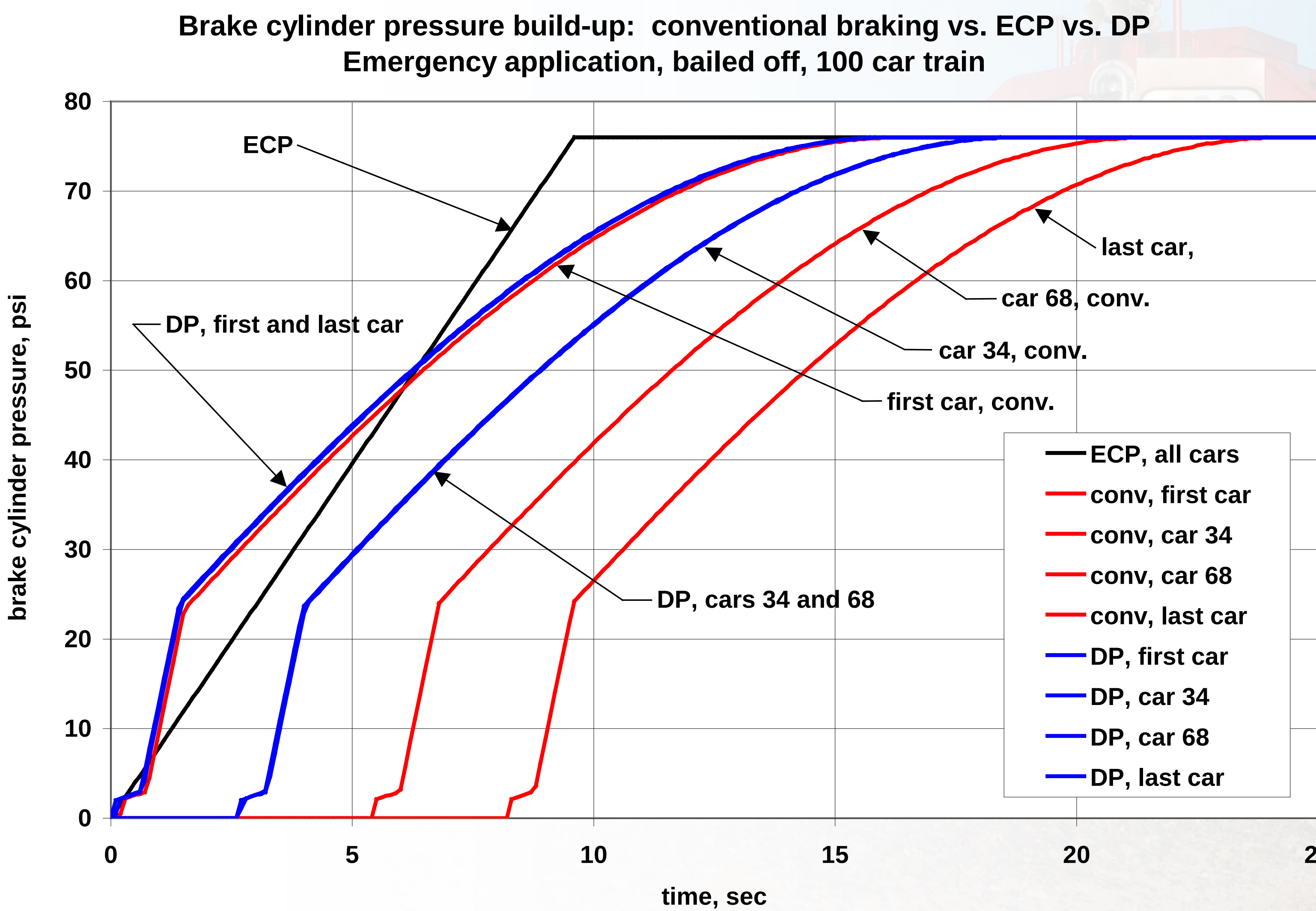
- Instantaneous brake signal communication leads to quicker brake application and therefore reduced stopping distances.
  - Additional cars might also be able stop before they reach the POD.
  - A given car would have a reduced velocity before it reaches the point of derailment (POD) or pileup, reducing the potential damage.
- Uniform deceleration rate for all cars minimizes relative car velocities and, therefore, coupler forces.
  - Leads to enhanced stability in the longitudinal direction, which would have a positive influence on the severity of derailment
- Potential for increased braking force, further resulting in reduced stopping distances.

Scenarios Simulated

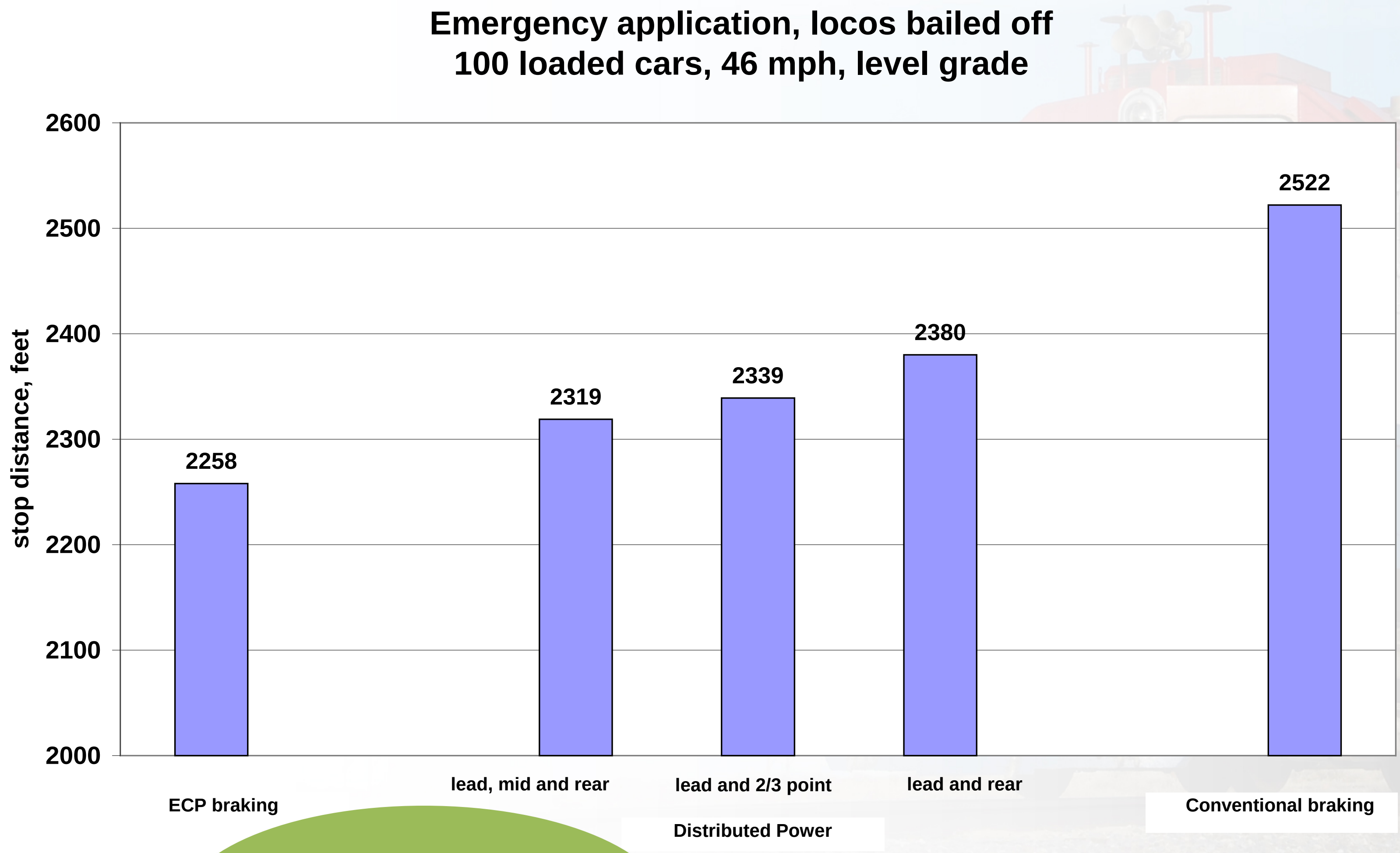
- Emergency braking is initiated on a train traveling at a nominal 46 mph on level grade.

- The simulations compared the dynamic behavior of an ECP brake equipped train to a conventional train and to a Distributed Power (DP) train under these emergency braking conditions.

Brake Cylinder Pressure Buildup

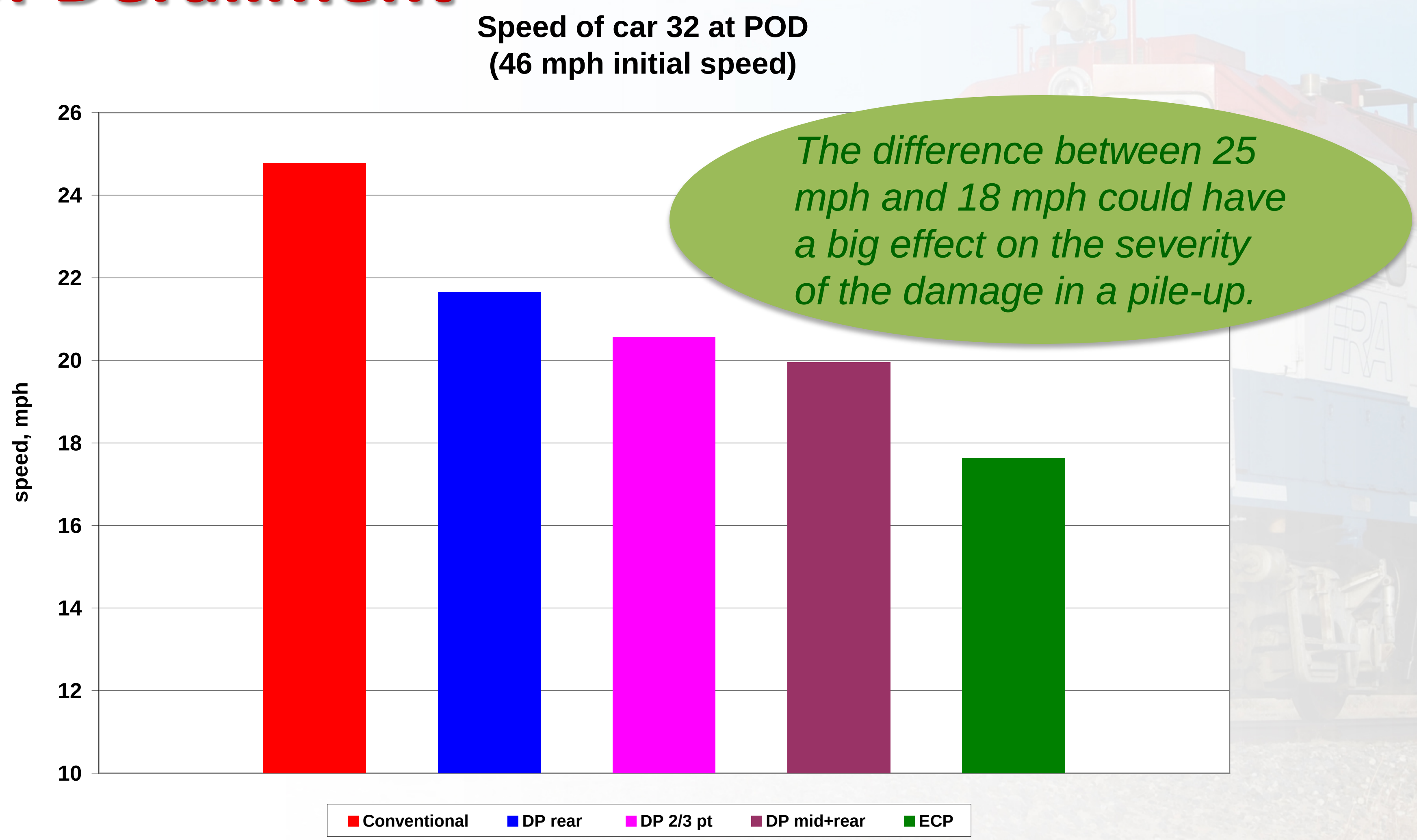


Stopping Distance Comparisons



Fewer Cars in the Pileup

Potential Speed Reductions @ Point of Derailment



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Other Related Research

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Barriers to ECP Implementation

- The benefits of ECP brakes are well documented and numerous:
  - Better stopping distances
  - Better train control
  - Improved readiness for re-application, graduated release
  - Improved fuel efficiency
  - Reduced wear on components
  - Reduced train inspection intervals , etc.
  - Reduced derailment damage
  - Increased safety
- Why then, given all the benefits of the system, have ECP brakes been slow to gain wide-spread acceptance?
- FRA is studying approaches to identify and address the challenges.
- This is ongoing work.

EDHB Development

- FRA R&D has been developing an Electrically Driven Hand Brake (EDHB) that has the potential to be applied remotely.

- The EDHB:
  - Push button application from side of car
  - Eliminates need to climb ladders and get between cars
  - Eliminates physical effort of applying/releasing hand brakes
  - Provides feedback on state of the hand brake – Clear signal of whether it is applied or released
  - Keeps all normal manual functions

Less affected by crew fatigue.

- Prototype units have been developed, tested, and are undergoing 'in-service' tests on three test cars running on the FAST track at TTCI.

- Such a device has the potential to prevent an 'runaway' train accidents.

EDHB - Test Installation

Sample installation on test car with push-button control from side of car.

Fire Test & Model Validation

- Fire test one-third scale model of tank car with North American insulation system
  - Will full scale system survive 100 minutes in 871^{o} C blackbody fire?
- Test data will be used to validate the AFFTAC software model, which is now the industry standard.
- A series of six tests is planned.

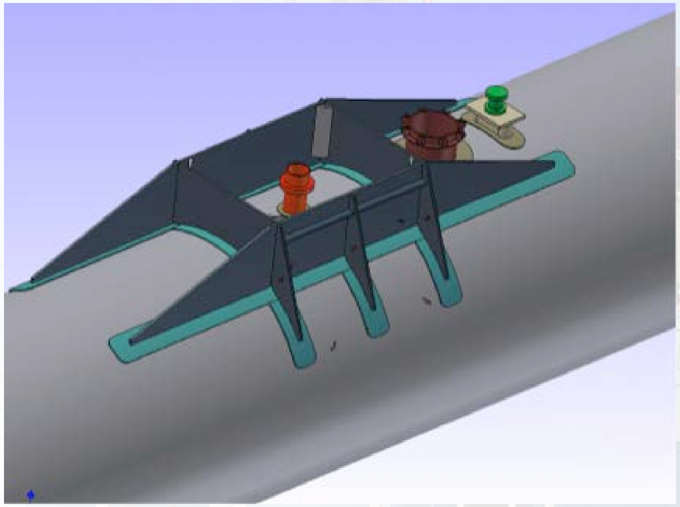
Sample Pictures from Prior Tests

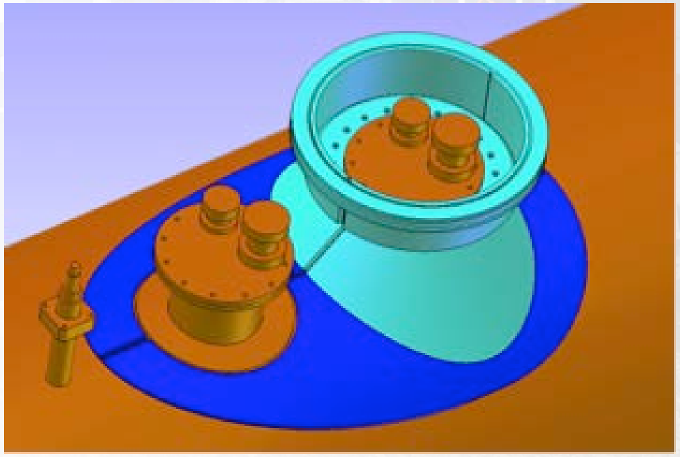
Fittings Protection Research

- Identify critically exposed fittings
- Evaluate survivability under rollover derailment conditions
- Develop concepts for improving protection
- Confirm & validate models used through appropriate full scale tests
- Guide the development of industry standards for fittings protection

Fittings Protection – Some Prior Effort

- It was seen from prior tests that:
  - Unprotected fittings were completely destroyed in the base case test, with a rapid release of lading resulting
  - Deflective skid structure succeeded in protecting the fittings at a test speed of 18 mph with no resulting lading release
  - Bolt-on sleeve with reinforcing cone also was successful in protecting the fittings at a test speed of 12 mph with no lading being released





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Thank You!

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Some Backup Slides

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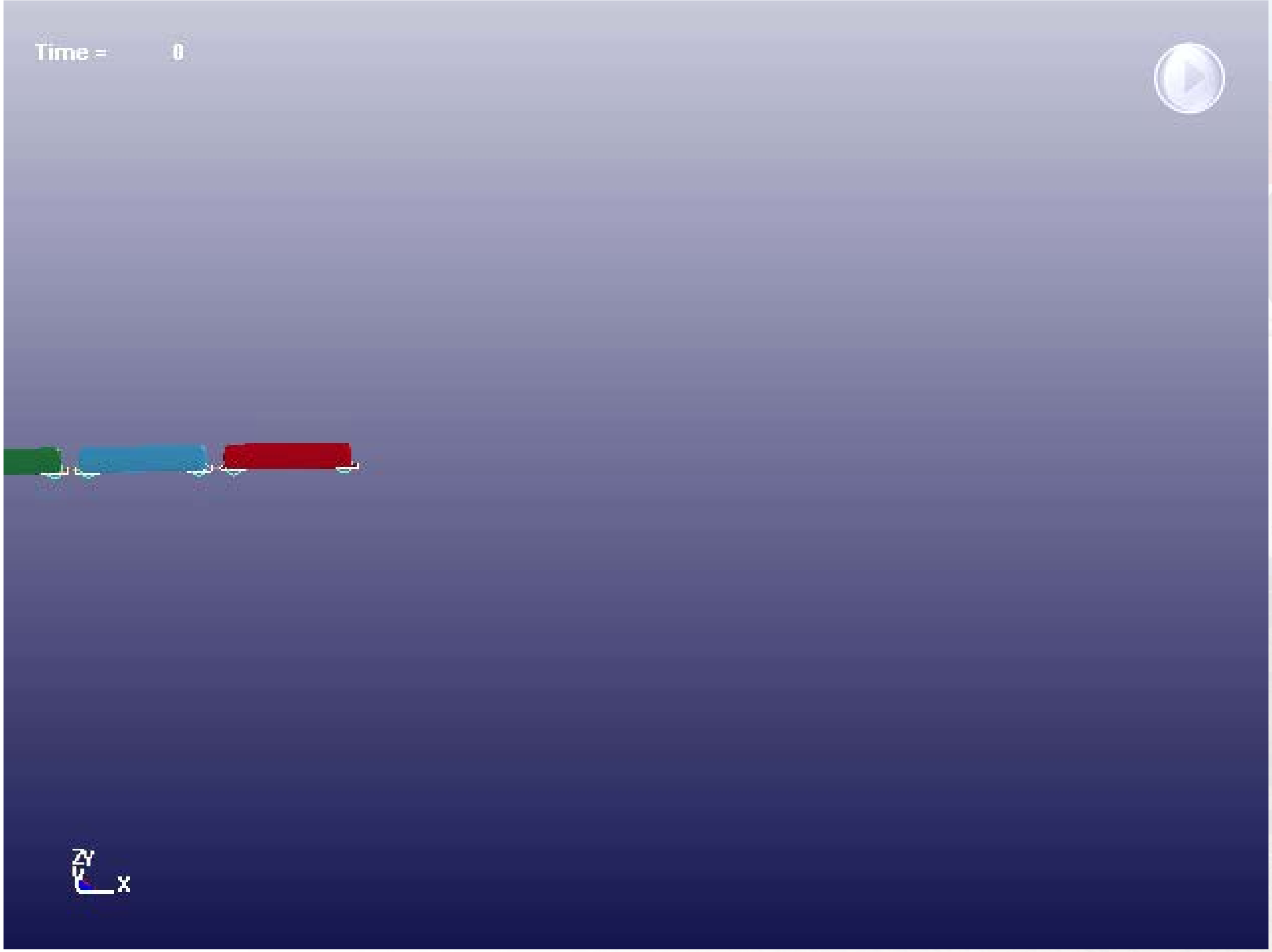
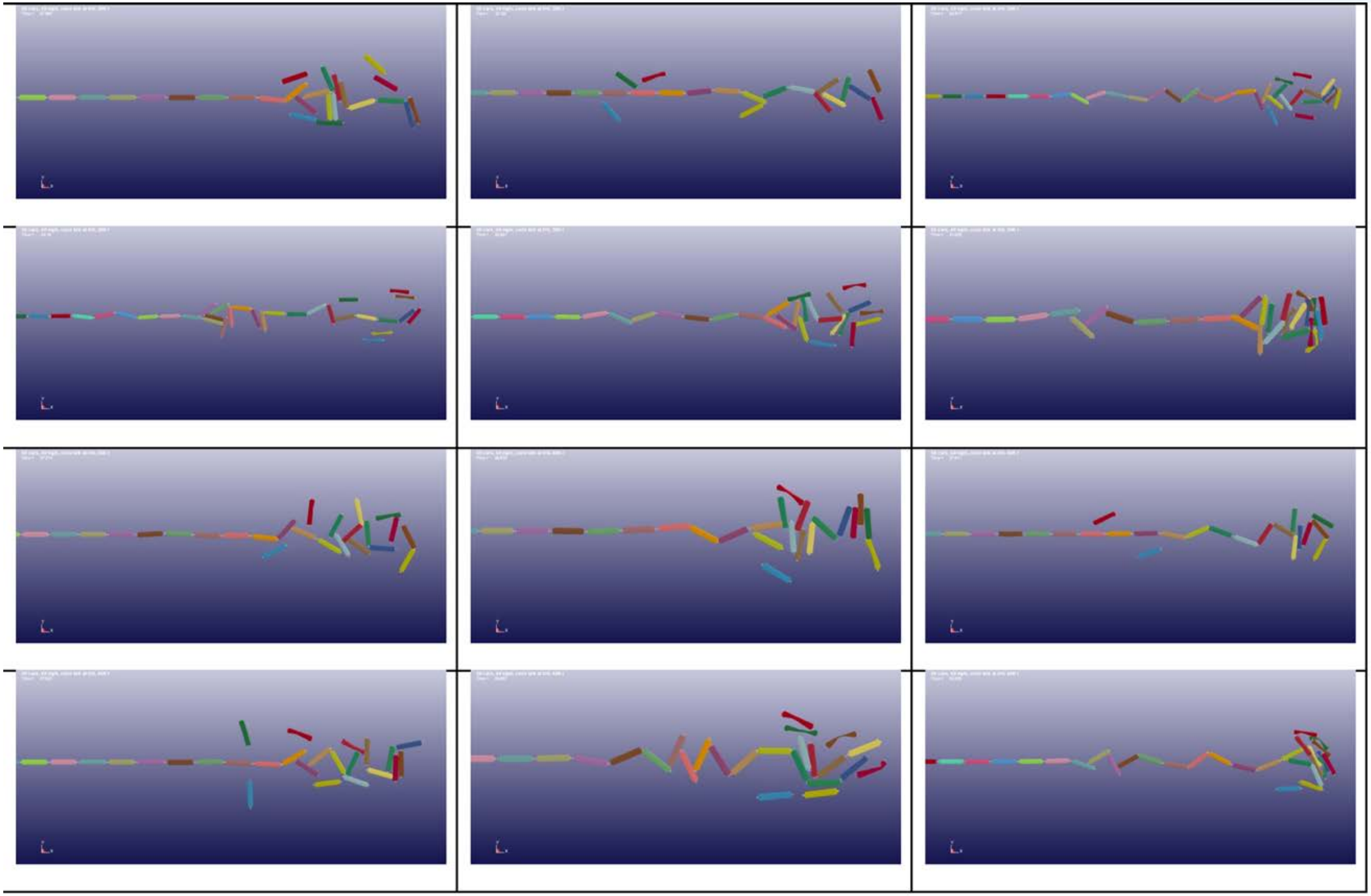
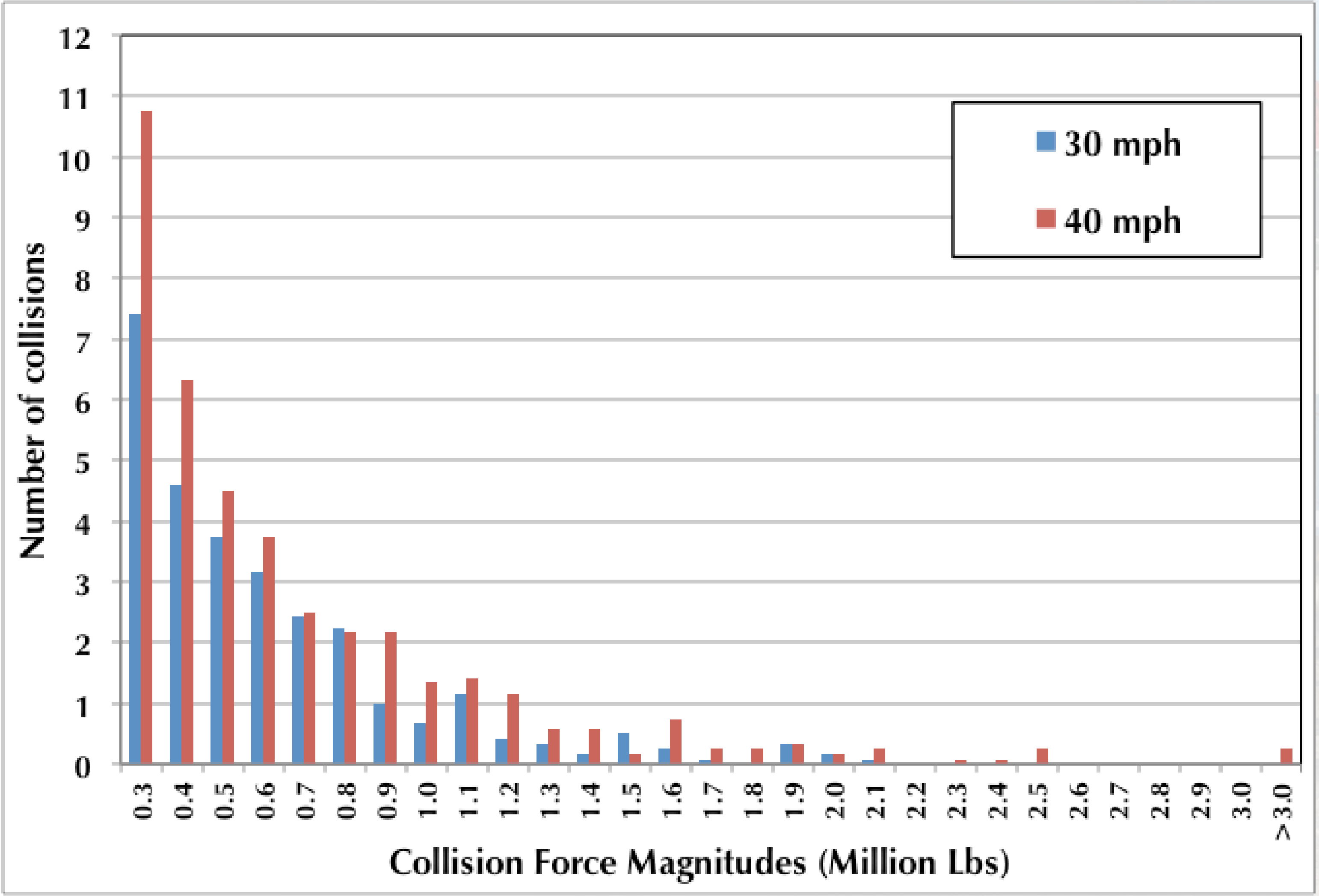
Sample Animation – 30 mph



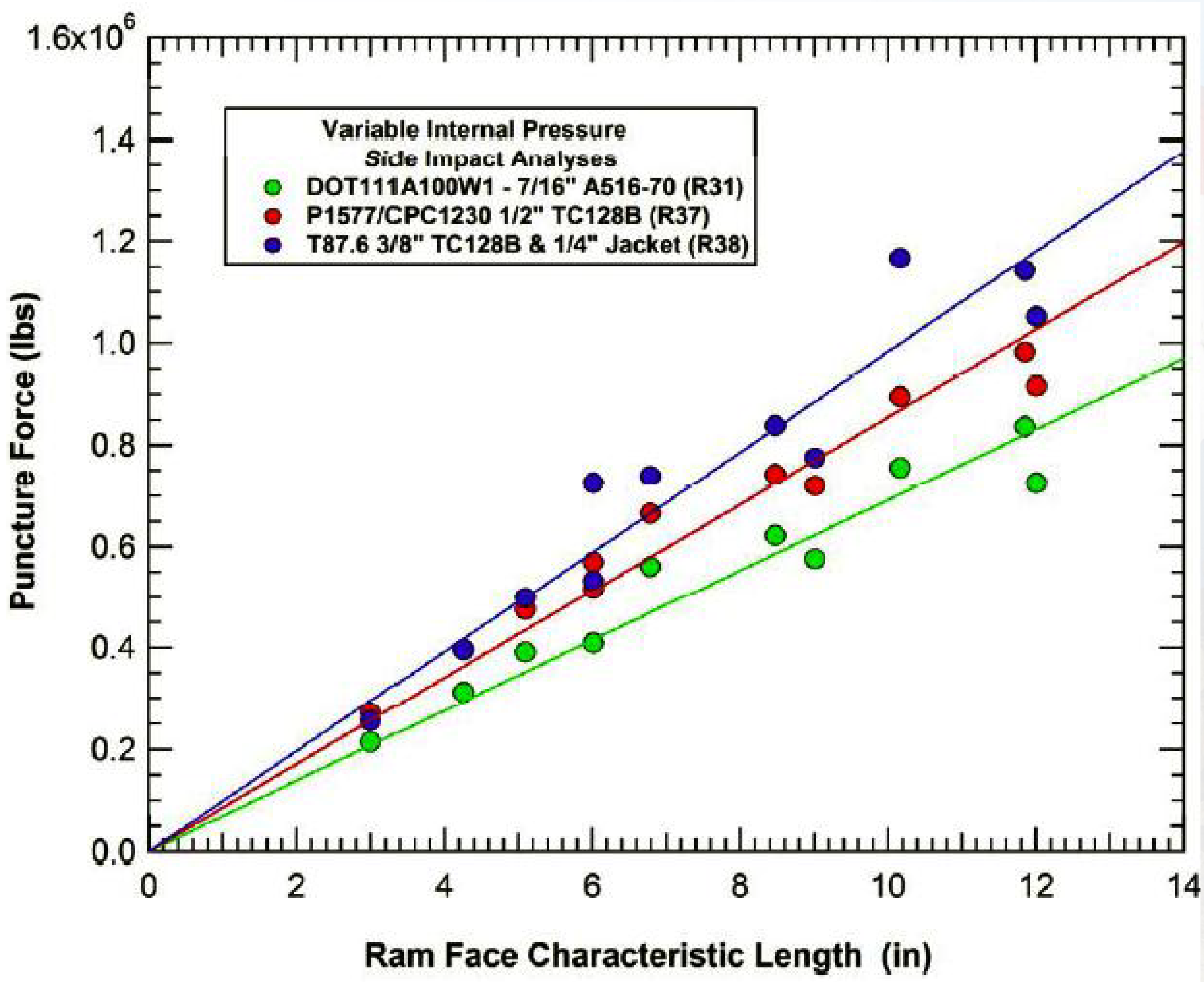
Derailment Distribution – 40 mph



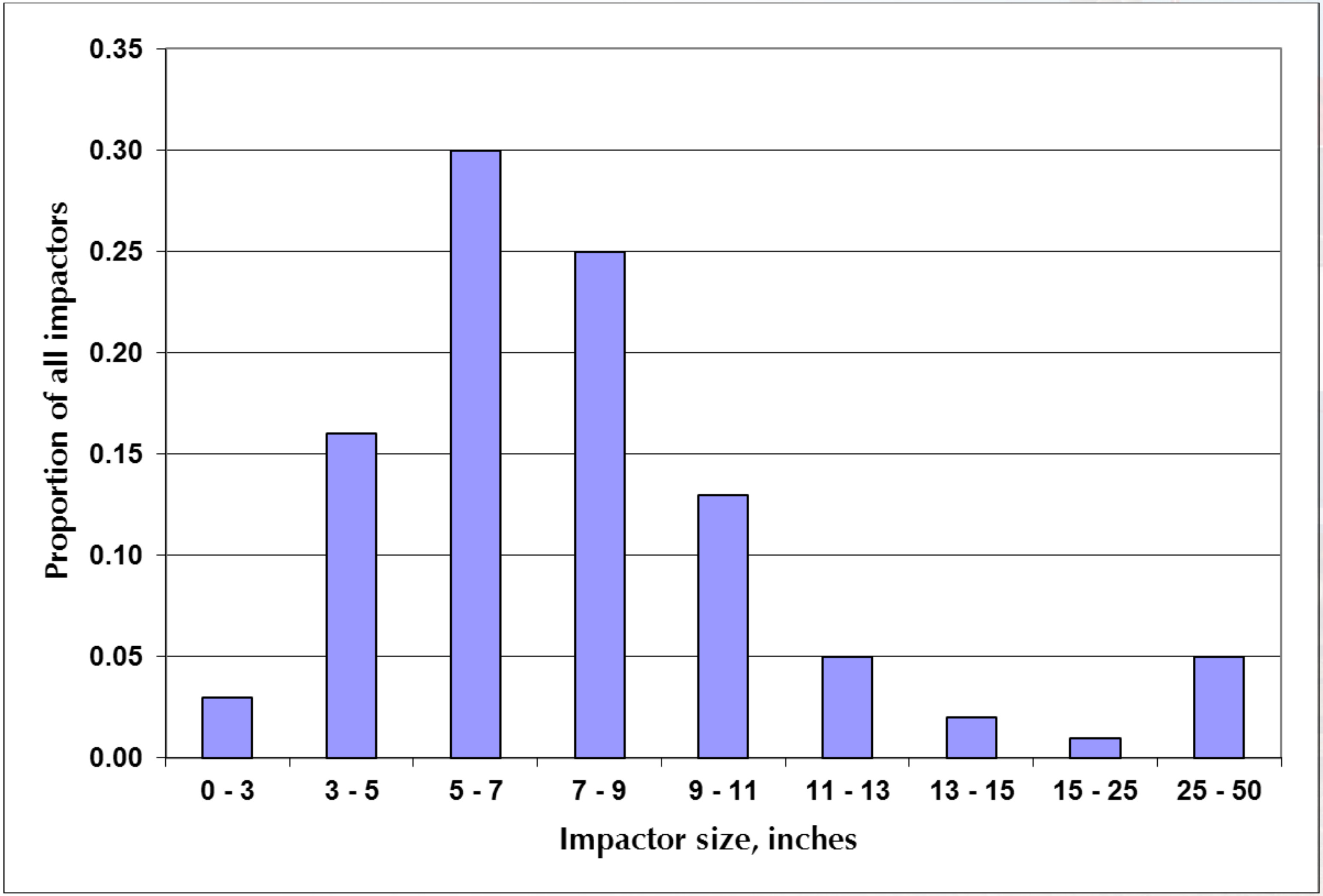
Collision Force Histograms



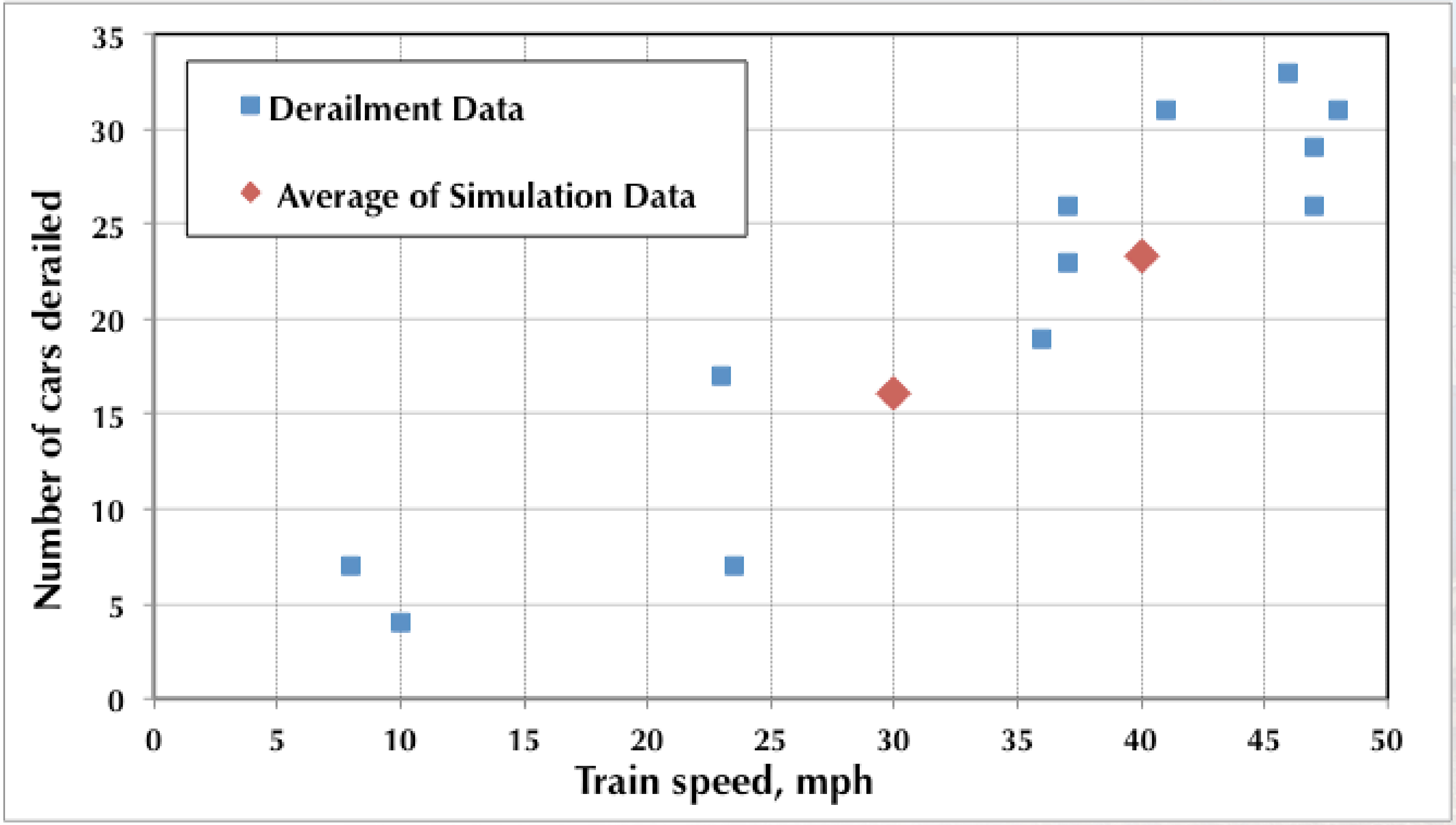
Car Strength Characteristics



Potential Impactor Size Distribution

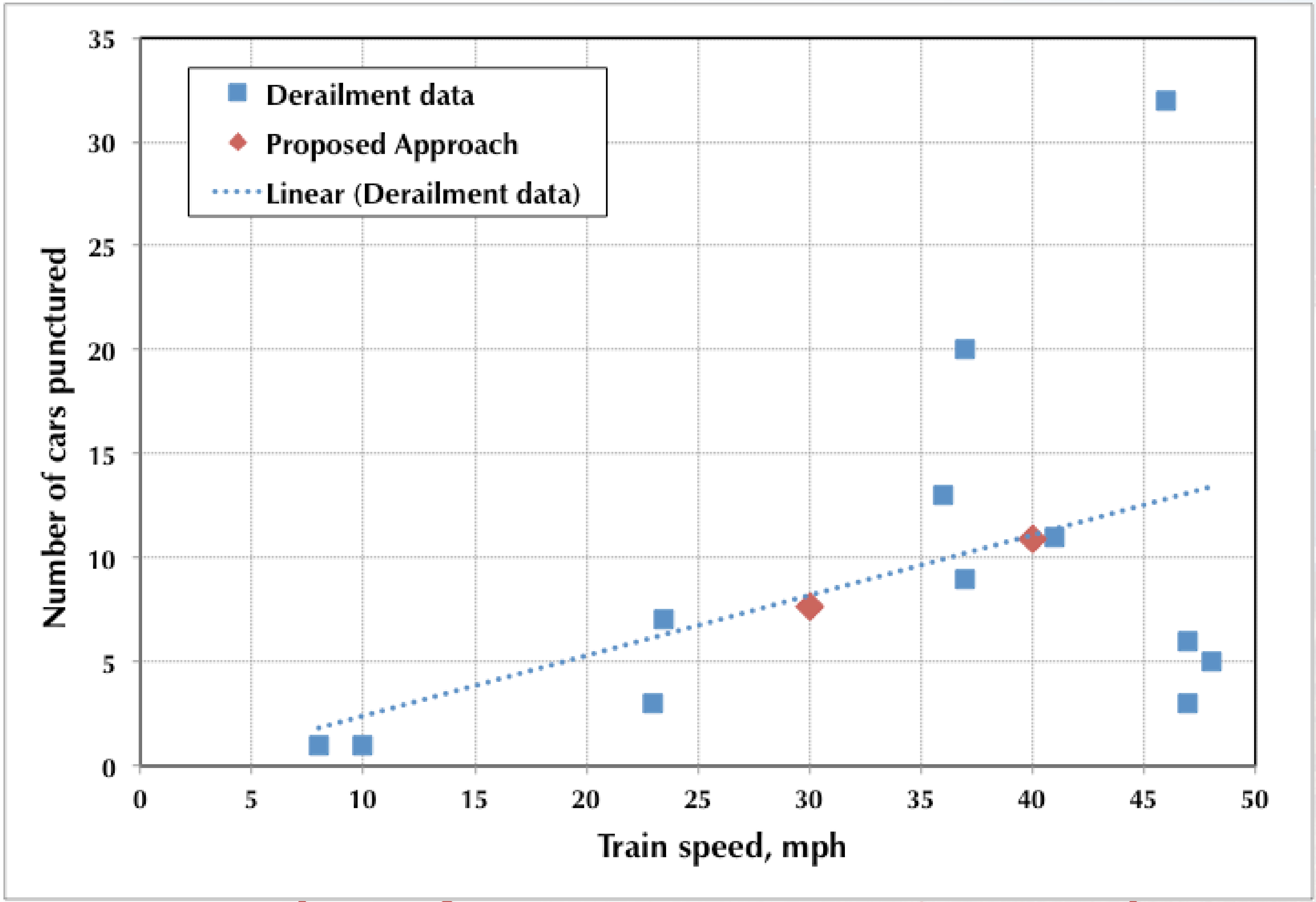


Process Validation



Number of Derailed Cars vs. Train Speed

Process Validation



Number of Punctures vs. Train Speed