Evolution of U.S. Crashworthiness Standards for Heavy and Light Rail

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Discussion Topics

- How did we get here?
- Role of CEM and performance-based standards, yesterday and today
- Changing operating environments
- What's next?

A History of Collisions

- Streetcars, subway and light rail vehicles have seen collisions since the turn of the century, the last century.
- Designs, standards and regulations addressing the needs

Standards and Regulations

- Government and industry devote millions of dollars to reduce risk and prevent injury
  - Automotive NHTSA, FMCSA
  - Transportation FRA, FTA, DOT, NTSB, TSB, Transport Canada
  - American Public Transportation Association
  - Association of American Railroads
  - Public Utilities Commissions
  - Technical and Engineering Societies (ASME, IEEE, ASCE, etc.)

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Federal Railroad Administration

NTSB
An Independent United States Federal Government Agency

FMCSA
Federal Motor Carrier Safety Administration

APTA

ASME

Government of Canada
Gouvernement du Canada

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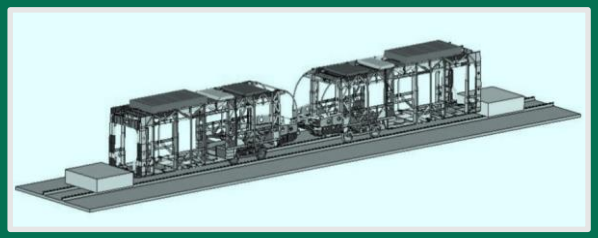
Evolutionary Progress



APTA PRESS Standards / ASME / FRA

FTA C-17

Phoenix Tech. Spec

ASME Revisions / Collision Scenarios, Weight, Collision Post, Performance Metrics

1998

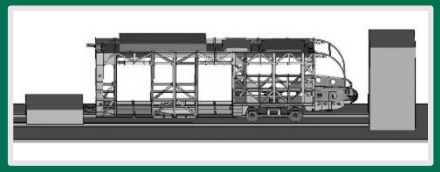
2008

2014

2017

CEM Moving away from sole static strength

ASME Release RT-1 / 2



FRA Collision Post

Alignment, refinement, performance metrics revision

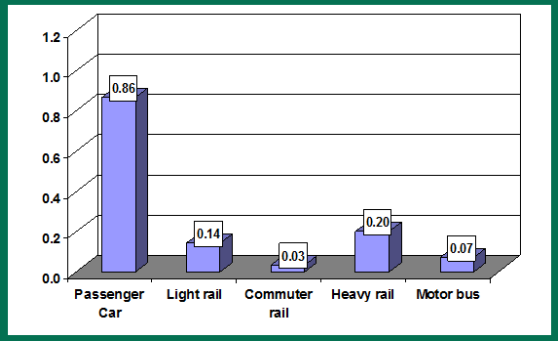
FRA Alternative Compliance Revisions to ASME

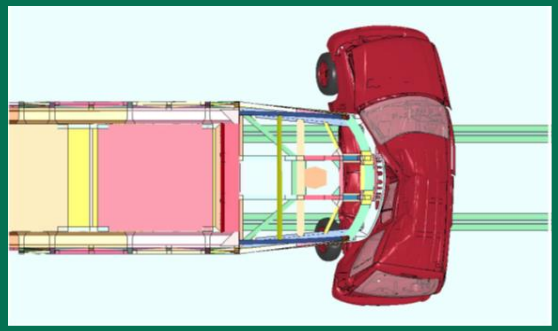
Safety Needs for Passengers and Operators

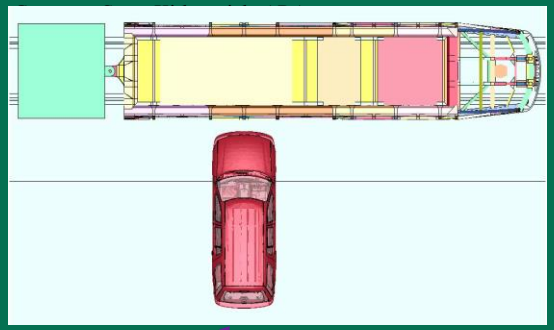
- Prevent collapse or loss of occupied volumes
- Prevent intrusion into occupied space
- Prevent loss of free space around the operator's seat and distance to control console
- Prevent blocked egress from cab
- Prevent rapid deceleration in occupied spaces
- Keep trains on tracks

Collisions with Street-running Vehicles

- Most streetcar and LRV accidents involve street running vehicles
- New standards have less aggressive end structures to mitigate intrusion into vehicle side doors and minimize entrapment
- Streetcar and LRV side structure to prevent penetration from trucks colliding with streetcars / LRVs, and strength of truck attachment







Principals of CEM

- Better able to manage the dissipation of energy in a collision providing progressive controlled collapse through energy absorbing structures.
- Reduce risk of injuries to occupants by preserving occupied volume and reducing severity of occupants colliding with car interior objects.
- Mitigation of car override by keeping cars aligned and more “stuck” together.

Move to Performance-Based Metrics

- Promotes innovative designs
- Potential for more direct relationship between specification and desired outcome
  - Greater reliability in meeting expected outcomes
  - Demonstrated retention of occupied volume
  - Applied to realistic cases and scenarios
  - Demonstrated collision performance
  - Potential reduction of over-specified designs
- Trade-off between performance and prescriptive specifications

Benefits of Today's Standards

- Crash energy management
- Performance requirements and collision scenarios to protect passengers and crew
- Benefit from new analytical capabilities of explicit finite element tools that can simulate behavior of trains in a collision

But Operational Conditions are Changing

Changing Conditions

- Streetcar consists are growing larger so need to absorb more energy – but can they?
- Streetcar modules are using articulated joints and link-bars with limited energy absorption
- Shared infrastructure between Light Rail and Streetcar
- Integrated antic-climber and CEM designs
- Challenge to design and validate specified high anti-climber loads
- Different approaches for preserving space around the operator

Remedies

- Reduce collision speed or set new requirements
- Innovative designs for energy absorption improvement
- Control shared corridor operating speed
- Performance metrics
- Performance metrics verification
- Meeting needs of small and large sizes

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Summary

- Crashworthiness standards have optimized railcar designs at the leading edge of technology
- CEM and performance-based metrics are now
- New operating conditions are creating challenges to vehicle design – but opportunity for innovation in standards and vehicle design

Questions?

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