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
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.)
Evolutionary Progress

1998
- APTA PRESS Standards / ASME / FRA
- FTA C-17
- CEM
  Moving away from sole static strength

2008
- Phoenix Tech. Spec

2014
- ASME Revisions / Collision Scenarios, Weight, Collision Post, Performance Metrics
- ASME Release RT-1 / 2
- FRA Collision Post

2017
- 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.

(Courtesy: Steve Kirkpatrick, ARA)
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
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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