



DESIGN



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Crashworthiness Standards

Ron Mayville

Simpson Gumpertz & Heger Inc.
41 Seyon Street
Waltham, MA 02453

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APTA has been a very active organization in developing crashworthiness standards and recommended practices related to rail vehicles.

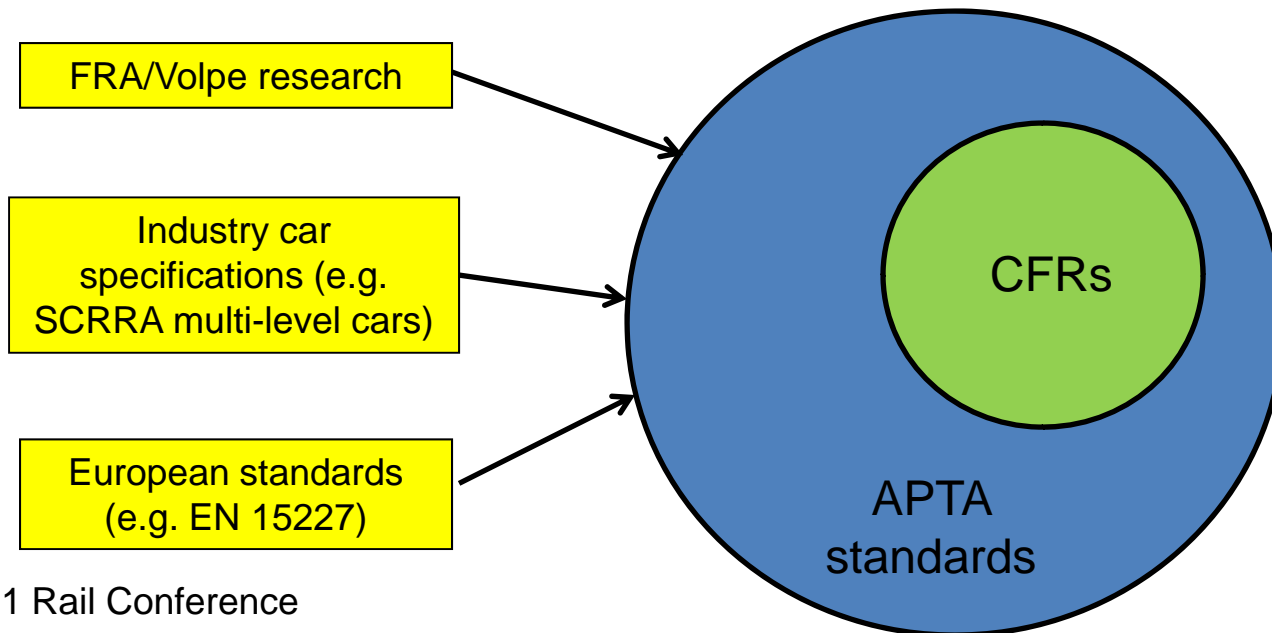
- Most of the documents have come from the Construction and Structural subcommittee of the Passenger Rail Equipment Safety Standards (PRESS) group.
- They include:
 - APTA SS-C&S-034-99 Rev. 2, Standard for the Design and Construction of Passenger Railroad Rolling Stock
 - APTA SS-C&S-006-98, Rev 1. Standard for Attachment Strength of Interior Fittings for Passenger Railroad Equipment
 - APTA SS-C&S-011-99, Standard for Cab Crew Seating Design and Performance
 - APTA SS-C&S-016-99, Rev. 2, Standard for Passenger Seats in Passenger Rail Cars

There are also related standards.

- Some other standards have parts that relate to crashworthiness:
 - APTA RP-C&S-001-98, Recommended Practice for Passenger Equipment Roof Emergency Access
 - APTA SS-C&S-007-98, Rev. 1, Standard for Fuel Tank Integrity on Non Passenger Carrying Locomotives
- Some others are under development:
 - Recommended practice on push back couplers (in its eight revision)
 - Standard on crashworthy tables
 - A revision to S-034 that includes the recommendations of the Railroad Safety Advisory Committee (RSAC), Engineering Task Force (ETF).

The APTA standards have connections with research, regulations, and other specifications and standards.

- The APTA crashworthiness standards include all of the applicable Code of Federal Regulations.
- Industry specifications and standards from other organizations are studied to develop the APTA crashworthiness standards.



The crashworthiness standards provide protection against certain types of collisions and collision modes. Currently:

- Train-to-train impact: buff strength; seat strength and protection
- Grade crossing collision: collision and corner post strength; horizontal framing members; end sheathing
- Derailment and rollover: side and roof strength; coupler strength
- Override: coupler and carrier strength; collision post strength; truck-to-car body attachment strength.
- Bypass: coupler and carrier strength.

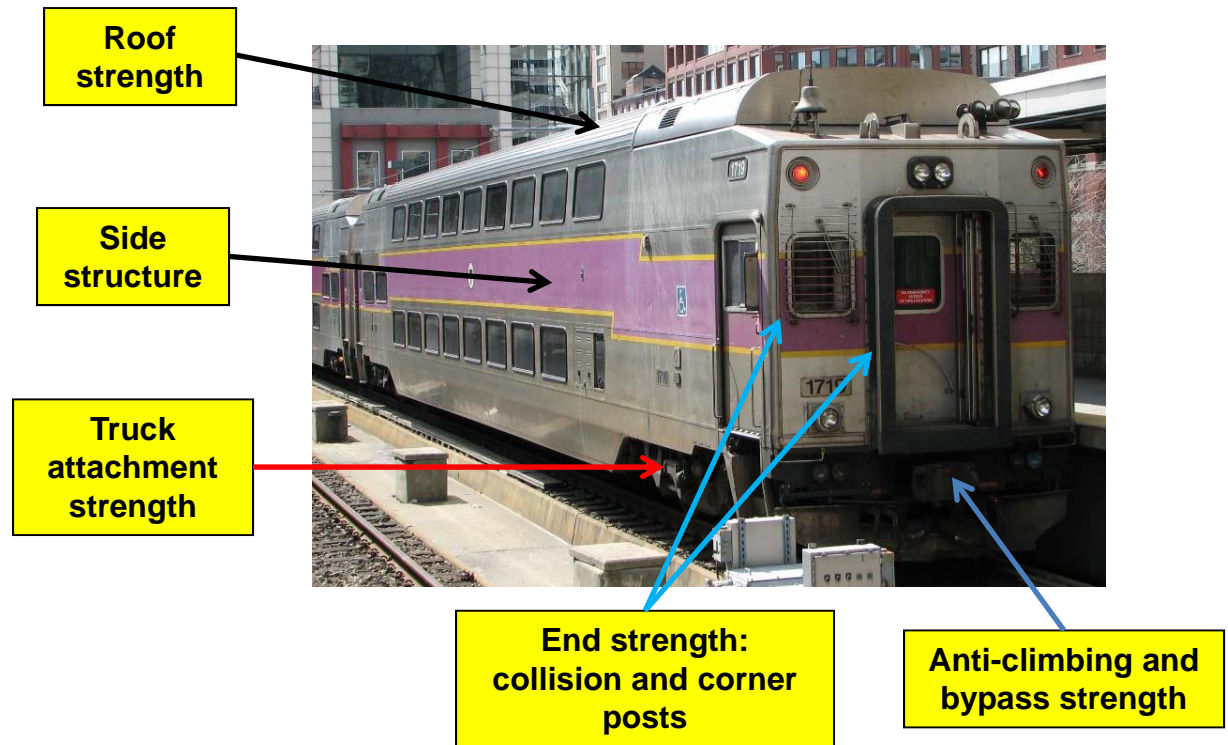


The Standard for the Design and Construction of Passenger Railroad Rolling Stock includes many aspects of crashworthiness.

Examples

Notes:

- These are mainly strength-based requirements.
- Although, the collision and corner posts must also absorb energy.



The Standard for Passenger Seats in Passenger Rail Cars also includes aspects of crashworthiness.

- Seats are tested for injury criteria and strength for a given crash pulse.
- An alternate approach to this standard is currently being considered in ETF-II on high-speed trains.

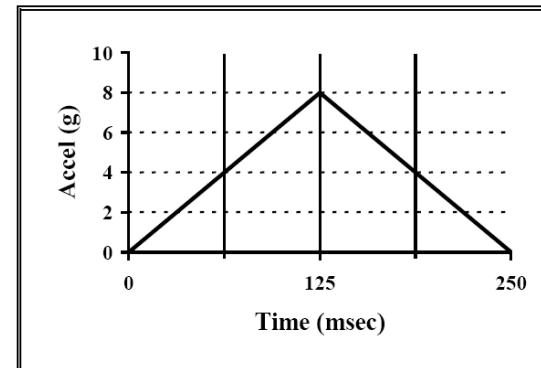
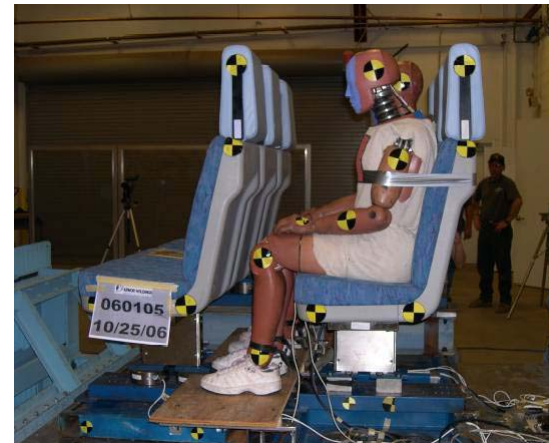
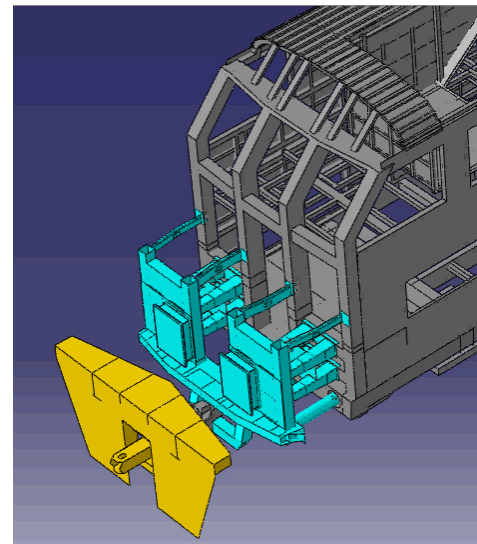
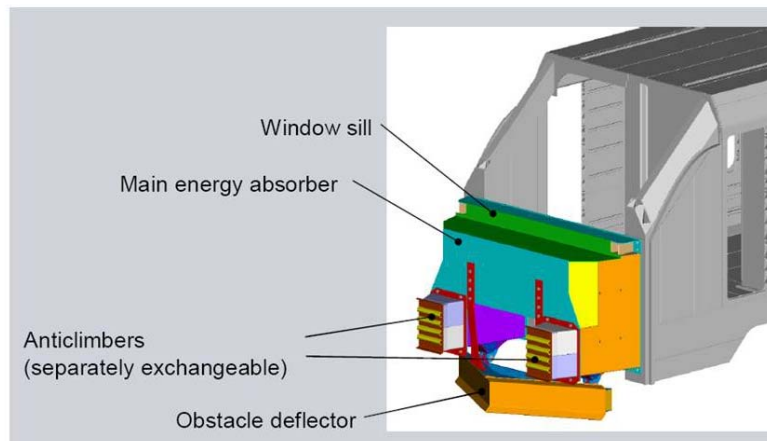


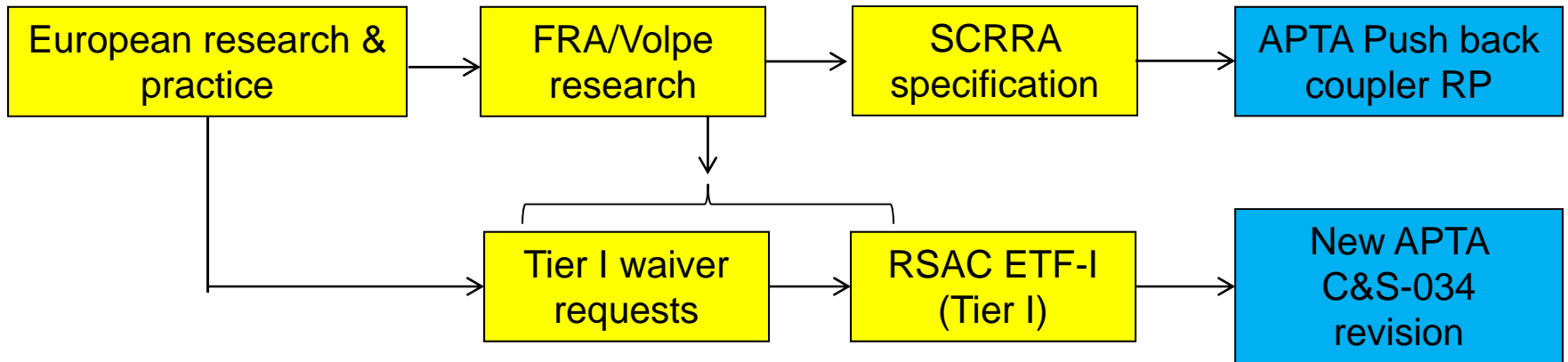
Figure 12 - Longitudinal Crash Pulse

The growing use of crash energy management (CEM) in trains is changing the way we protect against collisions.

- Europe and some other countries follow European crashworthiness standards, which require CEM.
- Many U.S. light rail and transit systems require CEM.
- Therefore, there are many trains with CEM available.

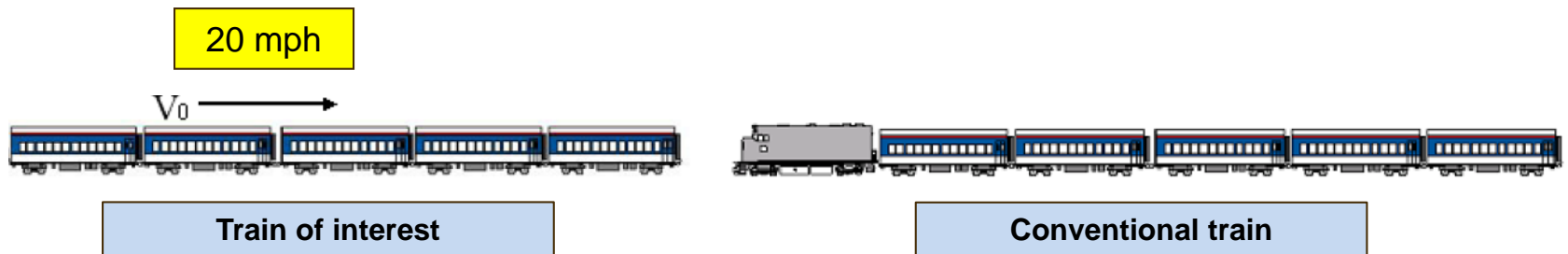


Recent government-industry activities are leading to new and substantially modified APTA standards.



The activities of the Railway Safety Advisory Committee's (RSAC) Engineering Task Force (ETF) will have a substantial influence on future APTA crashworthiness standards.

- The ETF-I is focused on Tier I operation.
- Work was instigated by several waiver requests, including Capital Metro and Caltrain.
- A collision scenario, rather than strength, is used to demonstrate several aspects of crashworthiness.



Many strength-based requirements are replaced with performance requirements.

Scenario/Loading Condition	Criterion	Protection for:
Train-to-train collision at 20 mph (analysis)	No intrusion into occupied volume	Occupant crush
<i>Same</i>	Mating cars at colliding and trailing interfaces cannot lift significantly with respect to each other or the rail	Override
<i>Same</i>	Truck remains attached (plus 3g vertical, 1g lateral, no yielding)	Override; equipment impact w/other trains
Static load on line of draft (test)	337k (min), no yield	Occupant crush; validated analysis
Static load on the crush zone supports (analysis)	800k, no yield; 1000k; minor plastic deformation; 1200k, no crippling	Occupant crush
Impact with a steel coil (analysis w/ some tests)	Limited crush into the occupied volume	Occupant crush

APTA continues to be a leader in developing standards for rail vehicle crashworthiness.

- Several standards exist on crashworthiness.
- C&S-034 is the primary crashworthiness standard.
- The standards are changing to reflect the benefits of modern crash energy management technologies.
- In particular, the C&S-034 will eventually incorporate the results of the RSAC Engineering Task Force.