



LTK

Engineering Services

Evaluation Criteria & Procedures: Implementation in Industry Standard

Eloy E. Martinez
LTK Engineering Services
Senior Consultant
Boston, MA



LTK

Engineering Services

Outline

- RSAC Engineering Task Force
- Evaluation Criteria & Procedures
- APTA C&S S034-Rev 3
- Summary



LTK

Engineering Services

RSAC Engineering Task Force

Task Force Mission Statement:

“Produce a clear **set of technical evaluation criteria and procedures** to provide means of comparing crashworthiness performance of new **trainset** designs with compliant Tier I equipment”

FRA proposed a Strawman. We all worked collaboratively over 4 meetings using research and practical experience to define acceptable levels of performance.



LTK

Engineering Services

Desired Metrics of Success

- Preservation of occupied space
 - For collision scenarios preserve space up to a **minimum safe closing speed**
 - Apply traditional load requirements for other aspects of car designs (side and roof loading, etc.)
 - For both cases maintain occupant containment
- Maintain survivable **Secondary Impact Velocities*** within interior of cars



LTK

Engineering Services

Approach

- Performance Criteria for Prescribed Impact Scenarios
 - Train-to-train Collision, Grade-crossing Collision, etc.
 - Assess Crashworthiness Performance with Tests and Computer Simulations
- Design Criteria for Fundamental Features
 - Occupant Volume Integrity
 - Verify Fundamental Aspects with Nondestructive Tests and Manual Calculations



LTK

Engineering Services

Desirable Characteristics

- Procedures must provide:
 - Readily analyzable conditions
 - Repeatable results
 - Safe test conditions
 - Clear means for comparison and design qualification



Final Product of RSAC ETF

DRAFT
RSAC ETF REPORT DRAFT



US Department
of Transportation

Federal Railroad
Administration

Office of Research and
Development
Washington, DC 20005

Technical Criteria and Procedures for Evaluating
the Crashworthiness and Occupant Protection
Performance of Alternately-Designed Passenger
Rail Equipment for Use in Tier I Service

DRAFT

DOT/FRA/ORD-xx/xx

Final Report
May 2010

This document is available to the public
through the National Technical Information
Service, Springfield, Virginia 22161
This document is also available on the
FRA web site at www.fra.dot.gov

DRAFT
RSAC ETF REPORT DRAFT

3.2 Guidance Summary

Table 2. Guidance Summary for Criteria and Evaluation

Requirement	Summary of Load Case	Summary of Criteria
Collision with conventional equipment	Alternately-designed train in collision with conventional locomotive-led train: (a) 20 mph, cab car-led; or (b) 25 mph, conventional locomotive-led.	Preserve occupied volumes
Occupied volume integrity	On the intended collision load path: (a) 800 kips. (b) 1000 kips. (c) 1200 kips.	(a) No permanent deformation. (b) Limited permanent deformation. (c) Without crippling.
Colliding equipment override	Alternately-designed equipment collision with conventional locomotive: (a) all equipment aligned. (b) consists offset 3 inches vertical and laterally.	Underframes remain engaged; and Wheel lift minimized.
Co equipment override	Alternately-designed equipment in collision with conventional locomotive, with 2-inch vertical/2-inch lateral offsets of first car-to-car connection	Underframes remain engaged; and Wheel lift minimized.
Fluid entry inhibition	Based on design review	(a) Equivalent to 3/4-inch steel plate with 25,000 psi yield strength; (b) Designed to inhibit the entry of fluids into the occupied area; and (c) Affixed to structural members.
End structure integrity of cab end	(a) Absorb minimum of 135 ft-kip of energy for impact offset 19 inches from longitudinal centerline. (b) Absorb minimum 120 ft-kip of energy for impact aligned with sidewall.	No more than 10 inches of longitudinal, permanent deformation
End (corner) structure integrity of non-cab end	(a) 150 kips at floor height. (b) 30 kips 18 inches above floor. (c) 20 kips at ceiling height.	(a) Without failure. (b) Without permanent deformation. (c) Without failure
Roof integrity	Equipment upside down, supported by roof	(a) No occupied volume intrusion; and (b) No more than 1/2 yield or buckling.
Side structure integrity	Design requirements on sidewall stiffness and material properties	Vertical modulus (in ⁴) ≥ 0.3 x L; and Horizontal modulus (in ⁴) ≥ 0.2 x L.
Truck attachment	Scenario 2.1 plus either: (a) 3g vertical, 1g lateral, 5g longitudinal; or (b) 3g vertical, 1g lateral.	Static analyses: Without yielding; and (a) Scenario 2.1: Avg. acc. ≤ 5g and Max. acc. ≤ 10g; or (b) Scenario 2.1: Without failure
Interior fixture attachment	Fixtures: 8/4/4g Longitudinal/lateral/vertical quasi-static load; and Seats: 8g longitudinal dynamic pulse	Fixtures and seats remain attached
Occupant protection features	8g longitudinal dynamic pulse	Injury criteria within accepted limits

Note: Table for use as a summary only for the requirements noted



LTK

Engineering Services

Post RSAC ETF Industry Activities

- APTA agreed to incorporate evaluation criteria and procedures into APTA Standard SS-C&S-S034 **Rev 3**
- Draft of Standard complete and available for comment
- Removed NPC locomotive requirements
- Can be used as basis for new rule in 49 CFR Parts 238 – incorporation by reference



LTK

Engineering Services

Summary

- Industry stakeholders worked in conjunction with FRA to develop a guideline document to expedite the waiver process for new trainsets designed to alternative standards
 - Combines use of both performance and design requirements
- Industry is planning on adopting within APTA Standard SS-C&S-S034 Rev 3
- The standard can be used as a mechanism to expedite the rule making process – use of incorporation by reference