A Review of European Standards and Waiver Requirements for Mainline Equipment

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2010 RAIL CONFERENCE

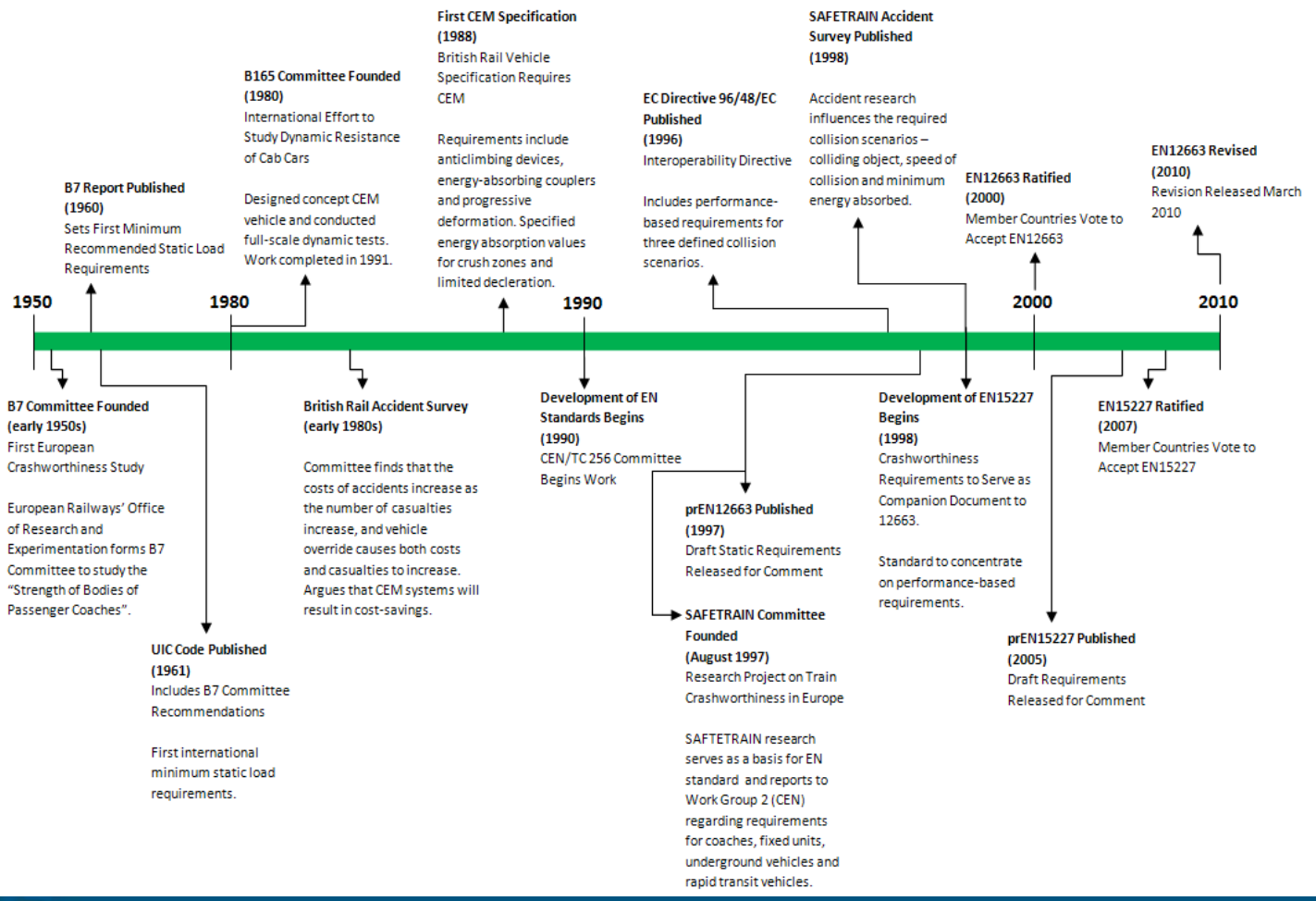
Overview

1. Euro-Norm (EN) Development
2. Brief Review of US Crashworthiness Research
3. Description of Railroad Safety Advisory Committee (RSAC) Engineering Task Force (ETF) Effort
4. EN Influences on FRA Waiver Requirements

EN Standards: Philosophy

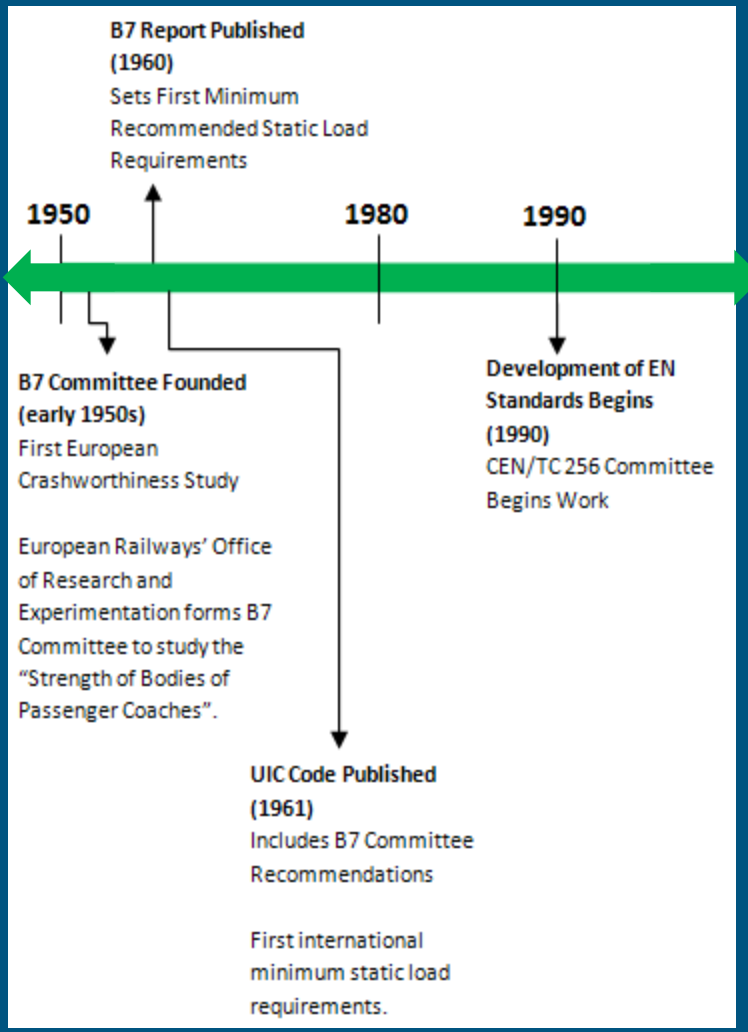
European standards combine low-level static requirements with demanding performance criteria to achieve optimal designs for European service

EN Standards: Timeline



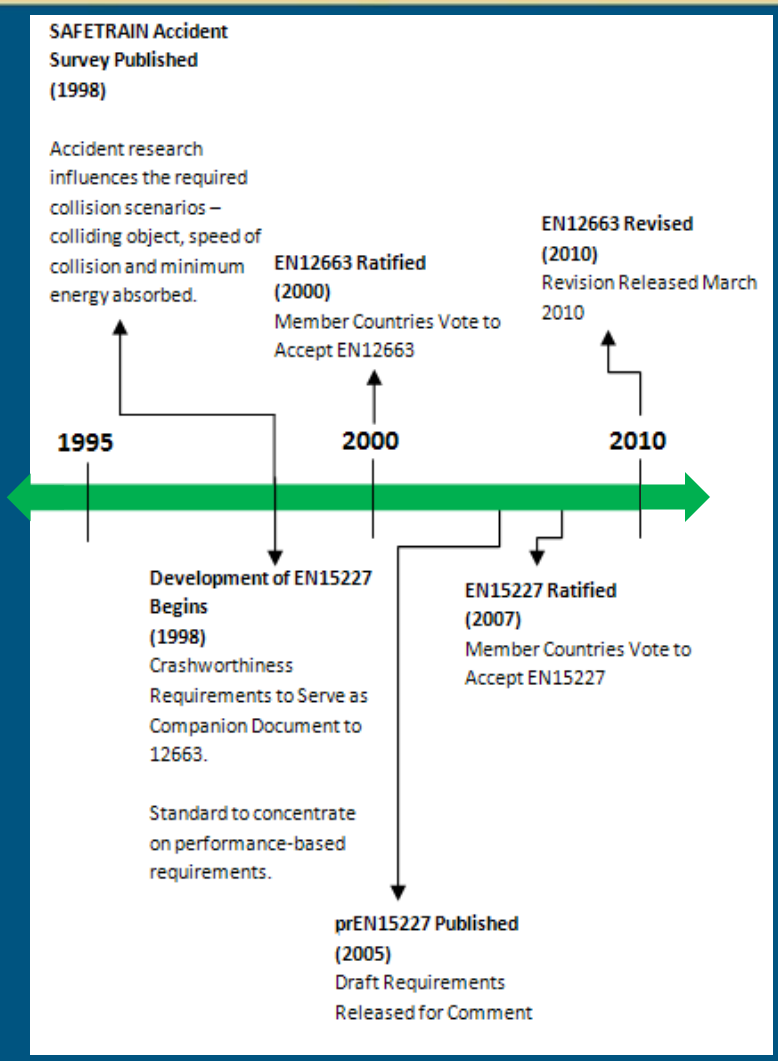
EN Standards: Milestones

- Crashworthiness research began in the early 1950s
- EU began development of standards in 1990



EN Standards: Milestones

- EN12663 Ratified in 2000 - Static load requirements
- EN15227 Ratified in 2007 - Dynamic requirements



Research in the US

- FRA intensified crashworthiness research in the early 1990s

- Program included the development of CEM system retrofitted onto conventional North American vehicle

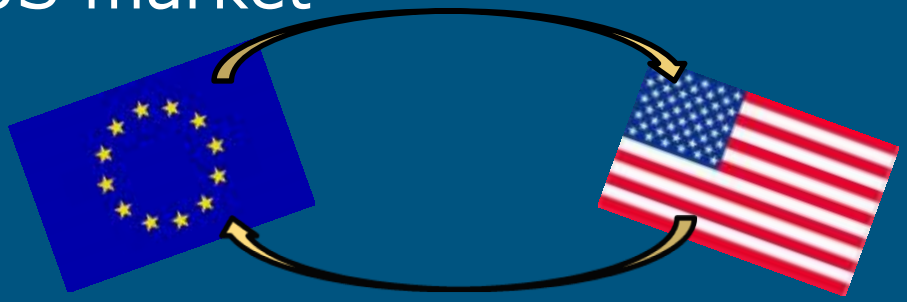
FRA Results

Video Courtesy FRA/Volpe Center – "Train-to-Train Impact Test of Crash Energy Management Passenger Rail Equipment", 2006

RSAC ETF

RSAC ETF to provide a clear set of metrics to evaluate alternatively-designed equipment for waivered operation

- Include example procedures
- Allow designs of equivalent safety into the US market



RSAC ETF: Summary

CFR	Concern	Alternative Load Case	Criteria
238.203	Collision with conventional equipment	Alternatively-designed train collision with conventional locomotive-led train (a) 20 mph, cab car led (b) 25 mph, locomotive led	Preserve occupant volumes
238.219	Truck attachment		Trucks remain attached
238.205 238.207	Colliding car override Connected equipment override	Alternatively-designed equipment collision with conventional locomotive, (a) aligned and (b) with offsets	Underframes remain engaged Minimize wheel lift

RSAC ETF: Summary

CFR	Concern	Alt. Load Case	Criteria
238.203	Occupant volume integrity	(a) 800,000 lb - OR - (b) 1,000,000 lb - OR - (c) 1,200,000 lb Applied on collision load path	(a) No permanent deformation (b) Limited permanent deformation (c) Without crippling
238.211 238.213	End structure Integrity of cab end	Guidelines in Appendix F	Guidelines in Appendix F
238.213	Non-cab end corner post	Same as current CFR	Same as current CFR

RSAC ETF: Summary

CFR	Concern	Alt. Load Case	Criteria
238.209 238.215 238.217	Fluid entry Roof integrity Side structure integrity	Same as current CFR	Same as current CFR
238.233	Interior fixture attachment	Fixtures: 8/4/4 longitudinal / lateral / vertical quasi-static load Seats: 8G longitudinal dynamic pulse	Fixtures and seats remain attached

Waiver – 238.203 Dynamic

Requirements:

Alternatively-designed train in collision with conventional locomotive-led train:

a) 20 mph for cab-car led consists
b) 25 mph for conventional locomotive-led consists

Waiver – 238.203 Dynamic

Acceptance Criteria:

- Preserve occupied volume
- Preserve operator space
- Global vehicle shortening limited
- Maintain safe secondary impact environment

Image courtesy FRA/Volpe Center, "Rail Passenger Equipment Collision Tests: Analysis of Occupant Protection Measurements", 2000

EN15227 – Dynamic

Basic Requirements

1. Front-end impact between two identical train units, 22.4 mph
2. Front-end impact at buffer, 22.4 mph
3. Front-end impact with large road vehicle at high speed, up to a maximum of 68.4 mph
4. Train impact with low obstacle*
   – a maximum load of 67,400 lbs

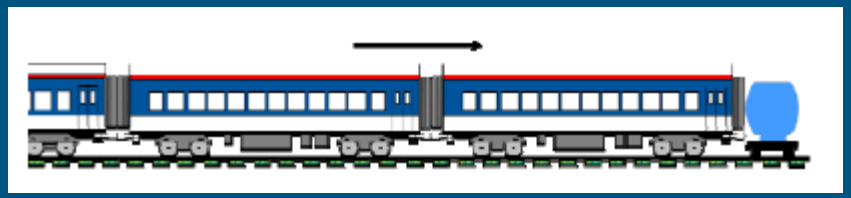


Image courtesy FRA/Volpe Center, "Structural Crashworthiness Standards Comparison, Grade Crossing Collision Scenarios, 2009

EN15227 - Dynamic

Acceptance Criteria:

- Passenger volume integrity/Driver survival zone
- Minimal reduction in overall length of vehicle
- Limited plastic strains
- Carbody deceleration limited

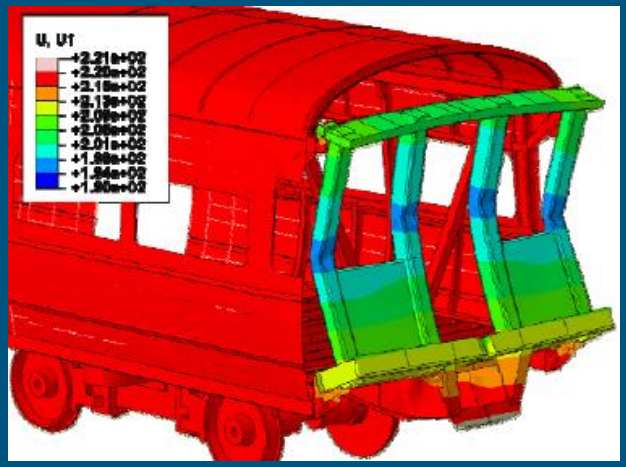
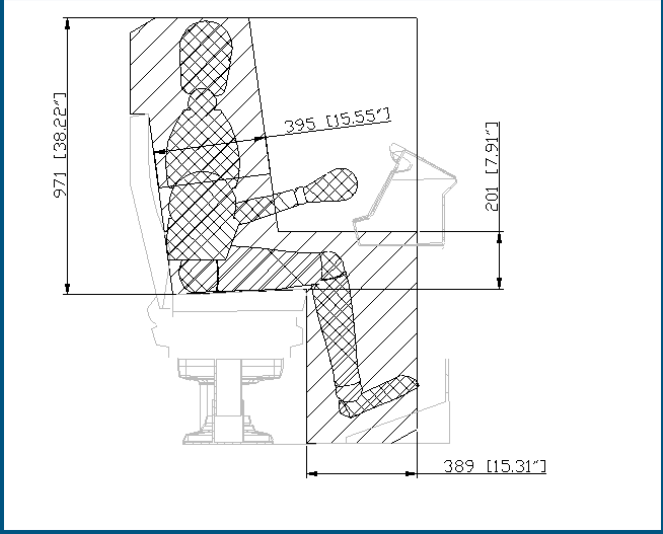


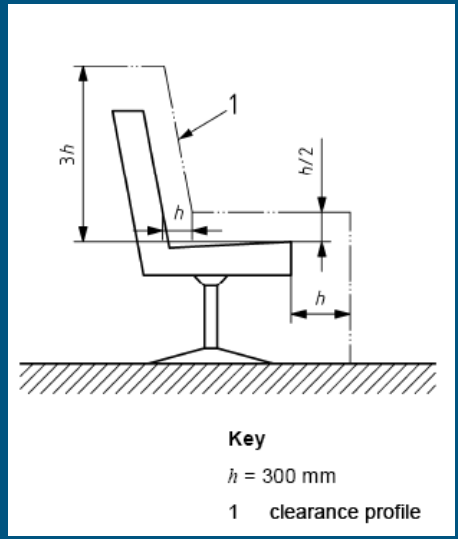
Image courtesy FRA/Volpe Center, "Structural Crashworthiness Standards Comparison, Grade Crossing Collision Scenarios, 2009

Requirement Comparison

- Collision at similar speed
- SIV criteria/deceleration limit
- Operator Survival Zone:



Waiver



15227

Waiver – Quasi-Static

Requirements

Meet any one of the following three options:

	Load	Acceptance Criteria
Option A	800,000 lb	No permanent deformation
Option B	1,000,000 lb	Limited permanent deformation
Option C	1,200,000 lb	Without crippling the carbody

All loads applied on the collision load path

Waiver – Quasi-Static

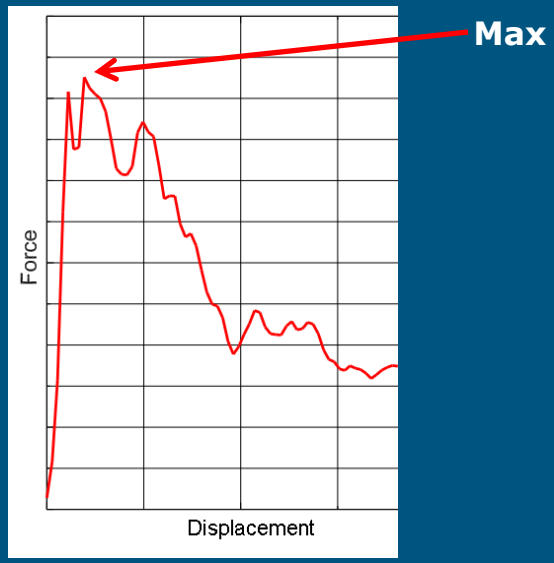
Definitions

"Limited Permanent Deformation":

- Maximum plastic strain < 10% and
- Strains exceeding 5% not located on primary longitudinal load-carrying component

"Crippling Load":

- Maximum point on the force-displacement characteristic curve.



EN12663 – Static

Load	P-I	Criteria
Load at Buff Stops	450,000 lb	Yield
Diagonal Load at Side Sill	112,000 lb	"
Tensile Load at Coupler	225,000 lb	"
Compressive Load at 5.9 in	90,000 lb	"
Compressive Load at Belt Rail	67,000 lb	"
Compressive Load at Cantrail	67,000 lb	"

Requirement Comparison

- Waiver emphasizes prescriptive load to show equivalent safety in addition to separate requirements for collision scenarios

- EN standards allow collision scenarios to dictate strength requirements by keeping static load requirements low

RSAC ETF: Effect on CFR?

- Language drafted for waiver requirements may eventually become part of Code of Federal Regulations (CFR)
- FRA recognizes value of performance-based requirements

Summary

- EN standards are the product of >50 years of research and development

- FRA has considered European standards during development of waiver criteria

Summary

- The FRA is incorporating performance-based requirements into waiver criteria

- Exercise has illustrated challenges and advantages of performance-based approach to regulation

Summary

Waiver guideline document serves three purposes:

- Help FRA evaluate waivers efficiently and expediently with confidence in safety levels
- Open North American market to alternatively-designed equipment
- Increase number of off-the-shelf designs available (and decrease cost of vehicles) for North American service