Federal Motor Vehicle Safety Standard No. 213 Child Restraint Systems

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What Did Congress Say?

- Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, says in part:
  - Section 14 (a). Not later than 12 months after the date of the enactment of this Act, initiate rulemaking to improve the safety of child restraints.

Elements for Consideration

- Use of dynamic tests to:
  - Replicate side- and rear-impact crashes
  - Reflect the design of the current fleet of passenger motor vehicles
- Use of anthropomorphic test devices:
  - New Hybrid III dummies
  - Represent a greater range of children, including a 10-year-old
- Apply scaled injury criteria performance levels of adults including neck injury
- Raise the upper weight limit of the standard from 50 to 80 pounds
- Improve protection from head injuries in side- and rear-impact crashes

What Did NHTSA Do?

- Crash data analysis (FARS, NASS, and University of Pennsylvania CHOP)
- Sled testing program
- Measurements of vehicle compartment seat & belt geometry and stiffness
- Analysis of measurements of seats and vehicle crash dynamics (pulses)

Crash Data Analysis

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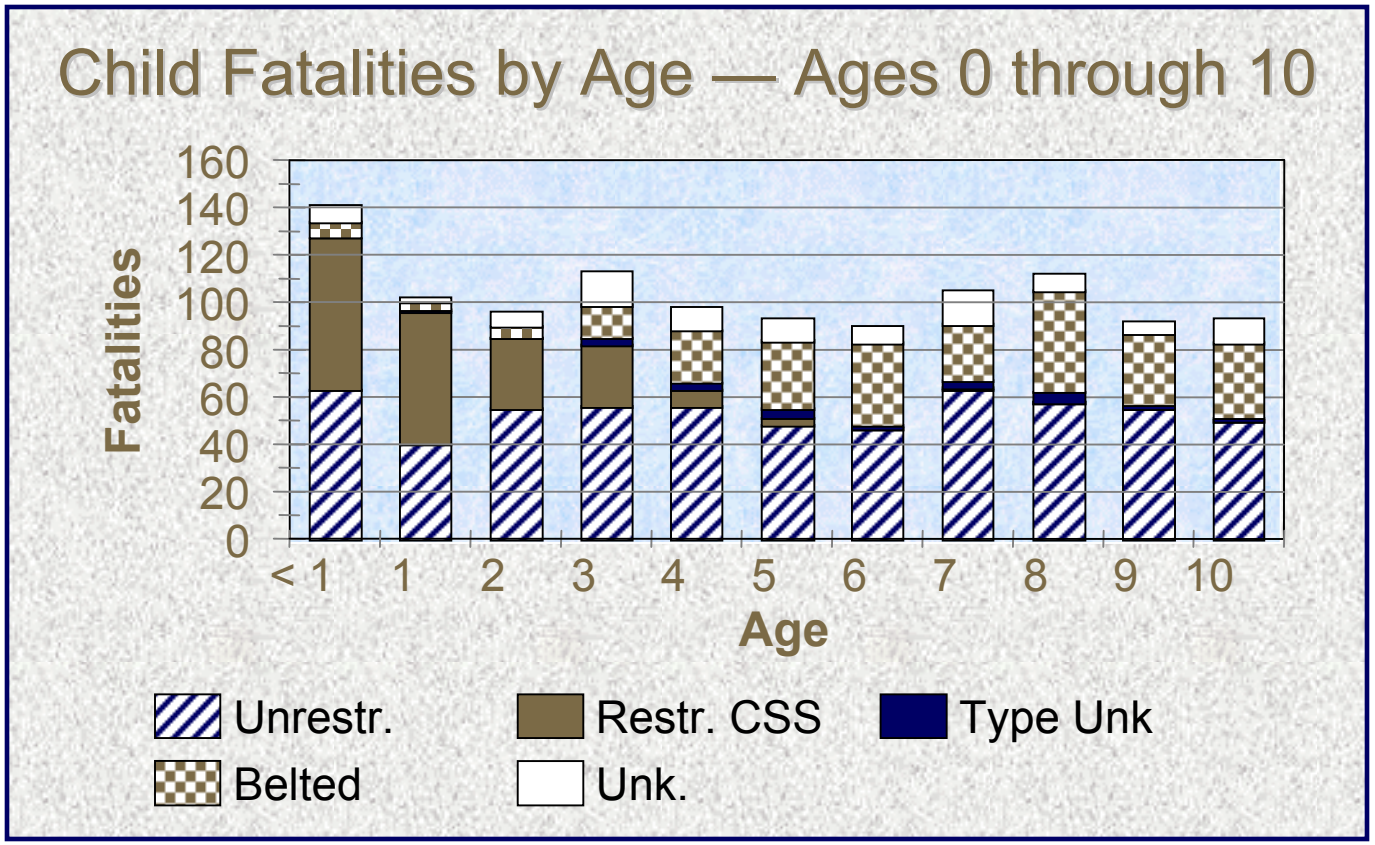
Crash Data Analysis
Child Passenger Safety — 1999 FARS



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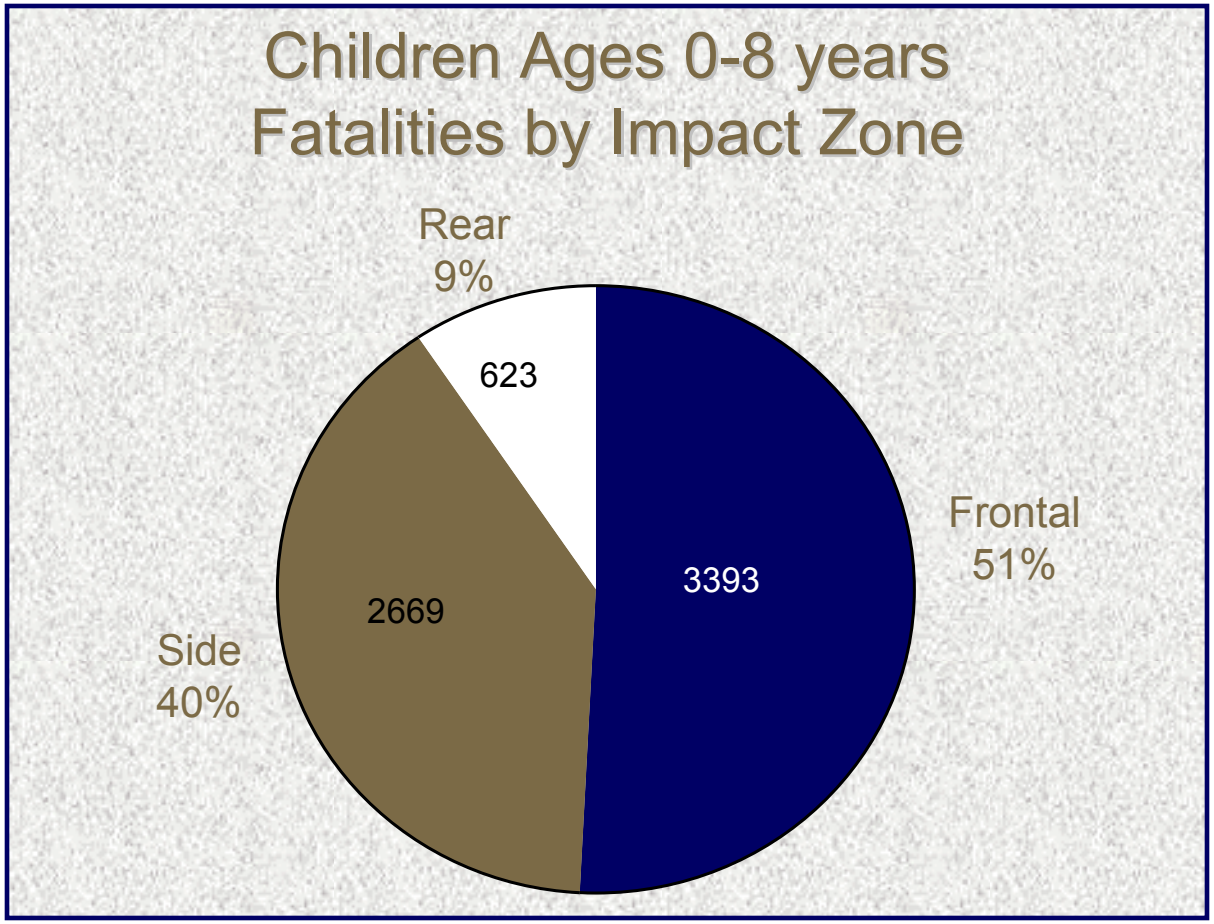
Crash Data Analysis
1991 – 1999 FARS



Dynamic Test Procedure

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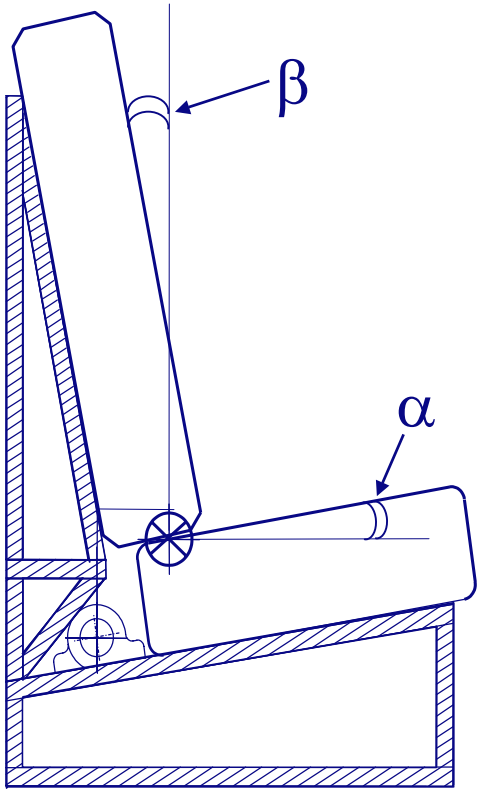
Dynamic Test Procedure

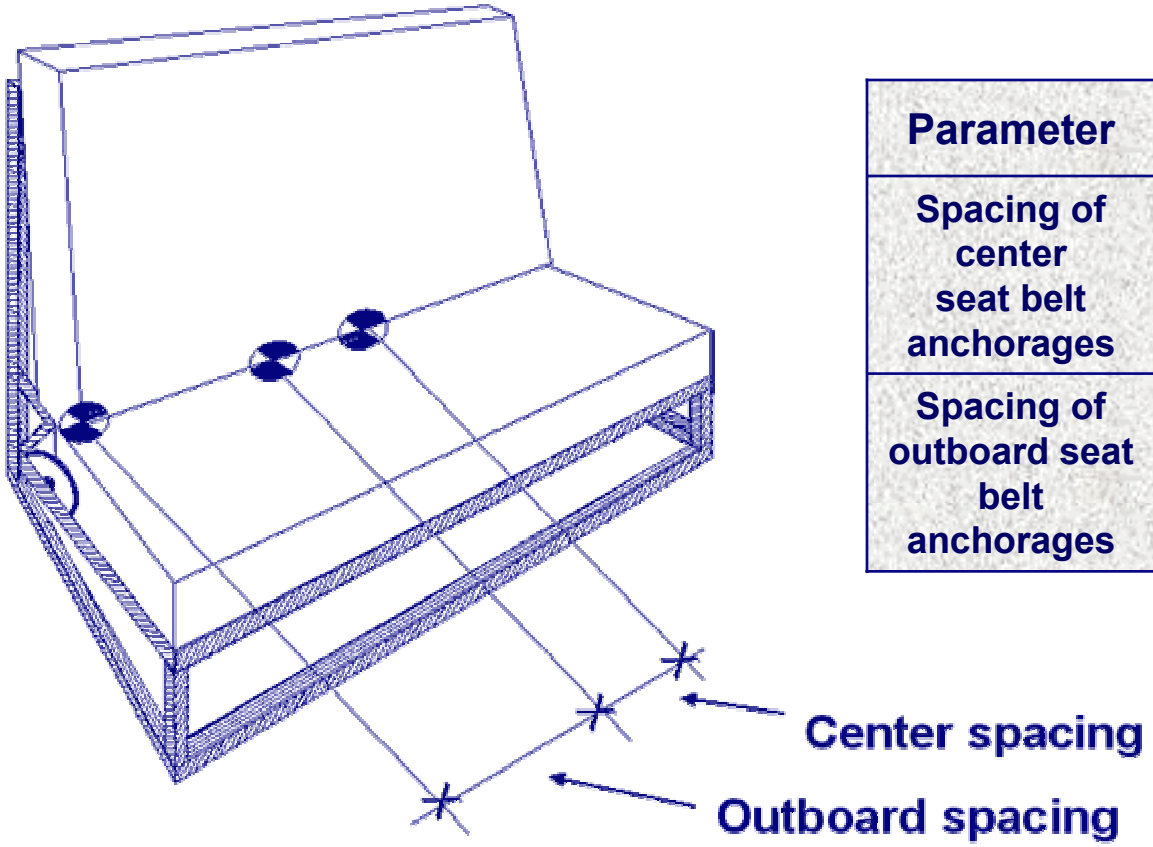
- In response to TREAD, NHTSA initiated a test program to assess seat parameters of production seats, working with
  - Veridian Engineering (Veridian)
  - U.S. Naval Air Warfare Center Aircraft Division at Patuxent River, Maryland (PAX)
- Analysis of FMVSS No. 208 crash pulses
- Survey of 41 interior measurements from vehicles that are representative of the current US vehicle fleet

Dynamic Test Procedure
Seat Assembly – Side View



Parameter	Current	Proposed
α	8°	15°
β	15°	22°
Seat back assembly	Flexible	Fixed

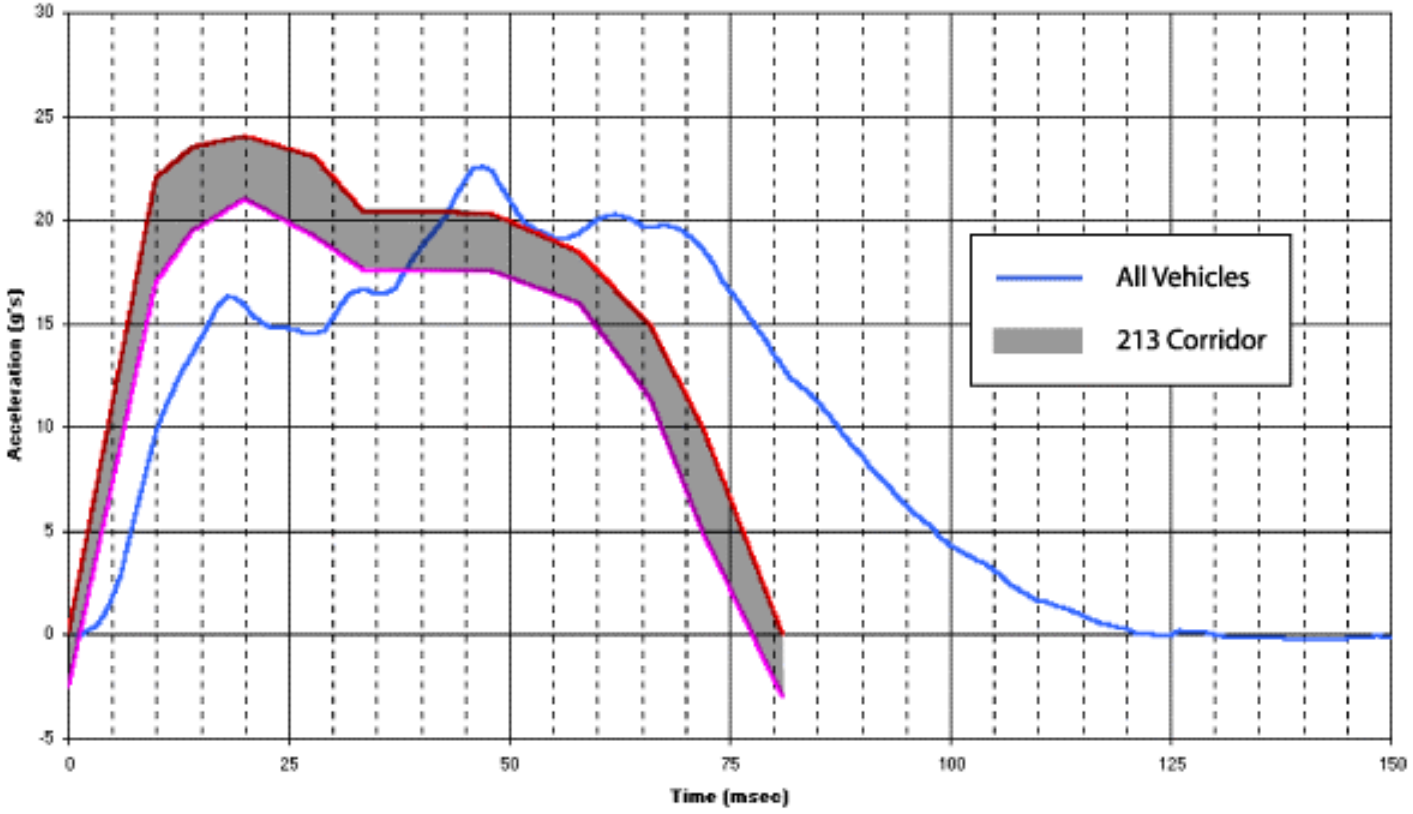
Dynamic Test Procedure
Seat Assembly – Frontal View



Parameter	Current	Proposed
Spacing of center seat belt anchorages	222mm	392mm
Spacing of outboard seat belt anchorages	356mm	472mm

Dynamic Test Procedure Combined Crash Pulse

FMVSS 213 vs 208 — Combined Crash Pulse



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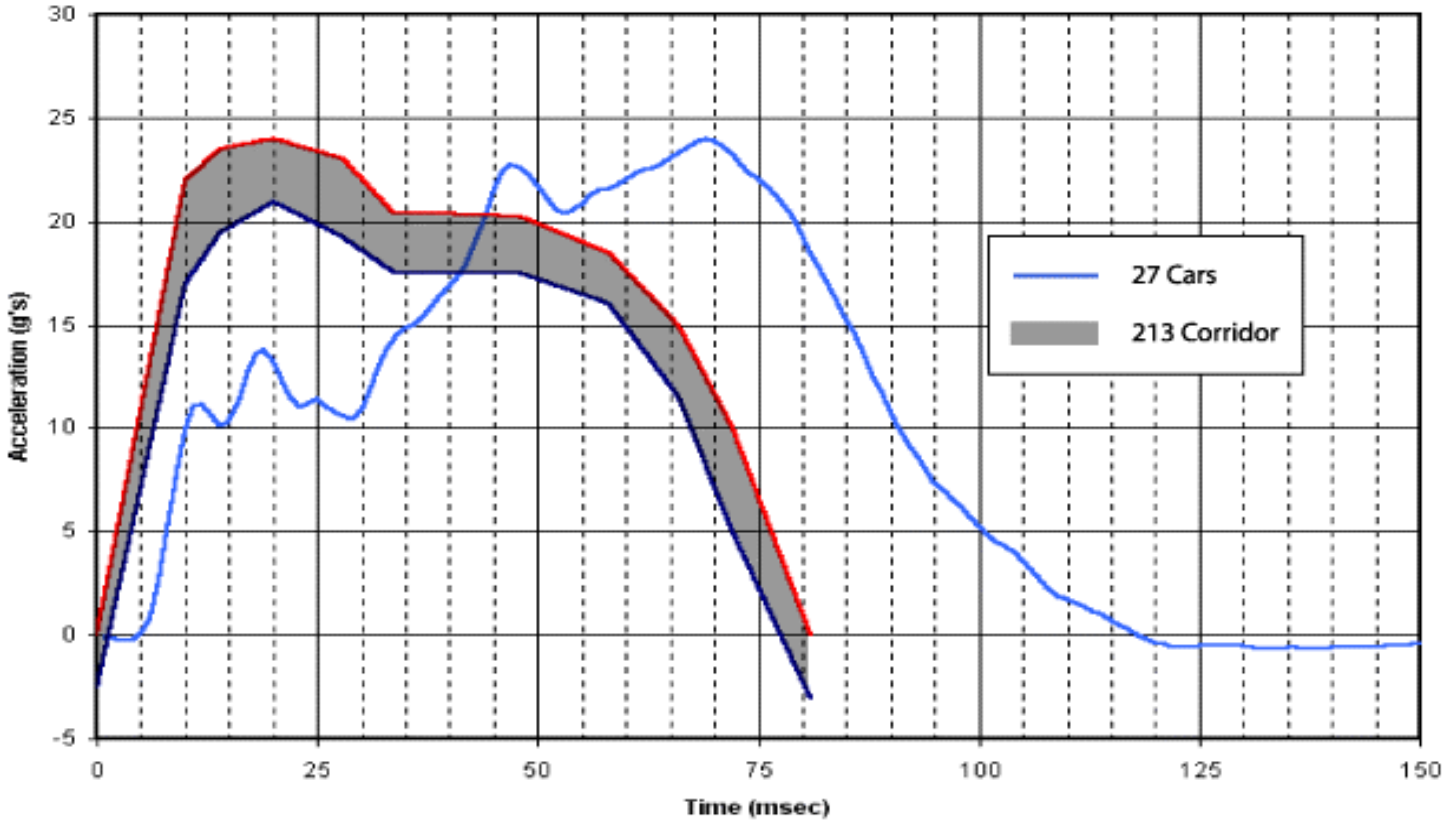
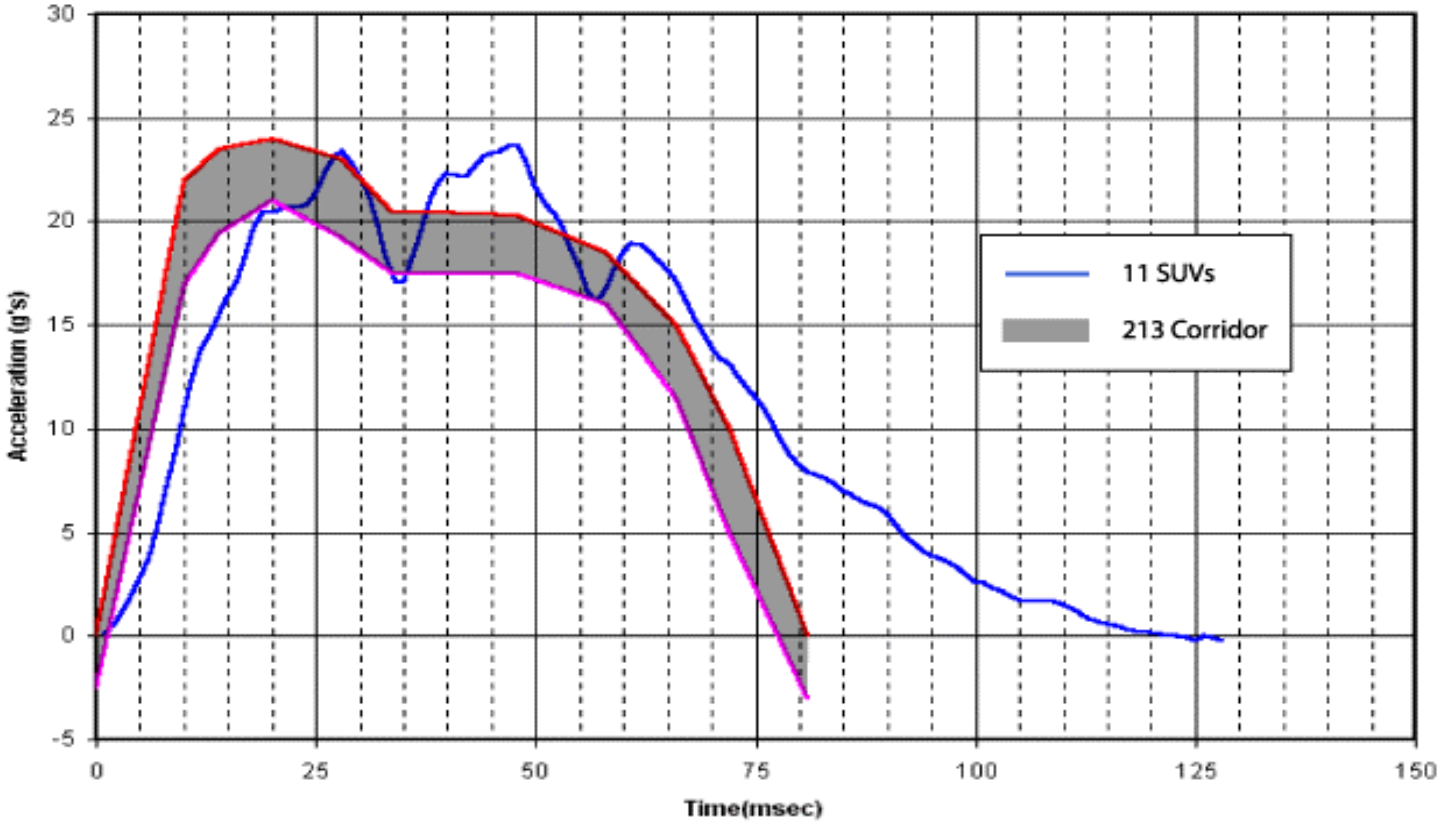
Dynamic Test Procedure
Passenger Car Crash Pulse

FMVSS 213 vs 208 — Passenger Car Crash Pulse

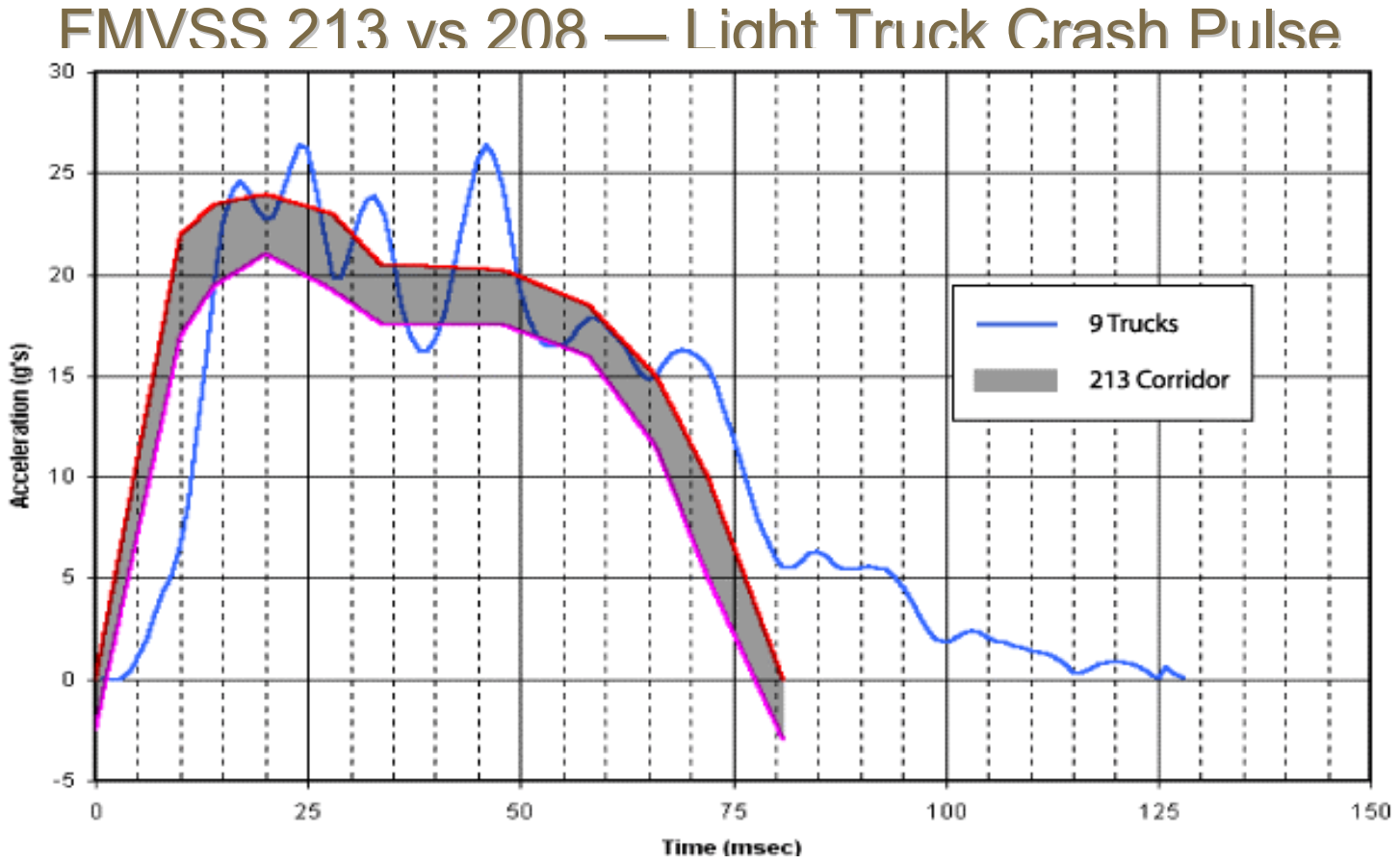


Dynamic Test Procedure
SUV Crash Pulse

FMVSS 213 vs 208 — SUV Crash Pulse

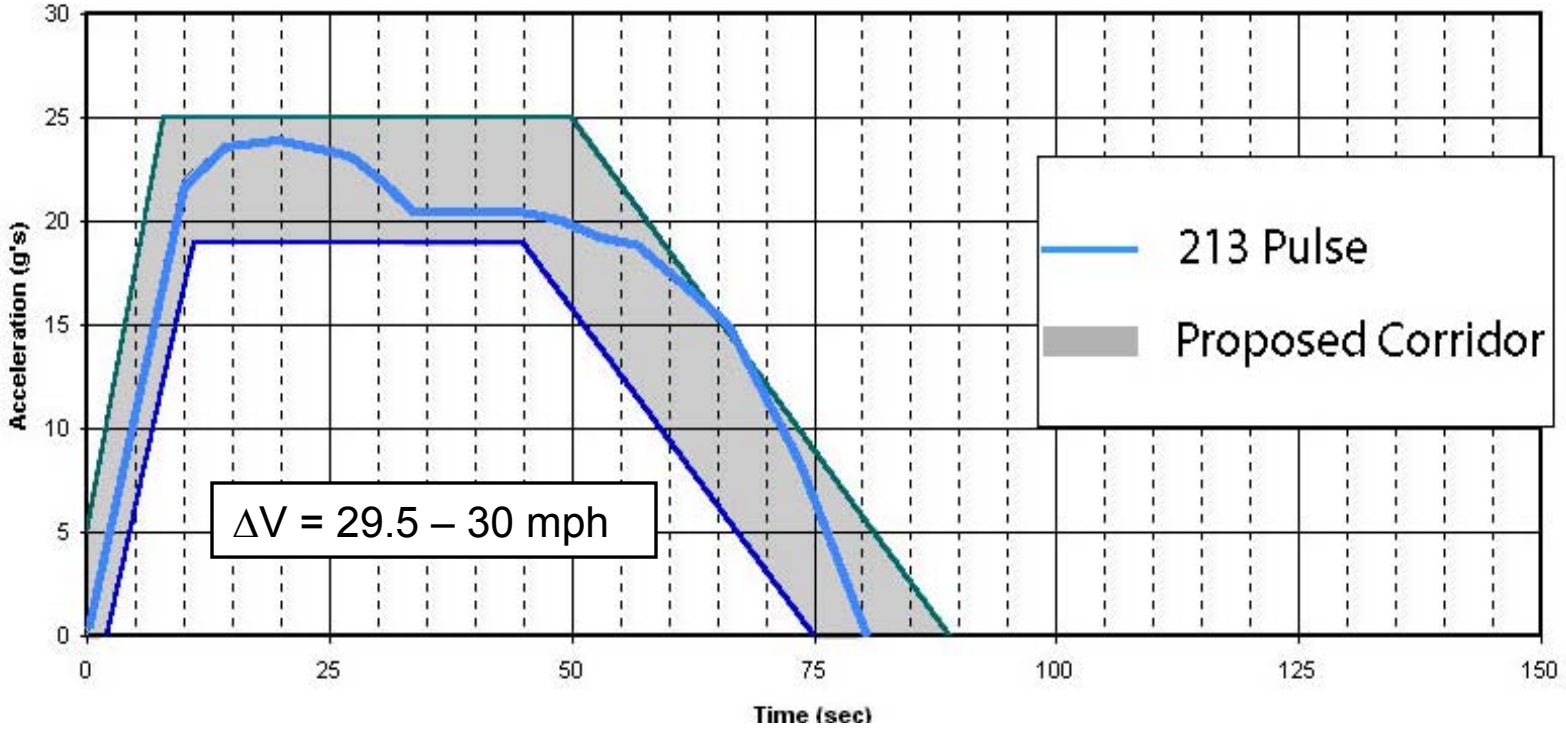


Dynamic Test Procedure
Light Truck Crash Pulse



Upgrade of Dynamic Test Procedure Proposed Crash Pulse Corridor

Current vs Proposed FMVSS No. 213 Pulse



New Anthropomorphic Test Devices and Injury Criteria

- Represent a greater range of children, including a 10-year-old
- New Hybrid III dummies

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New Anthropomorphic Test Devices and Injury Criteria

Development of 10-Year-Old Dummy

Hybrid III Height and Weight Comparison

	Standing Height (ft in)	Weight (lbs)
5th Female	4'11"	108.0
10-year-old	4’5”	76.0
6-year-old	3'9"	51.6

New Anthropomorphic Test Devices and Injury Criteria

Development of 10-Year-Old Dummy

The 10-Year-Old Hybrid III Dummy First Prototype

New Anthropomorphic Test Devices and Injury Criteria

Development of 10-Year-Old Dummy

Schedule

Specifications and Prototype Development	January - Sept 2001
Perform component and sled tests	October 2001 – Feb 2002
Publish NPRM	Fall 2002
Publish final rule	Fall 2003

New Anthropomorphic Test Devices and Injury Criteria

Weighted 6-Year-Old Dummy

- Developed a weighted 6-year-old dummy
- Increased weight from 51.6 to 62.0 pounds
- For possible use to test child restraints for children weighing from 50 to 65 pounds

New Anthropomorphic Test Devices and Injury Criteria

Weighted 6-Year-Old Dummy

Spine Weights

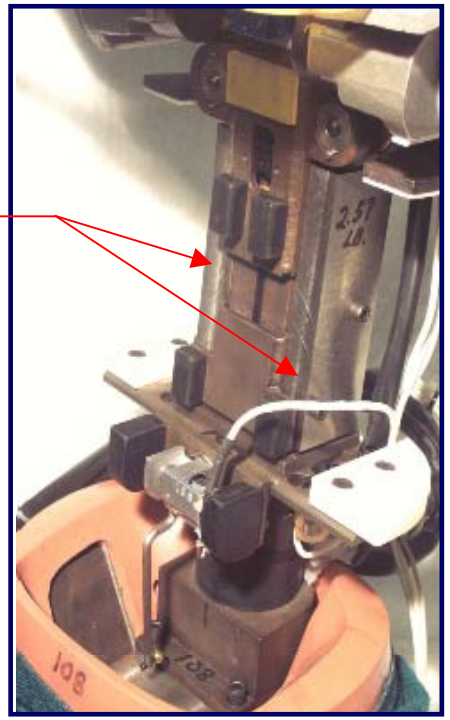

Fig. 1. Oblique frontal view of spine weights

Pelvis Weight

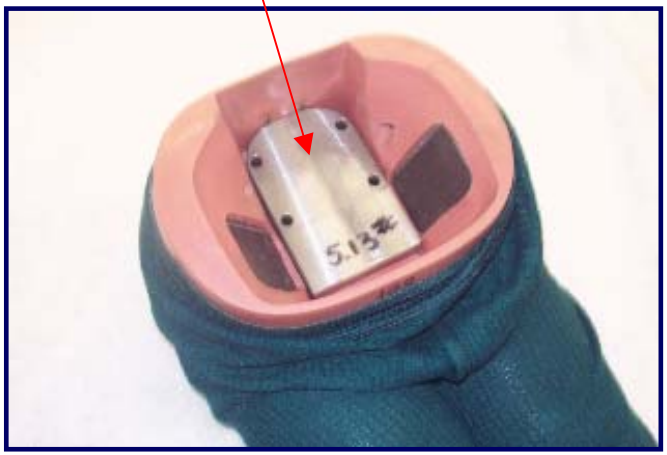

Fig. 2. Location and shape of pelvis weight

New Anthropomorphic Test Devices and Injury Criteria

The Hybrid III Family

- CRABI 12-month
- 3-year-old
- 6-year-old
- Added features vs. Hybrid II
  - Neck loads
  - Chest compression
  - Additional load measurement

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New Anthropomorphic Test Devices and Injury Criteria

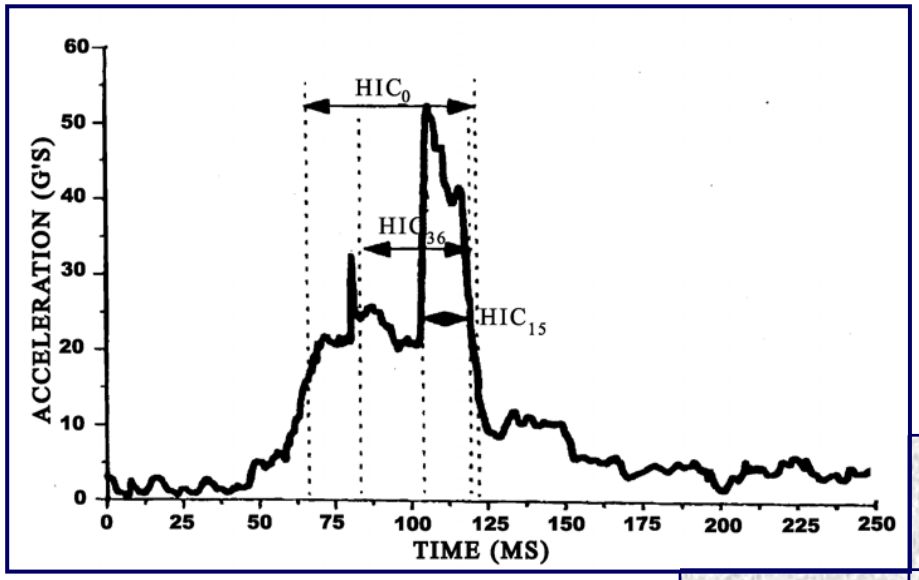
Dummy Equivalency Evaluation

Injury Assessment Reference Values (IARV)

Dummy	HIC	Nij	Chest Acceleration (G's)	Chest Deflection (mm)	Head Excursion (mm)	Head Excursion no tether (mm)	Knee Excursion (mm)
12-month-old CRABI	390_{15}	1	50	N/A	720	813	915
Hybrid III 3-year-old	570_{15}	1	55	34			
Hybrid III 6-year-old	700_{15}	1	60	40			
Hybrid II 9-month-old	N/A	N/A	N/A	N/A	720	813	915
Hybrid II 3-year-old	1000_{∞}	N/A	60	N/A			
Hybrid II 6-year-old	1000_{∞}	N/A	60	N/A			

New Anthropomorphic Test Devices and Injury Criteria

Head Injury Criterion ~ HIC



$$HIC = \max\left[\left(\frac{1}{t_2-t_1}\int_{t_1}^{t_2} a(t)\,dt\right)^{2.5}(t_2-t_1)\right]$$

$HIC_{15} \leq HIC_{36} \leq HIC_0$

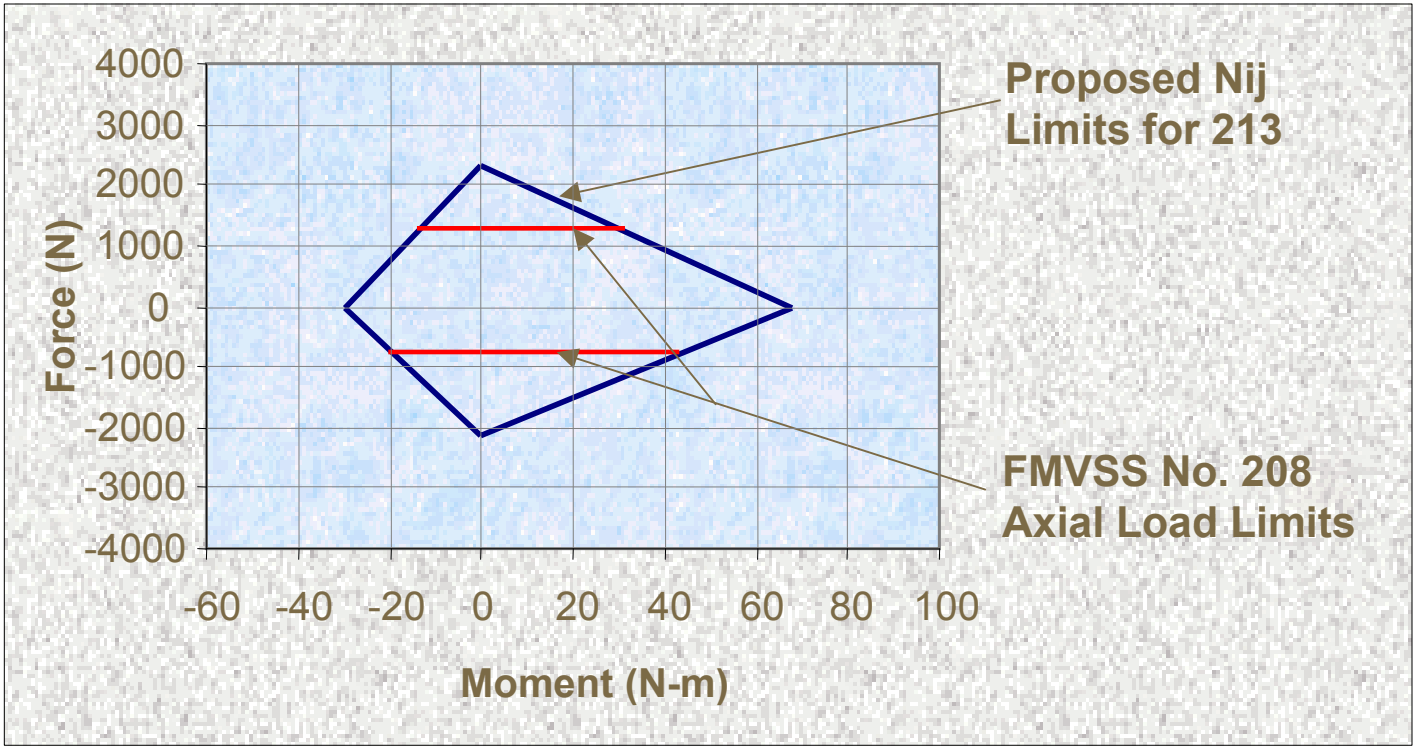
	HIC_0 Overall	HIC_{36} $t_2-t_1 \leq 36.0$	HIC_{15} $t_2-t_1 \leq 15.0$
HIC Value	229.0	200.0	184.2
(t_1,t_2)	(66.30,121.4)	(83.54,119.5)	(103.7,118.7)
(t_2-t_1)	(55.10)	(36.00)	(15.00)

Data on this slide adapted from Clifford C. Chou, Ford Motor Company, 1998

New Anthropomorphic Test Devices and Injury Criteria

Nij In-position Critical Values

FMVSS No. 213 Proposed Nij Values vs FMVSS No. 208

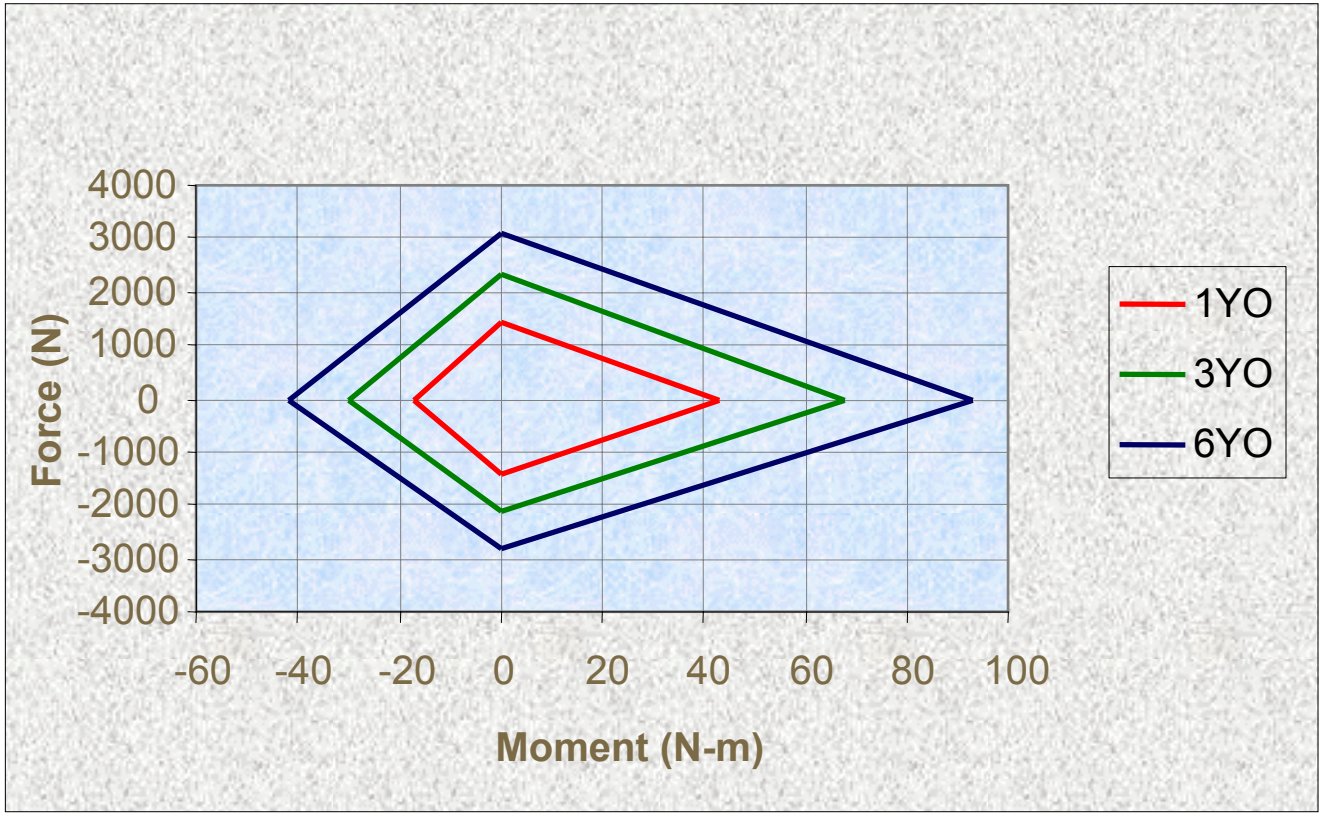


3-Year-Old

New Anthropomorphic Test Devices and Injury Criteria

Nij In-position Critical Values

CRABI 12-month and Hybrid III 3- & 6-year-old



New Anthropomorphic Test Devices and Injury Criteria

NHTSA Testing Purposes

- Establish the equivalency of child dummies
  - CRABI-12 vs. Hybrid II 9-month-old infant
  - Hybrid III vs. Hybrid II 3-year-old
  - Hybrid III vs. Hybrid II 6-year-old
- Determine Hybrid III dummy performance levels with child restraint systems
- Repeatability and reproducibility validation

New Anthropomorphic Test Devices and Injury Criteria

FMVSS No. 213 Sled Frontal Tests

Dummy Type	Test Type				
	Rear-facing 5pt belt	Tether 5pt belt	No tether 5pt belt	LATCH 5pt belt	Booster w/ lap/shoulder belt
Hybrid III CRABI-12	✓	✓			
Hybrid II 9-Month-Old		✓			
Hybrid III 3-Year-Old		✓	✓	✓	
Hybrid II 3-Year-Old		✓	✓	✓	
Hybrid III 6-Year-Old					✓
Hybrid II 6-Year-Old					✓

Side Impact Protection

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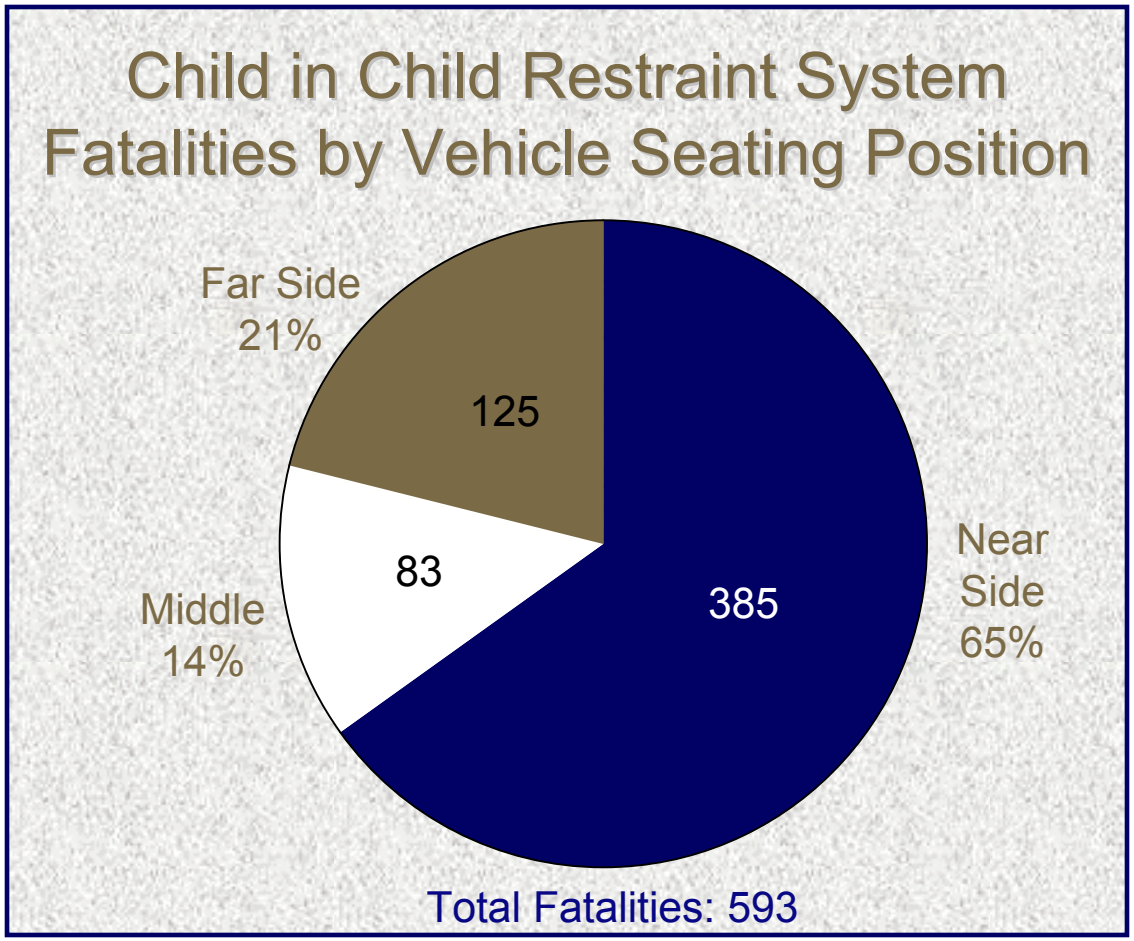
Side Impact Protection
1991 – 1999 FARS



Side Impact Protection
Previous Regulatory Activities

- Requirements proposed to specify a minimum level of performance for child restraints in dynamic side impact would be first in the world
- On March 1, 1974, agency proposed
  - 20 mph lateral impact (90°) dynamic test
  - Limits head motion to 19 inches in each lateral direction
  - No loss of structural integrity
- Agency withdrew 1974 proposal
  - Only tethered restraints satisfy requirements
  - Tethers not widely used at the time
  - High cost implications

Side Impact Protection
Testing of European Child Restraints

- Dynamic sled test of European and U.S. manufactured child restraints
  - Passenger compartment Grand Am test buck
  - 90° lateral impact
  - 15 and 21 mph
  - 3-year-old Hybrid III dummies in outboard seating positions
- No difference in head containment between European and U.S. child restraints

Side Impact Protection
U.S. vs European CRS

U.S. Child Restraint System
Century (meets FMVSS 213)

European Child Restraint System
Britax (meets ECE Regulation 44)

Side Impact Protection
Grand Am Test Buck — Side View

Side Impact Protection
U.S. Child Restraint System

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Side Impact Protection
European Child Restraint System

Side Impact Protection
Additional Side Impact Testing

- Dynamic sled testing (summer 2001)
  - 20 mph (same as New South Wales Consumer Ratings Program and NHTSA 1974 proposal)
  - 45° and 90° impact orientations
- LATCH seats
- Hybrid III 3-year-old dummy

Side Impact Protection
Side Impact Test with Wall

Proposed Revisions to FMVSS No. 213—Child Restraint Systems

Summary

- Use of dynamic tests
  - Revision of FMVSS No. 213 standard seat assembly and crash pulse to more accurately reflect the design of current passenger motor vehicles
- Use of anthropomorphic test devices
  - Incorporation of most technologically advanced anthropomorphic test devices available, to include 12-month-old CRABI and Hybrid III 3- and 6-year-old dummies
- Apply scaled injury criteria performance levels of adults including neck injury
  - Adoption of scaled injury criteria performance levels similar to FMVSS No. 208, to include neck and chest deflection parameters

Proposed Revisions to FMVSS No. 213—Child Restraint Systems

Summary

- Raise the upper weight limit of the standard from 50 to 80 pounds
  - Upper weight limit of FMVSS No. 213's applicability raised from 50 to 65 pounds
  - Adoption of weighted 6-year-old dummy as a short-term, interim approach for testing child restraints certified for use by children weighing more than 50 pounds
- Improve side and rear head protection
  - ANPRM issued to seek input on possible development of a dynamic side impact test for FMVSS No. 213
  - Near-side crash scenario requires long-term effort