

NHTSA Research on Restraint Performance in Dynamic Rollovers

January 27, 2010

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NHTSA/VRTC



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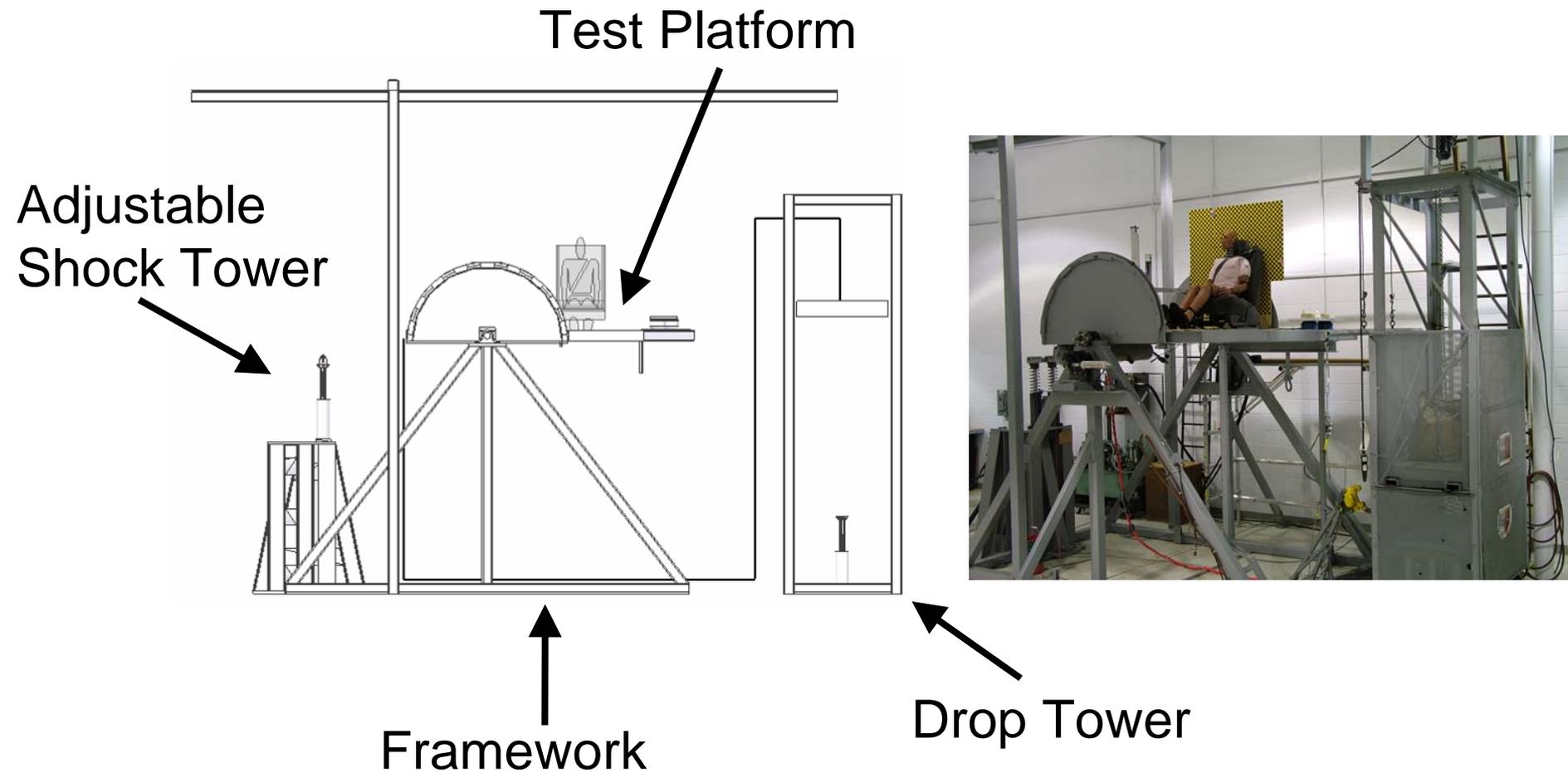


Rollover Restraint Tester (RRT)

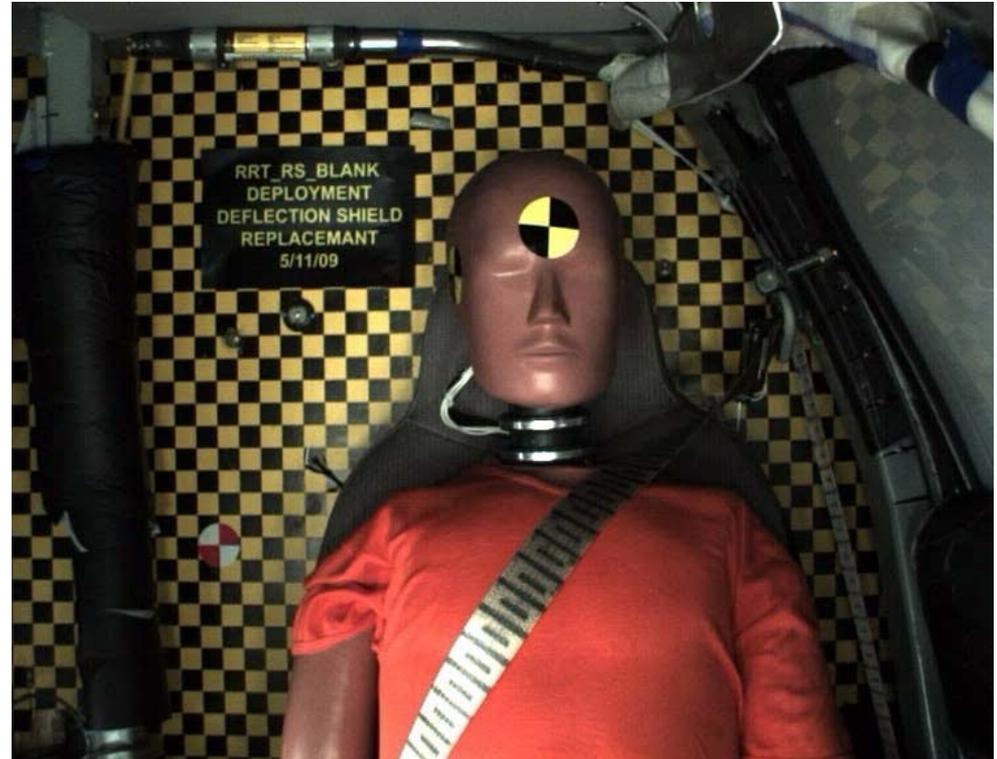
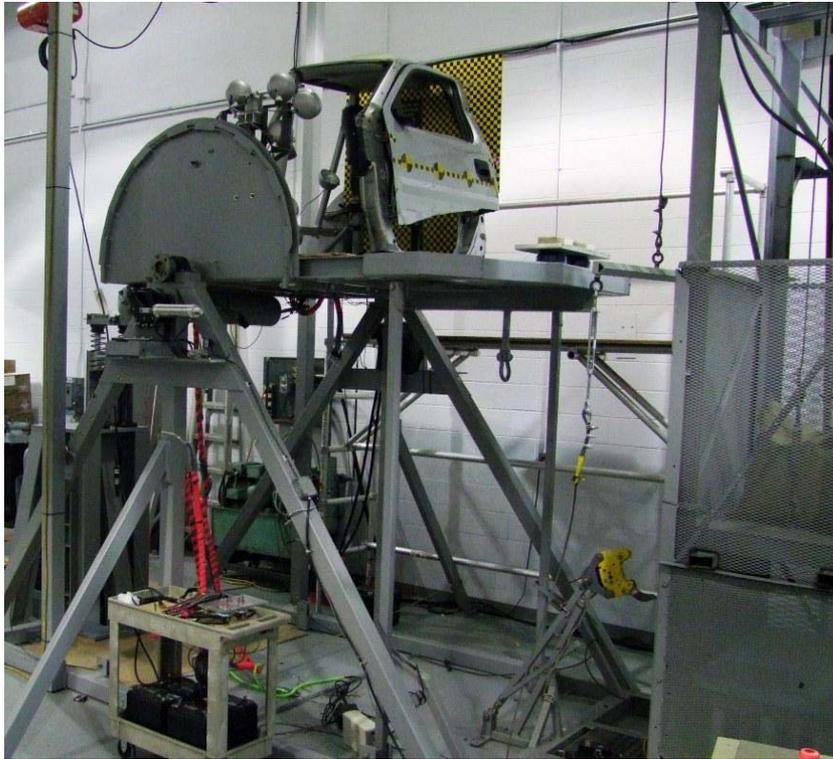
Introduction/Objectives

- Previous NHTSA research found reduced occupant excursion with improved restraint systems.
 - Without reaction surface & air curtain
 - Vertical and lateral
- Evaluate current and prototype restraint systems in a rollover condition with a reaction surface.
 - Using a cab and rollover style curtain
 - Occupant excursion from seat

RRT Test Fixture



Modified Reaction Surface



Fixture Dynamics

- Roll Rate (~308 deg/s at impact)
 - 1990's NHTSA RRT (260 deg/sec)
 - Crash Data (180-360 deg/sec)
 - Dolly (~360 deg/sec)
- Impact Force(~100000 N)
- Shock Deflection (up to 25 cm)
- Acceleration Under Seat (~50 g)
- Lap/Shoulder Belt Forces
- Reaction Surface-
 - 2007 Chevy Silverado 1500 air curtain
 - Repeatable air curtain deployment

Belt Configurations

Non-Integrated 3-point:

Baseline (No Pretension)

Lower D-Ring **C**

Upper D- Ring **D**

Pretensioners

Retractor Pretensioner **E**

Buckle Pretensioner **F**

Retractor & Buckle Pretensioner **G**

Motorized Pretensioner **H**

Motorized & Buckle Pretensioner **I**

Integrated 3-Point:

No Pretensioner **A**

SWAP No Pretensioner **B**

4-Point Belts:

4-Point w/ Pretensioners **J**

4-Point redesign w/Preten **M**

Inflatable Belts:

Inflatable Belt w/Pretensioner **K**

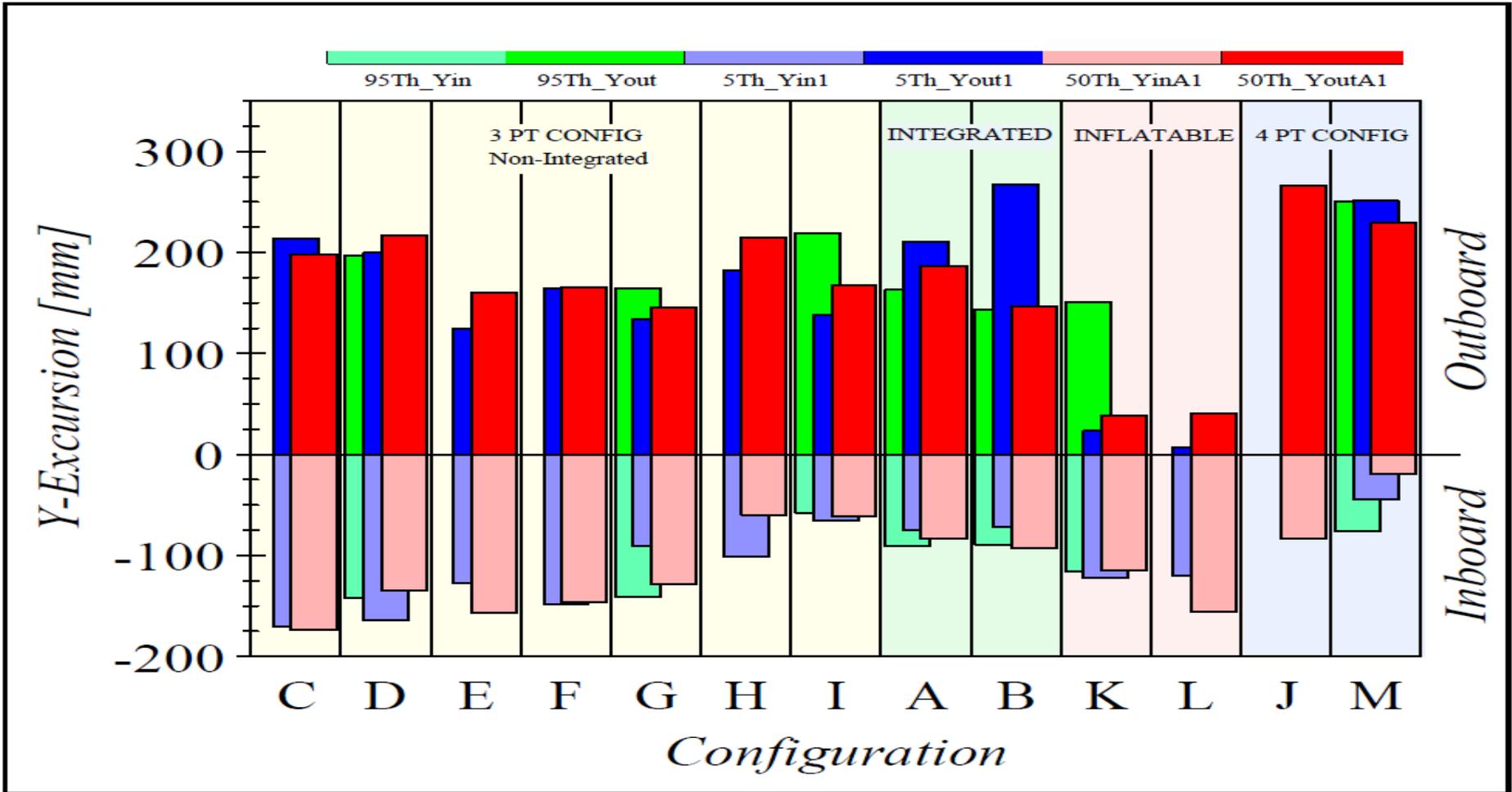
Inflatable Belt (No Pretension) **L**

50th, 5th, 95th Comparison

Lateral Excursions: non-reaction

KEY

- RED- 50th Male
- BLUE-5th Female
- GREEN-95th Male



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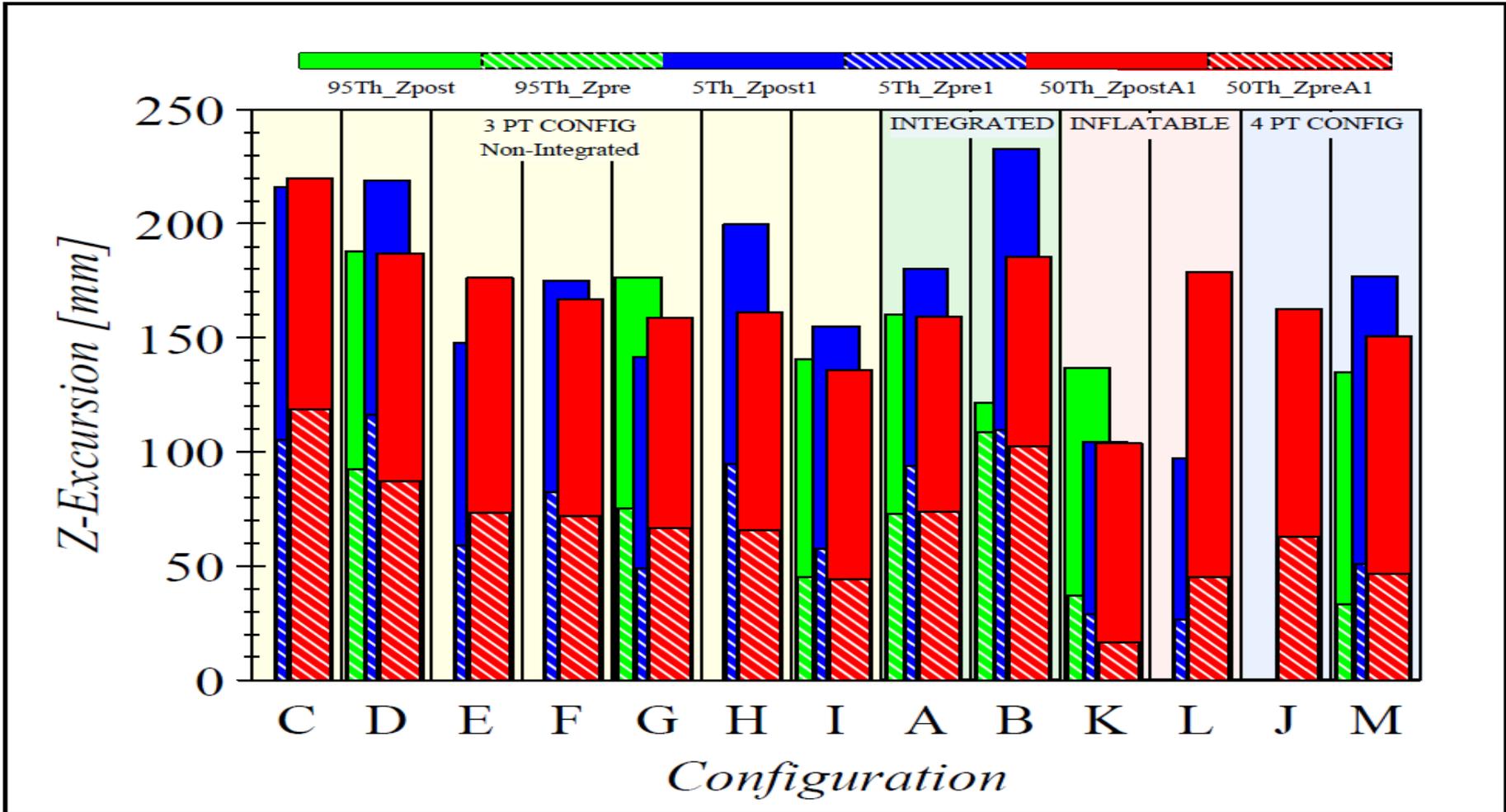
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50th, 5th, 95th Comparison

Vertical Excursions: non-reaction

KEY

- RED**- 50th Male
- BLUE**-5th Female
- GREEN**- 95th Male



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Summary of Non-Reaction Surface Testing on RRT

- Pretensioners and integrated seats reduced lateral and vertical excursions, both pre- and post-impact.
- Motorized retractor pretensioners reduced pre-impact lateral excursions.
- Inflatable belts with pretensioners produced the largest reductions in vertical and outboard lateral excursions.
- 4-point belts reduced vertical and inboard lateral excursions.
- Results did vary with dummy size, but general trends held.

Belt Configurations

Non-Integrated 3-point:

Baseline (No Pretension)

Lower D-Ring **C**

Upper D-Ring **D**

Pretensioners

Retractor Pretensioner **E**

Buckle Pretensioner **F**

Retractor & Buckle Pretensioner **G**

Motorized Pretensioner **H**

Motorized & Buckle Pretensioner **I**

Integrated 3-Point:

No Pretensioner **A**

SWAP No Pretensioner **B**

4-Point Belts:

4-Point w/Pretensioners **J**

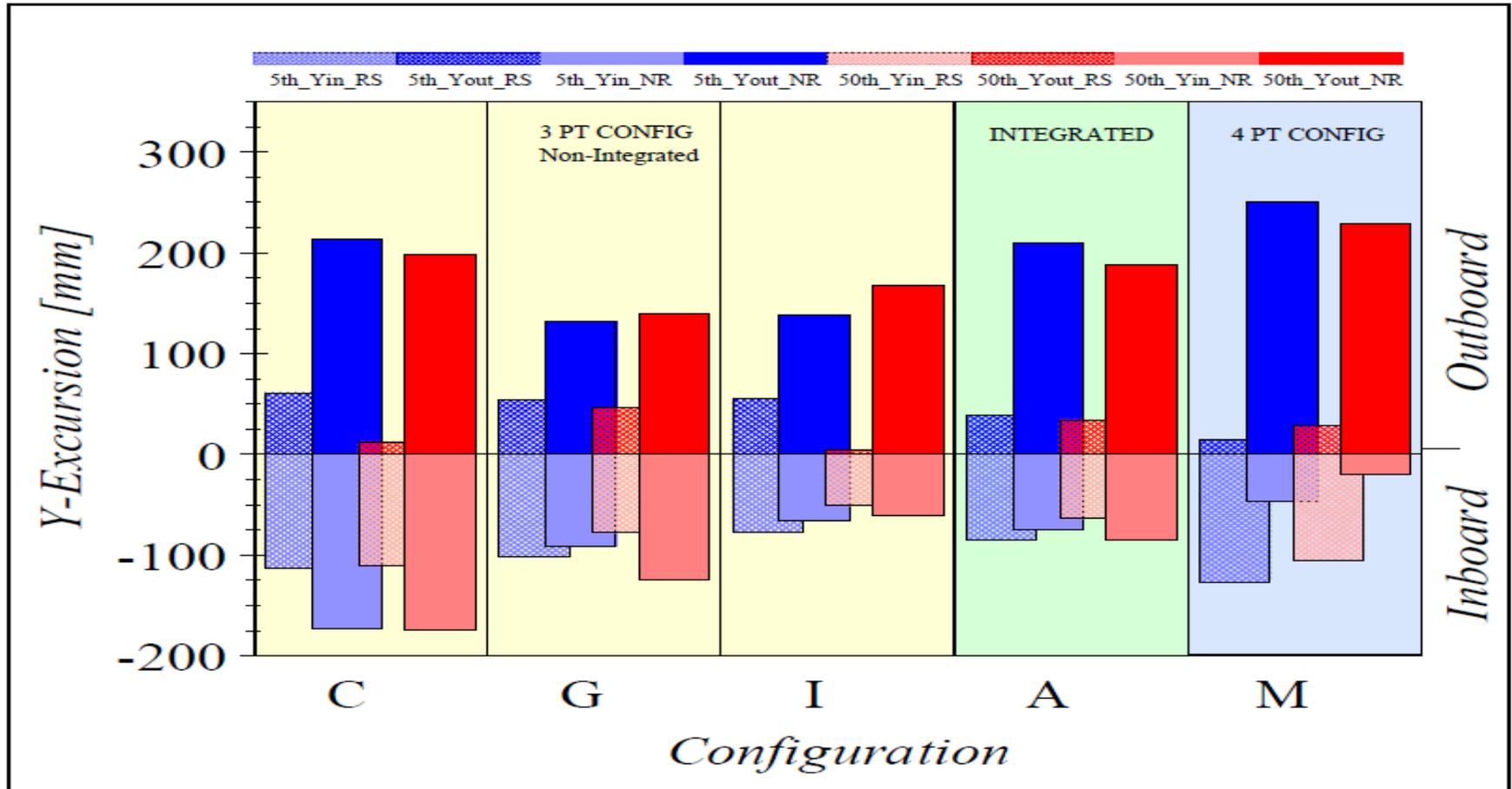
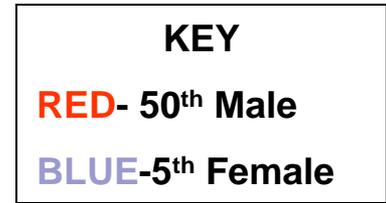
4-Point redesign w/Preten **M**

Inflatable Belts:

Inflatable Belt w/Pretensioner **K**

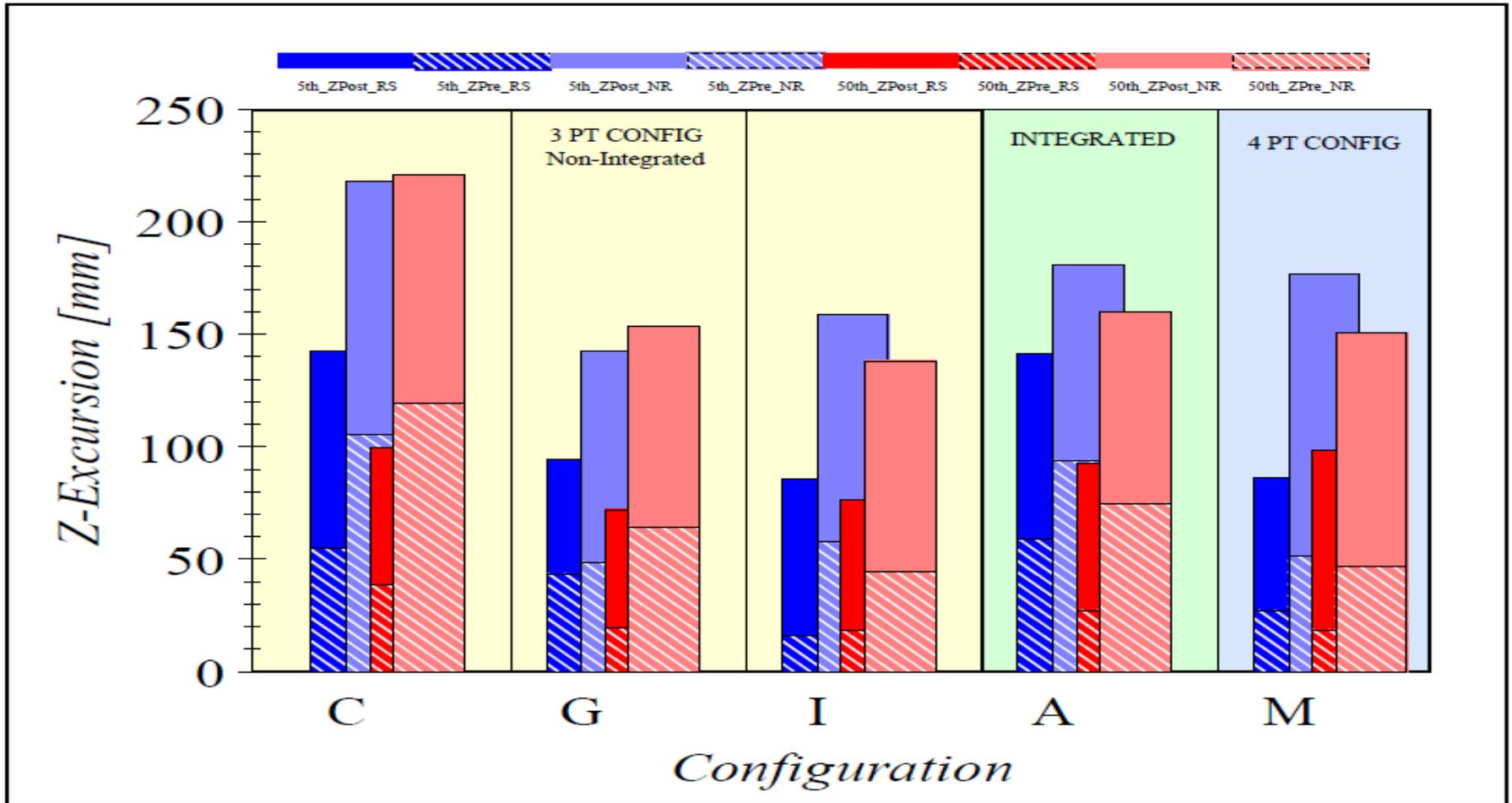
Inflatable Belt (No Pretension) **L**

Reaction vs Non-Reaction Lateral Excursions



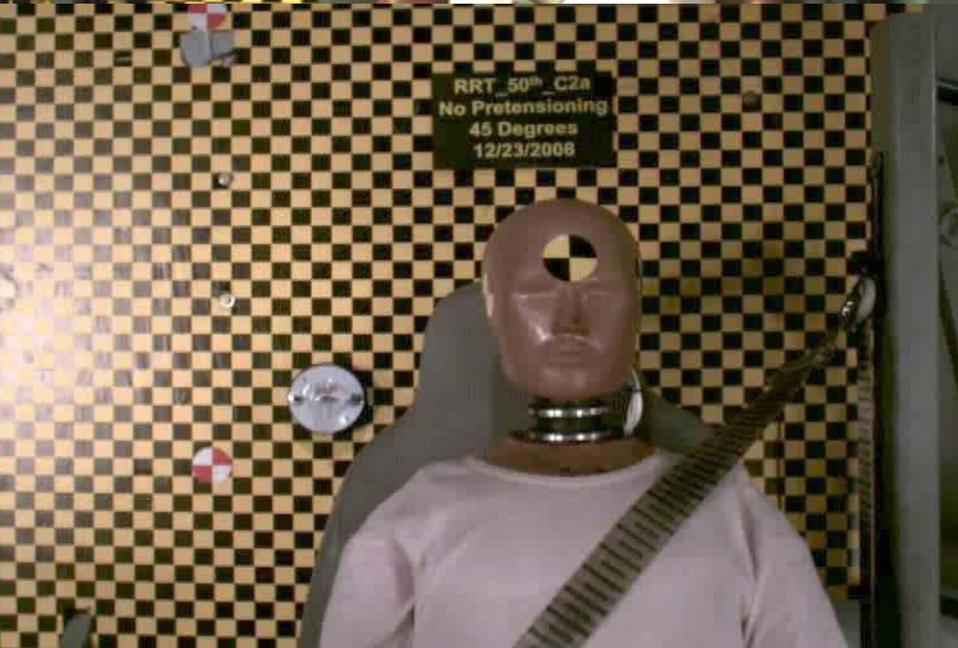
Reaction vs Non-Reaction Vertical Excursions

KEY
RED- 50th Male
BLUE-5th Female



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5th Female Config “C” vs “I” Reaction Surface



Summary of Reaction Surface Testing on RRT

- The air curtain reduces lateral outboard excursions for both sized occupants
 - Differences from belt configurations are relatively small
- The air curtain reduces vertical excursion for both sized occupants and in all belt configurations
- When used with an air curtain and compared to belt configuration “C”:
 - Configurations “G” and “I” reduced excursions for both sized occupants
 - Configuration “M” reduced excursion for the 5th female

Full-Scale Dynamic Rollover Tests

■ Goals

- Identify the dynamics and belted occupant kinematics in various rollover scenarios
- Assess what dynamics and belted occupant kinematics should be considered when evaluating restraint performance in rollovers
- Compare performance of restraints to that from RRT tests

Test Matrix

Test Type	Config C 3-PT Belt	Config I Motorized Retractor & Buckle Pretens.	Config G Retractor & Buckle Pretens.	Config A Integrated Belt	Air Curtain?
FMVSS 208 Dolly #1	1, 2				NO
FMVSS 208 Dolly #2	3	1, 2			NO
FMVSS 208 Dolly #3			3	1, 2	NO
FMVSS 208 Dolly #4		1, 2	3		YES
Corkscrew Ramp	1, 2, 3				YES
Corkscrew Ramp		1, 2	3		YES
Soil Trip	1, 2, 3				YES
Soil Trip		1, 2	3		YES
Curb Trip	1, 2, 3				YES
Curb Trip		1, 2	3		YES

1 – Front Occupant, Trailing Side

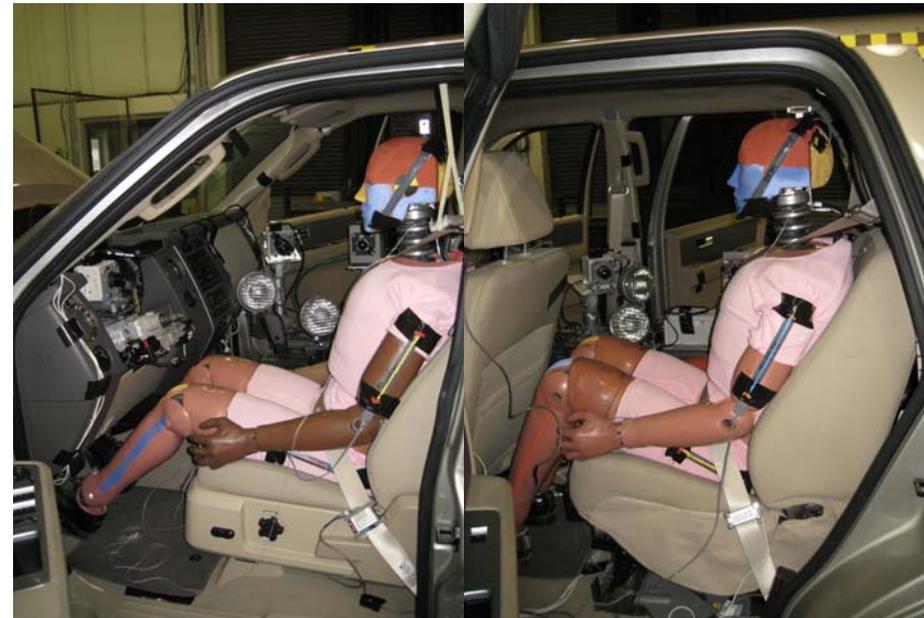
2 – Rear Occupant, Trailing Side

3 – Front Occupant, Leading Side



Test Set-Up

- Vehicle: **2007 Ford Expedition**
 - Replaced rear seat with a front seat
 - Allow front-to-rear comparison
 - Hybrid-III 50th male dummies
- Restraints chosen based on performance on RRT and availability
 - Config. C - 3PT
 - Config. G - Buckle & Retract. Pretensioner
 - Config. A - 3PT Integrated Belt
 - Config. I - Motor. Retract. & Buckle Pretensioner



For additional inquiries, contact

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Thank You!



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