

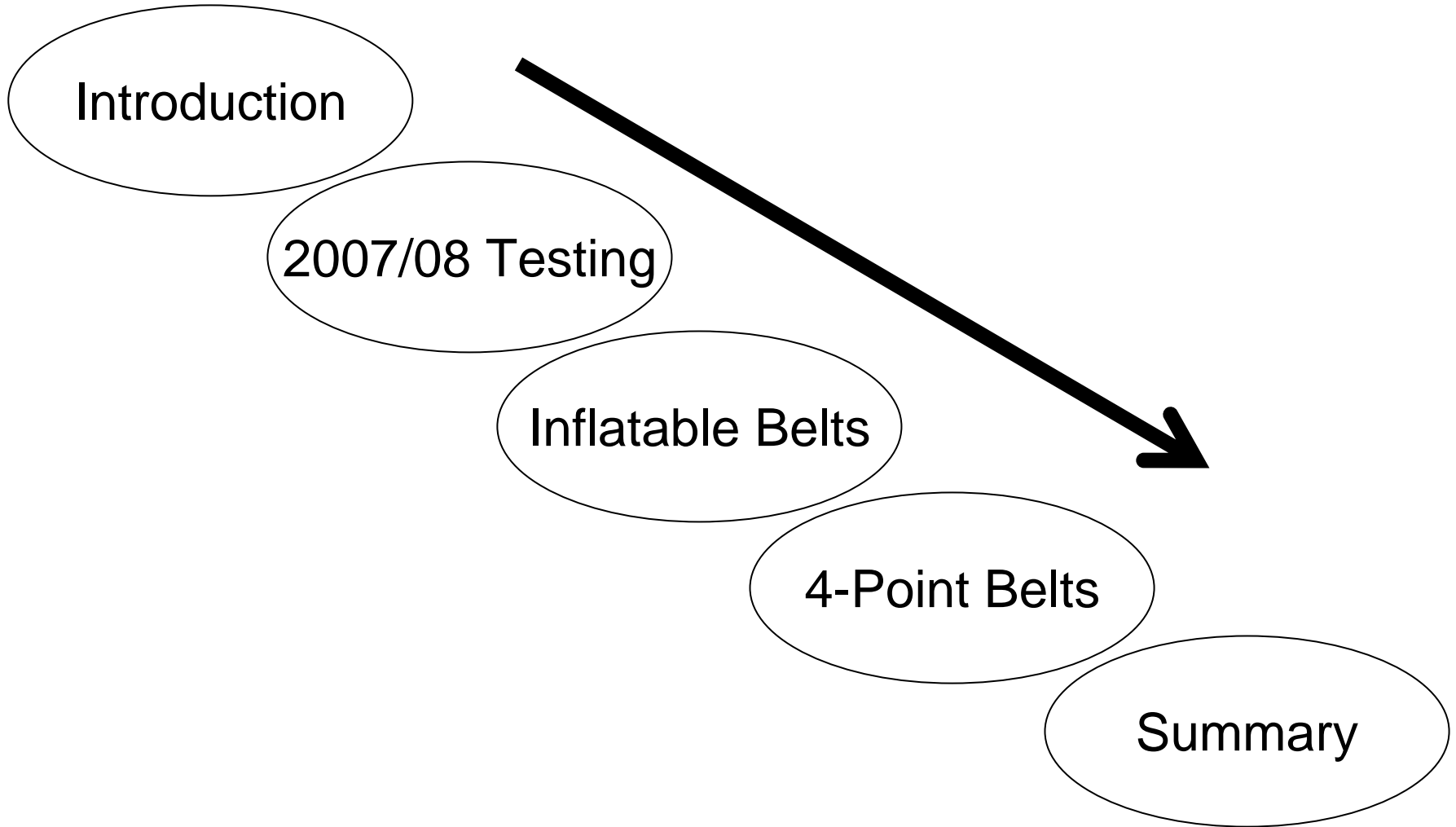
NHTSA Research on Improved Restraints in Rollovers

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Transportation Research Center, Inc.

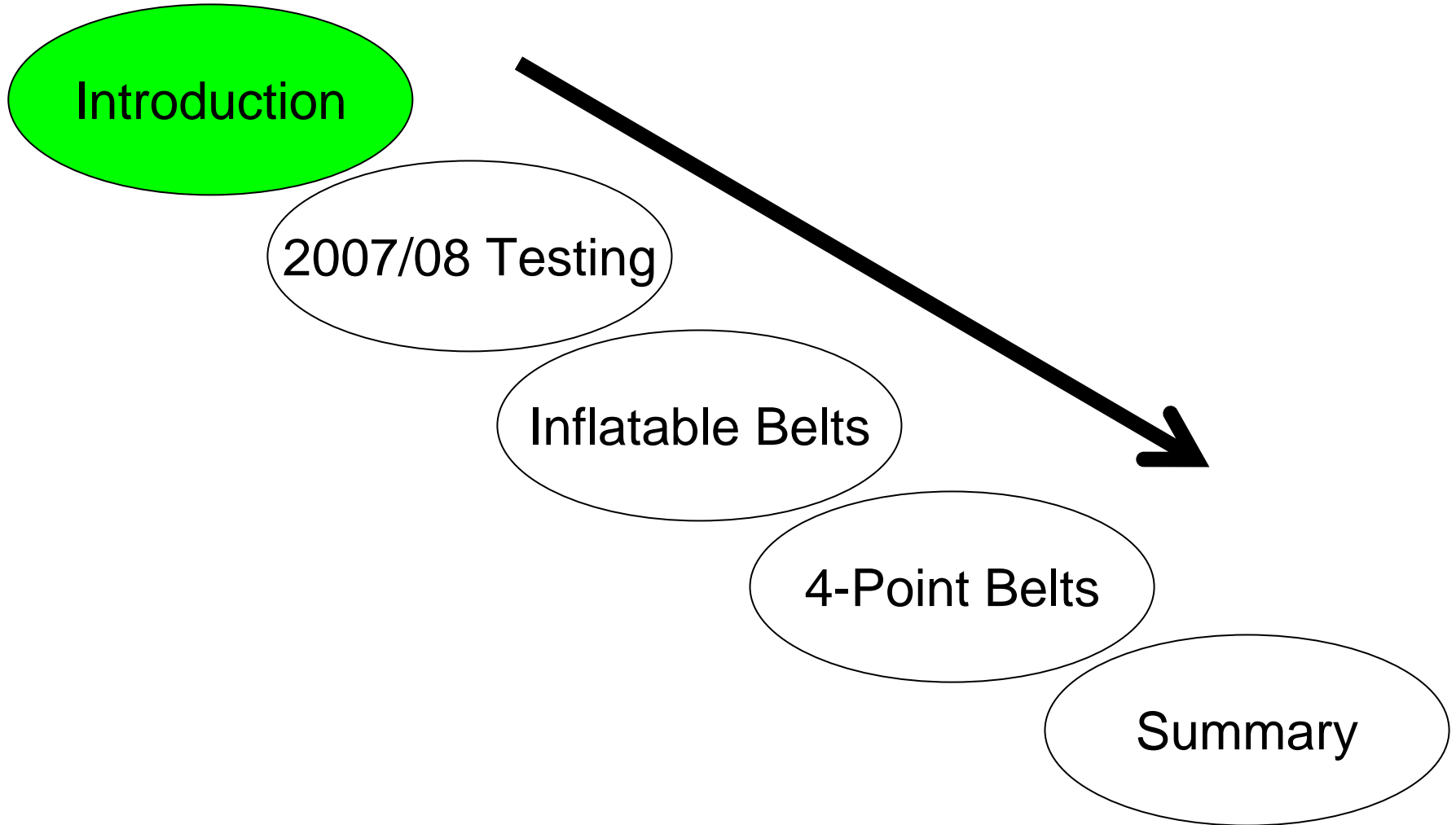
SAE Government/Industry Meeting
13 May 2008
Session G13: Rollover



Presentation Overview



Introduction



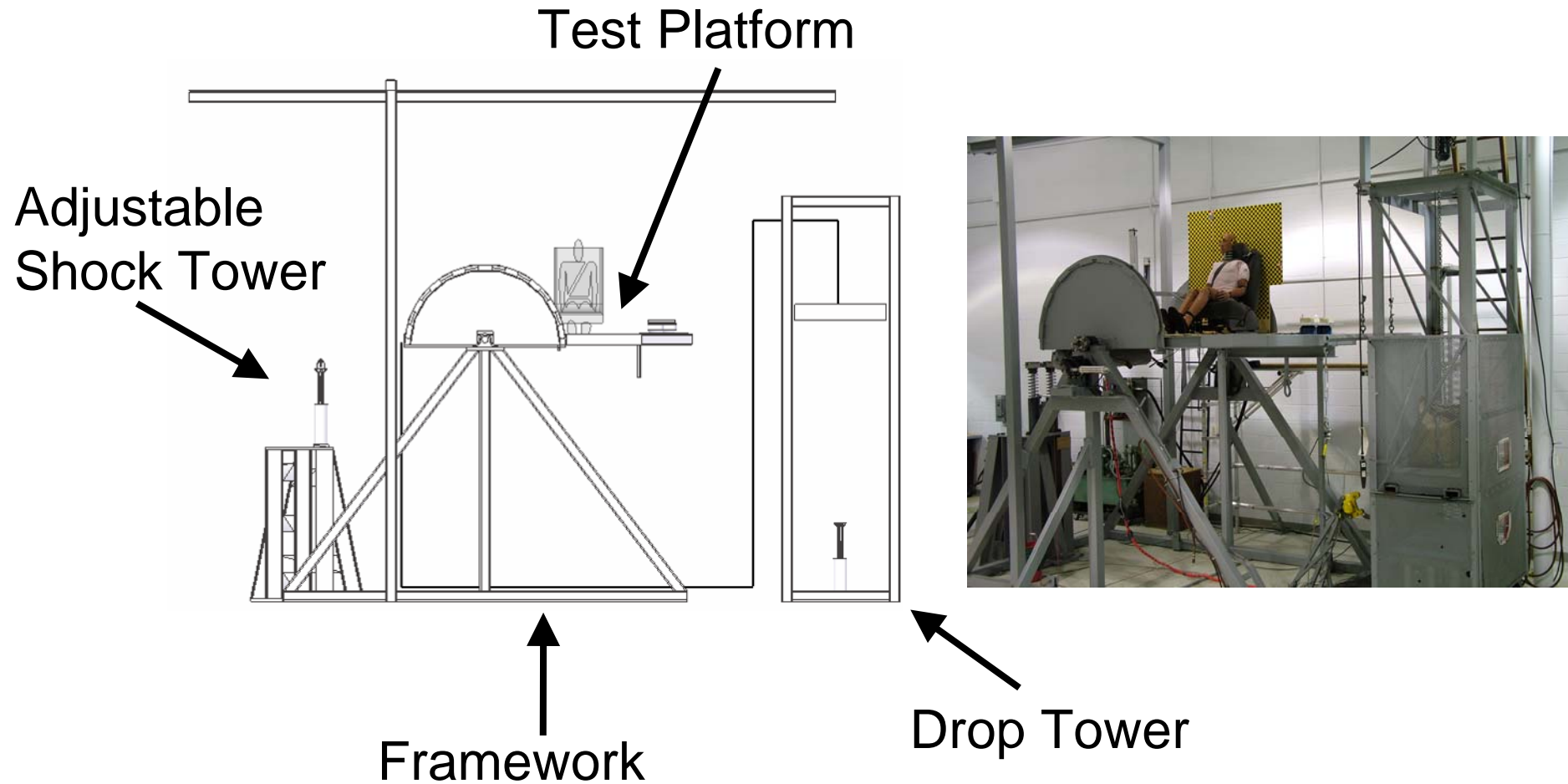
Introduction

- Reducing Roof Crush alone will not eliminate occupant contact with roof.
- Previous NHTSA (mid-1990's) research found reduced occupant excursion with improved restraint systems in rollover conditions.
- Few studies looking at improved restraint system effectiveness for rollover accident conditions exist.

Objective

- Evaluate the current state-of-the-art restraint systems in a rollover condition.
- Examine *Occupant Head Excursion* of various restraint configurations.
- Build research data for aiding in the potential test procedure development for assessing restraint effectiveness.

RRT Test Fixture



Introduction

RRT Overview Video



Fixture Dynamics

- **Roll Rate** (Goal: 315 deg/s at impact)
- **Impact Force** (~100000 N)
- **Shock Deflection** (up to 25 cm)
- **Acceleration Under Seat** (~50 g)
- **Lap Belt Force**
- **Shoulder Belt Force**

Base 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**

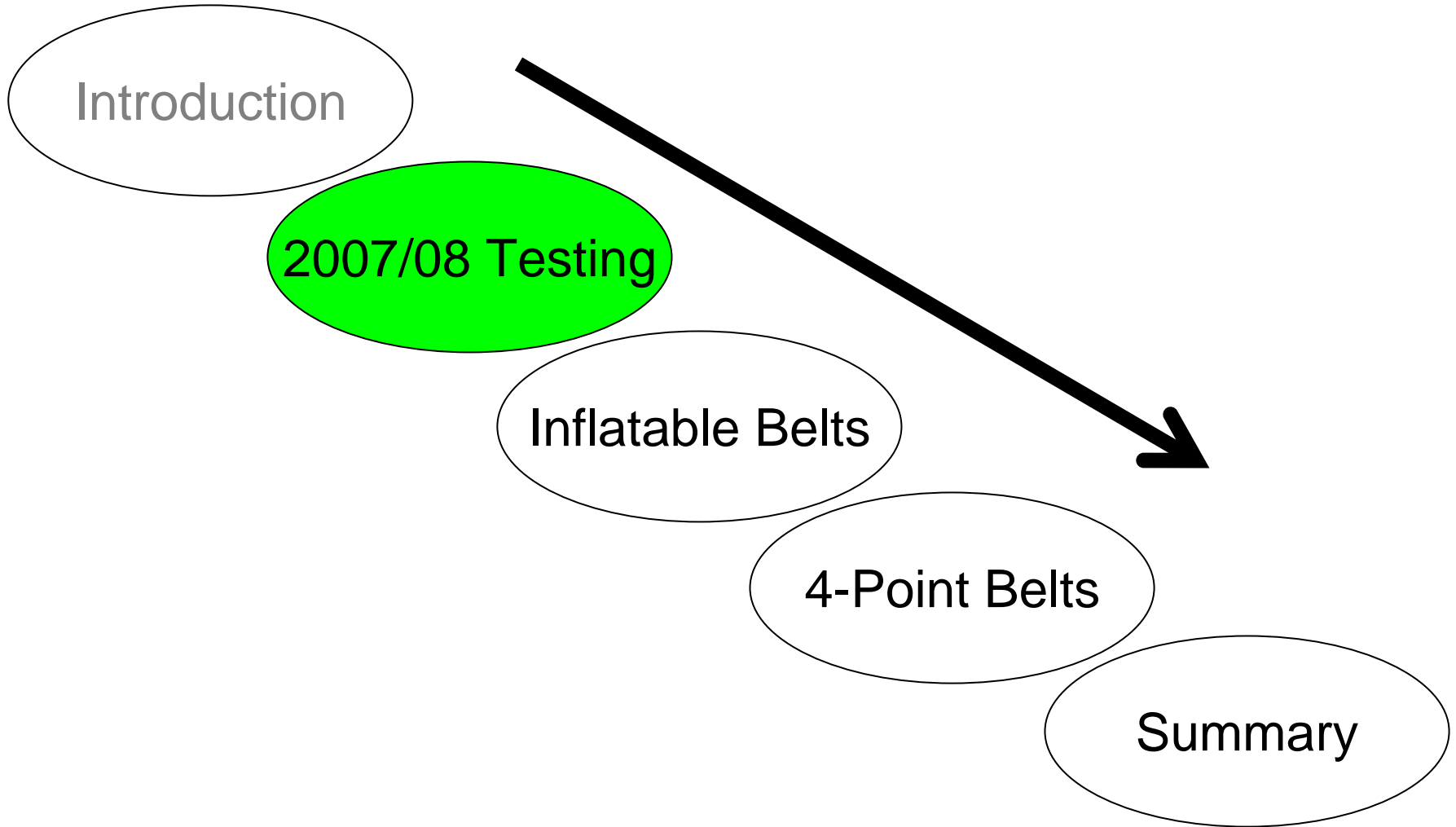
4-Point redesign w/Preten **M**

Inflatable Belts:

Inflatable Belt w/Pretensioner **K**

Inflatable Belt (No Pretension) **L**

2007/08 Testing



Base Configurations

Non-Integrated 3-point:

Baseline (No Pretension)

Lower D-Ring **C**

Upper D- Ring **D**

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95th Test Matrix

Non-Integrated 3-point:

Baseline (No Pretension)

Upper D- Ring **D**

Pretensioners

Retractor & Buckle Pretensioner **G**

Motorized & Buckle Pretensioner **I**

Integrated 3-Point:

No Pretensioner **A**

SWAP No Pretensioner **B**

4-Point Belts:

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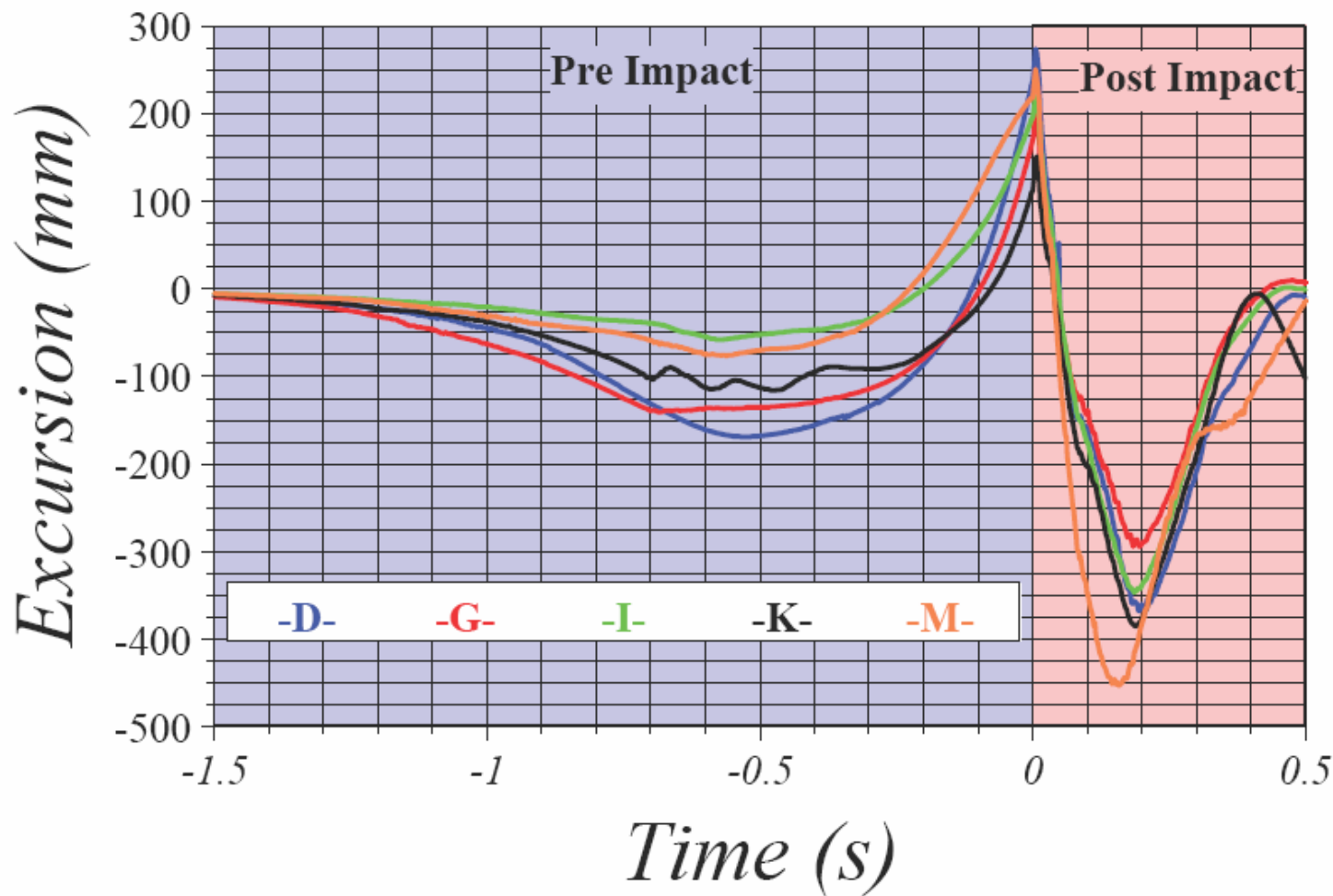
Inflatable Belts:

Inflatable Belt w/Pretensioner **K**

95th Male Average Plots

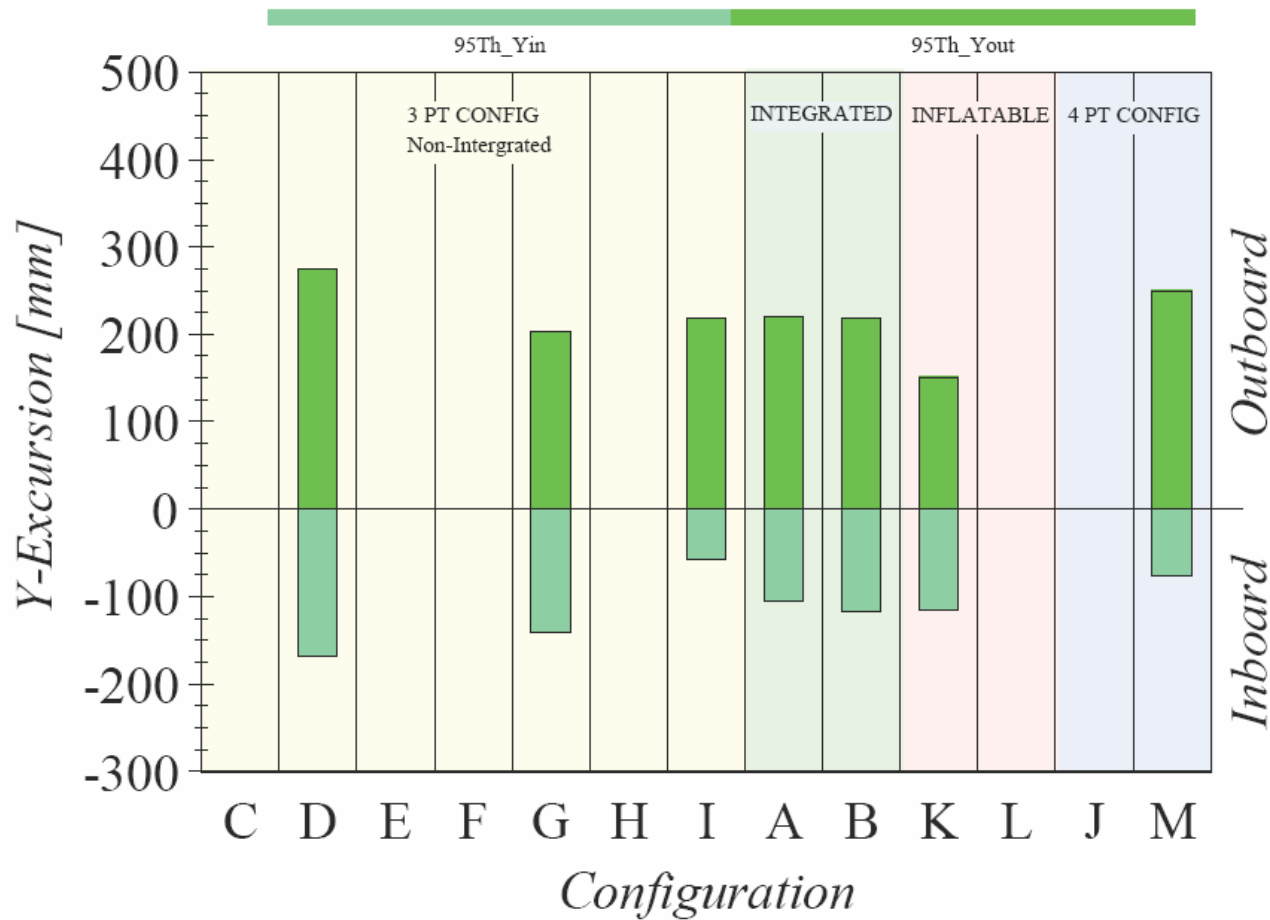
Y-Excursion

Testing



95th Male Average Y-Excursion

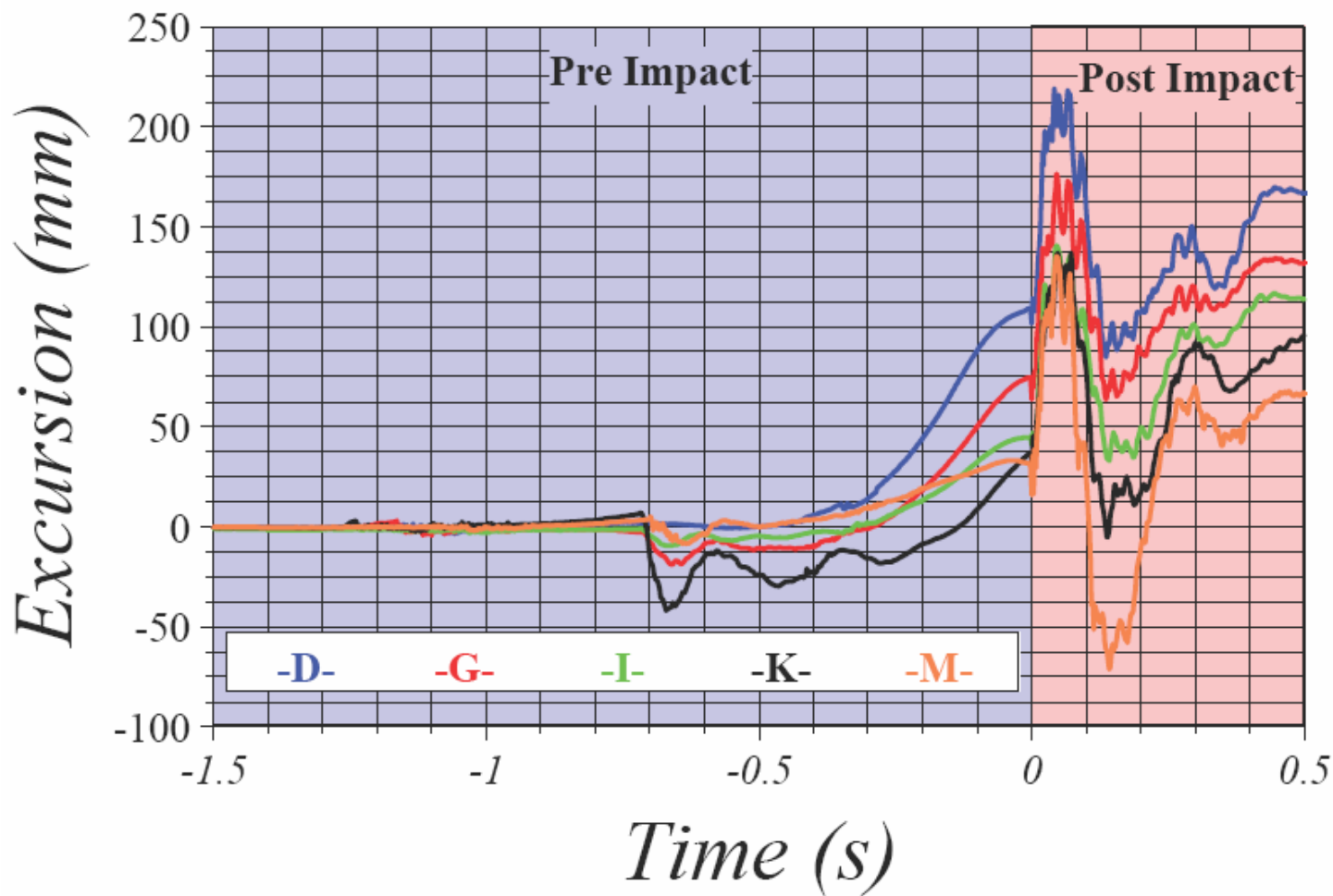
Testing



95th Male Average Plots

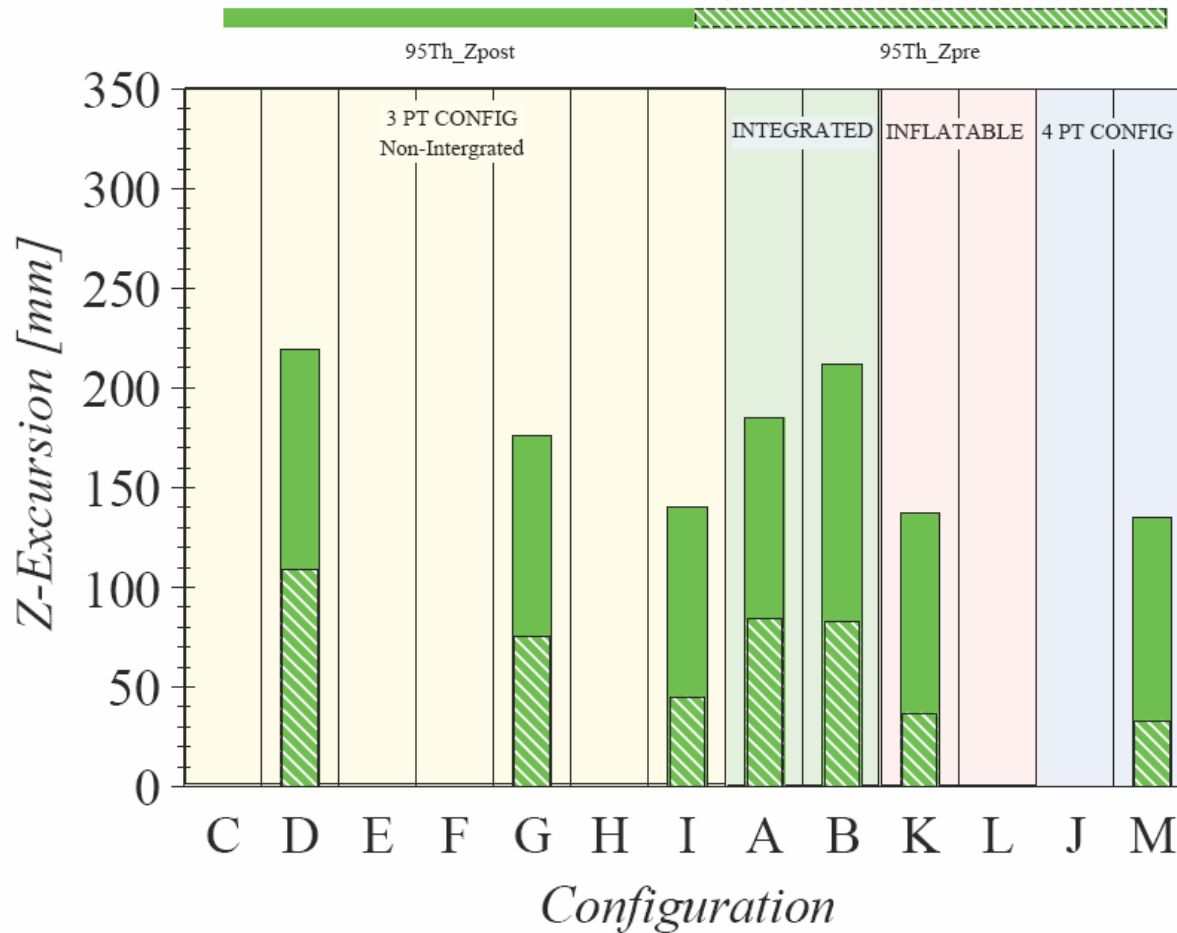
Z-Excursion

Testing



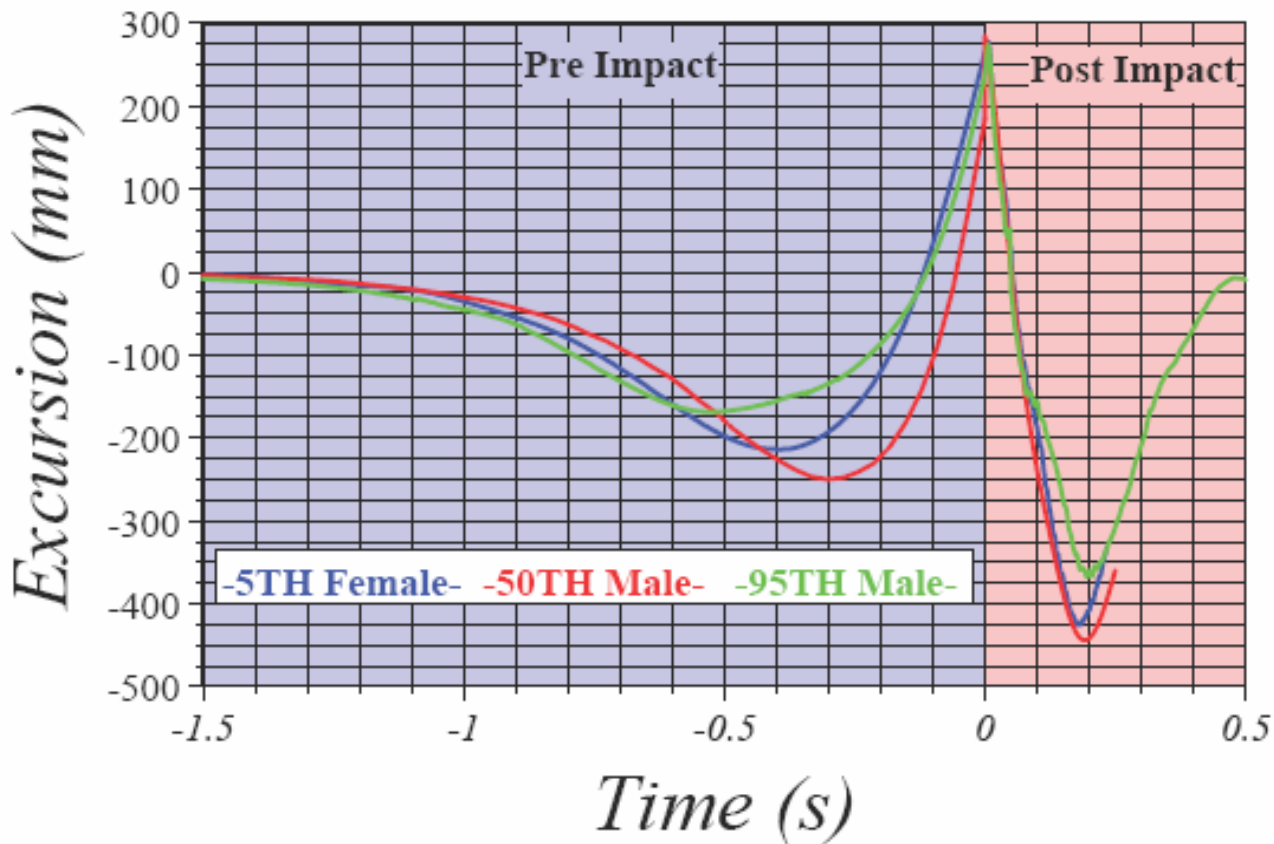
95th Male Average Z-Excursion

Testing



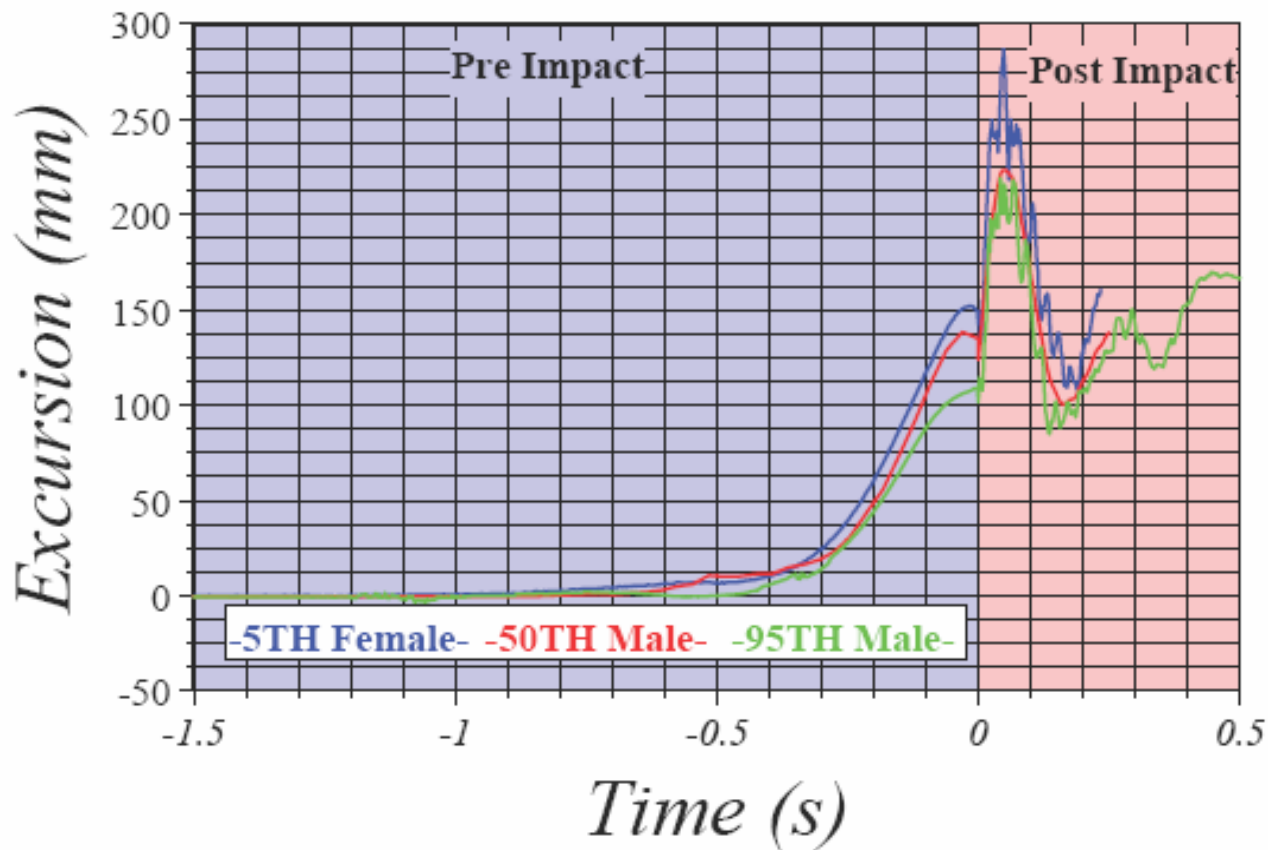
5th, 50th, & 95th Comparison Baseline (D)

No Pretensioning Y-Direction



5th, 50th, & 95th Comparison Baseline (D)

No Pretensioning Z-Direction

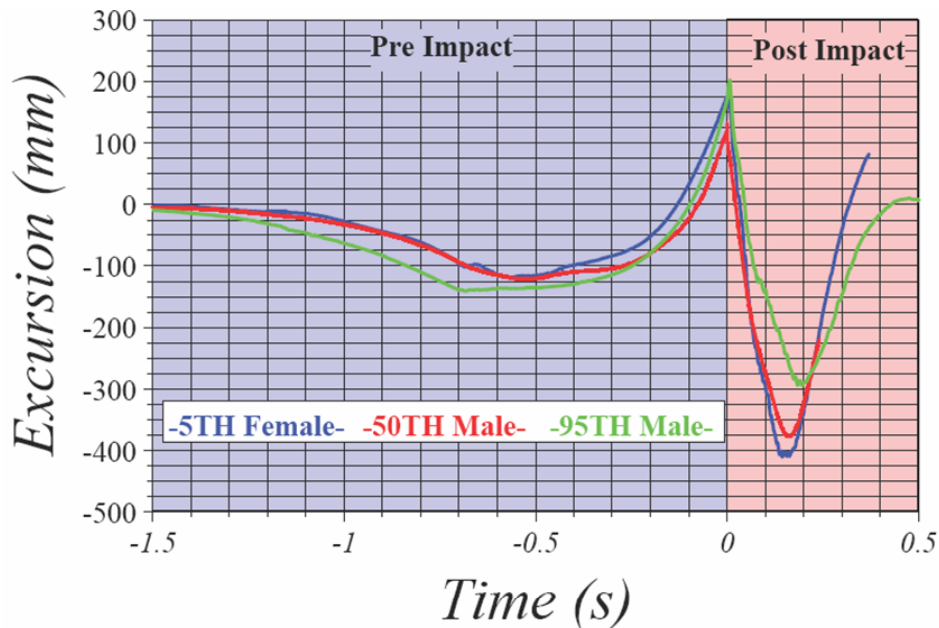


Testing

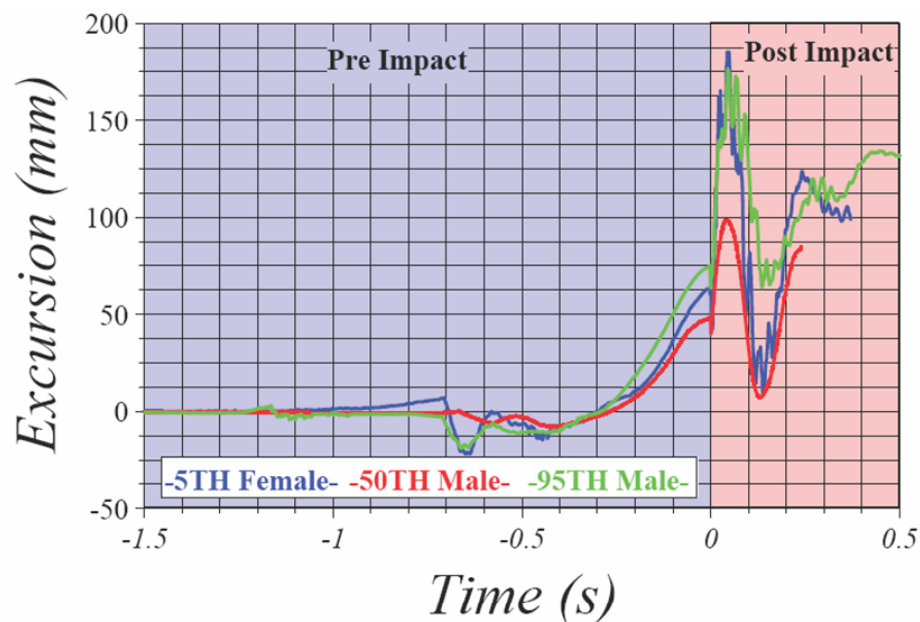
5th, 50th, & 95th Comparison Configuration G

Retractor and Buckle Pyrotechnic Pretensioners

Y-Direction



Z-Direction

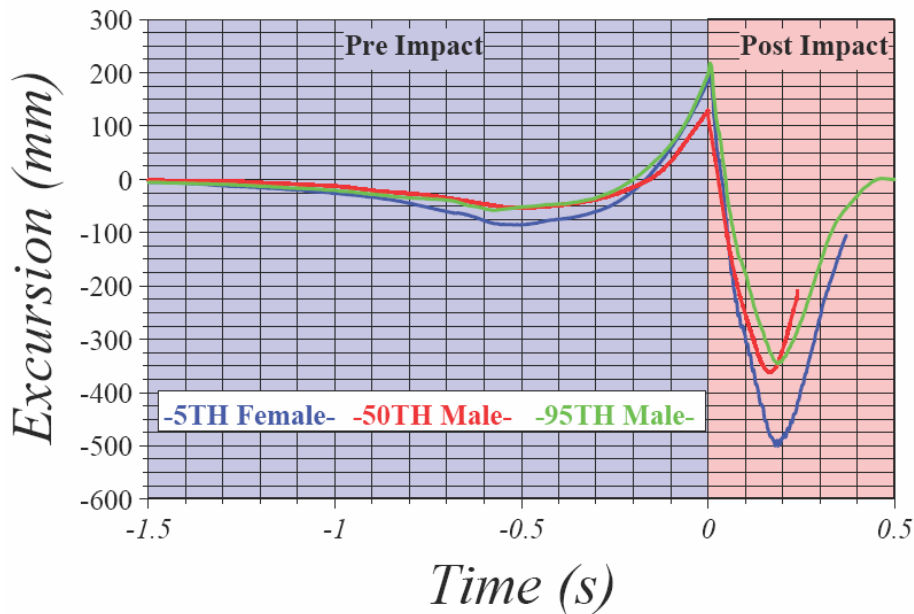


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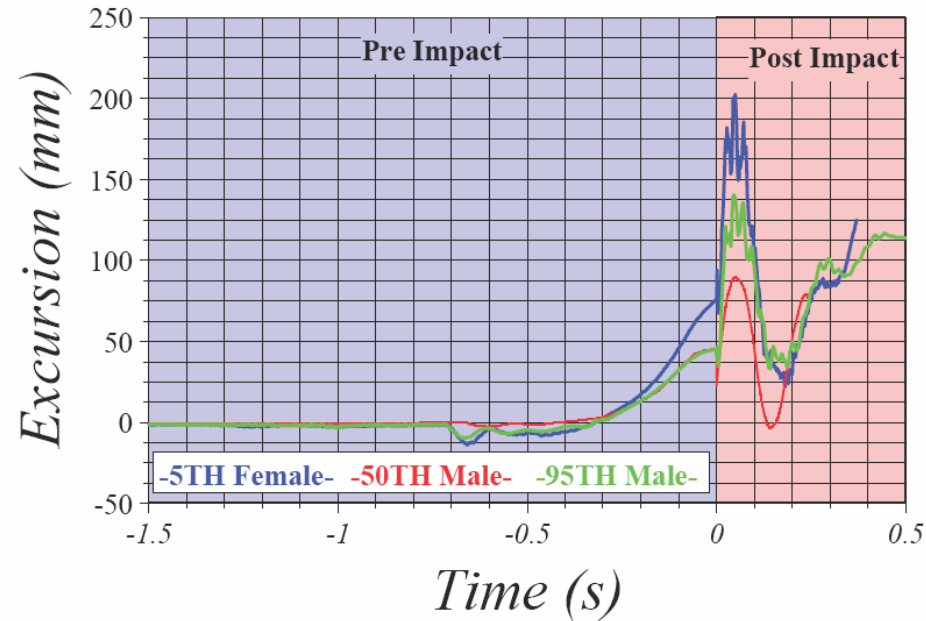
5th, 50th, & 95th Comparison Configuration I

Motorized Retractor and Pyrotechnic Buckle Pretensioners

Y-Direction

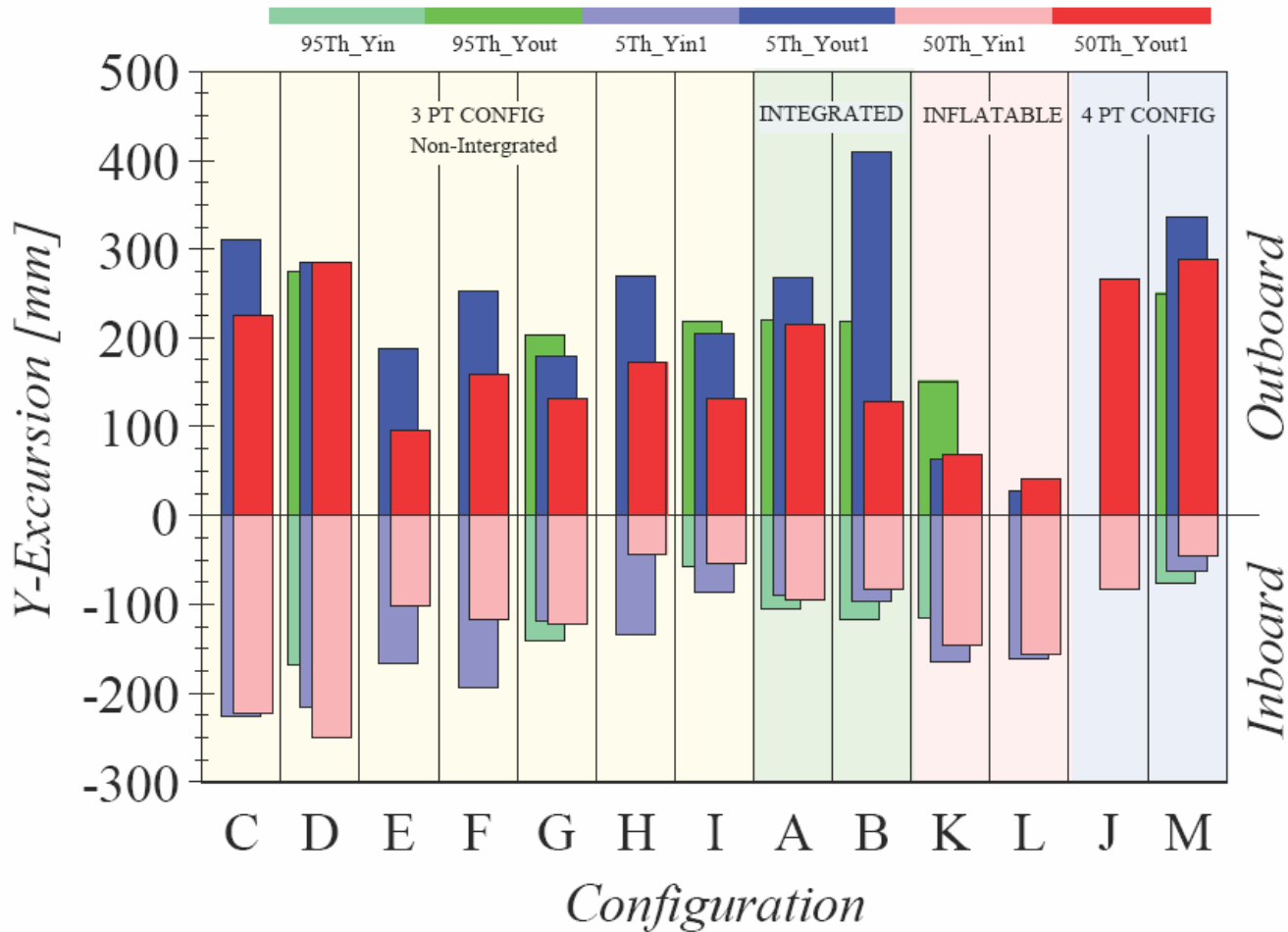


Z-Direction



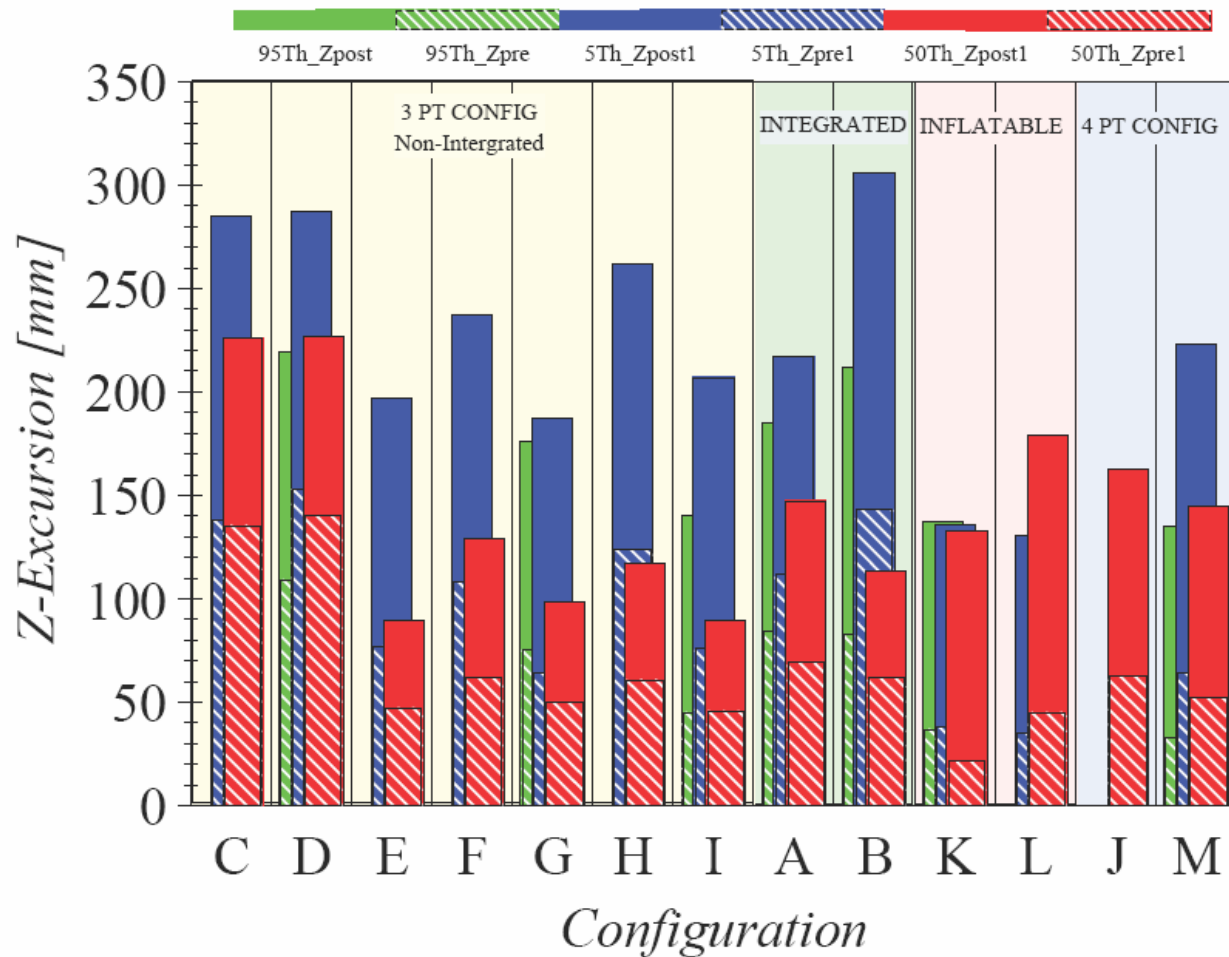
50th, 5th, 95th Comparison Y-Excursion

Testing

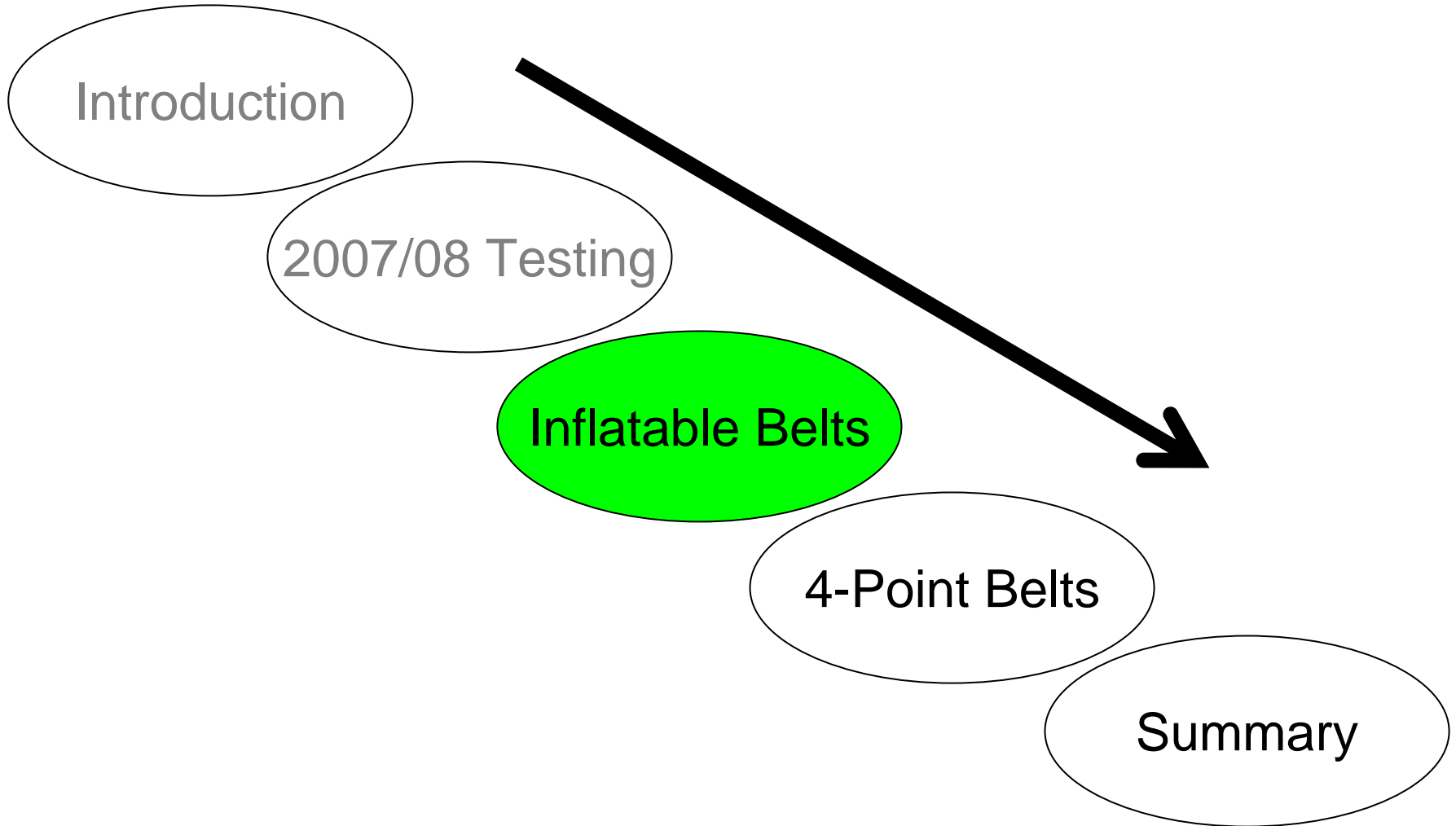


50th, 5th, 95th Comparison Z-Excursion

Testing



Inflatable Belts



Inflatable

95th Male Configuration K



**95th Male directly
prior to inflation**



**95th Male directly
after inflation**

5th, 50th, & 95th Configuration K

Inflatable



50th Male



5th Female



95th Male

Inflatable

5th Female Configuration K vs C



**5th Female
Inflatable Belt (K)**

**5th Female
Baseline (C)**

95th Male vs 5th Female Configuration K

Inflatable



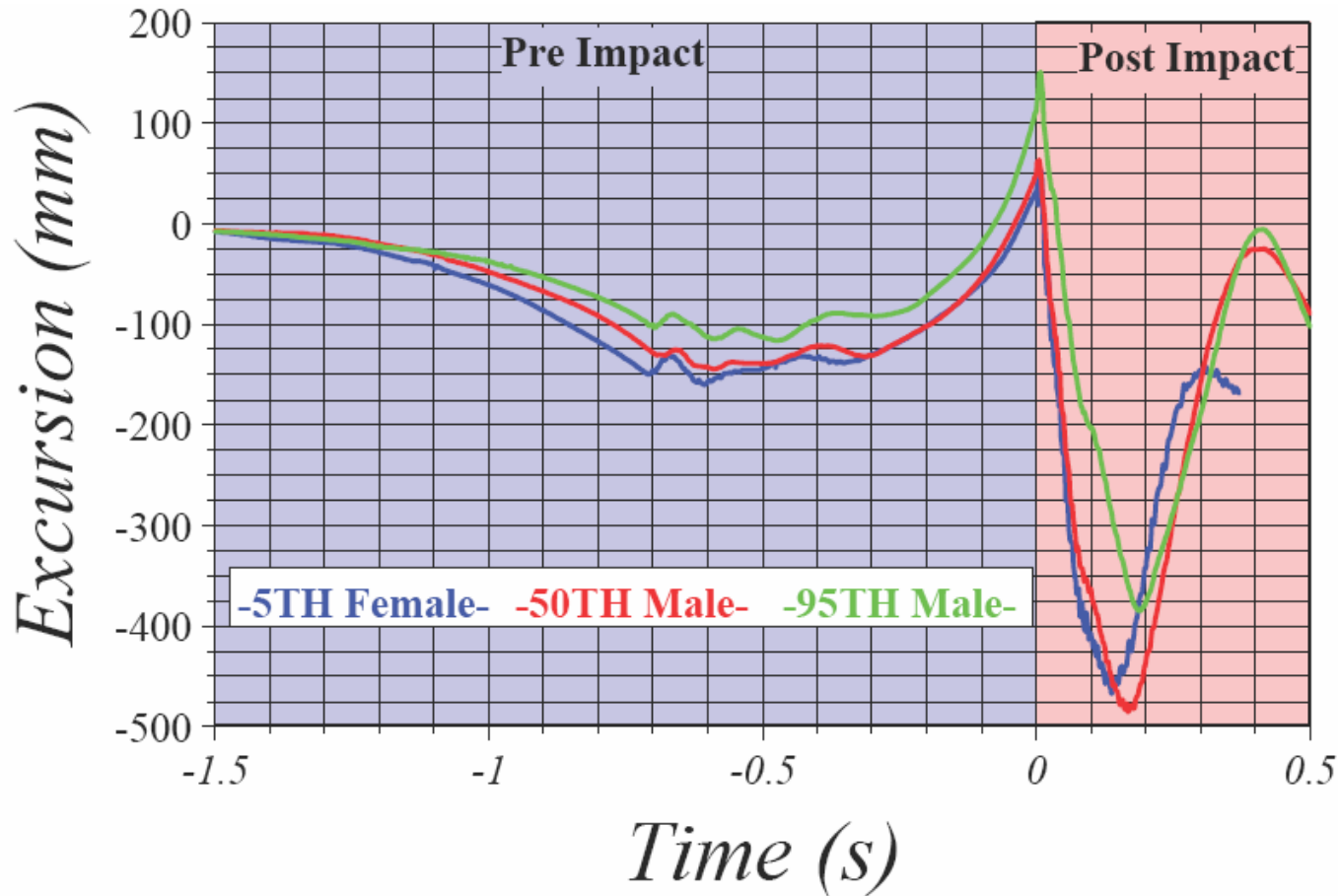
**5th Female
Inflatable Belt (K)**

**95th Male
Inflatable Belt (K)**

50th, 5th, 95th Comparison Configuration K

Inflatable

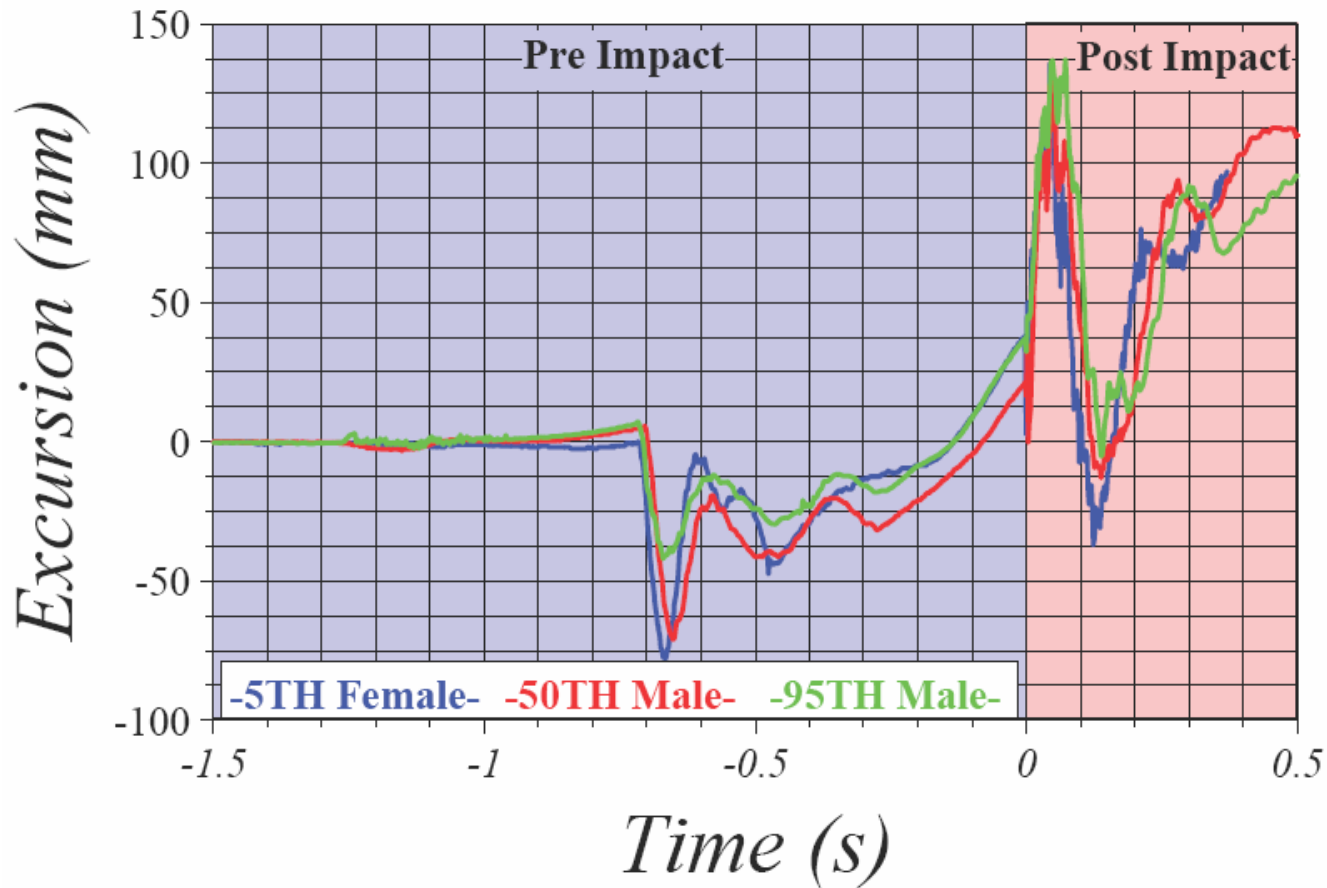
Y-Direction



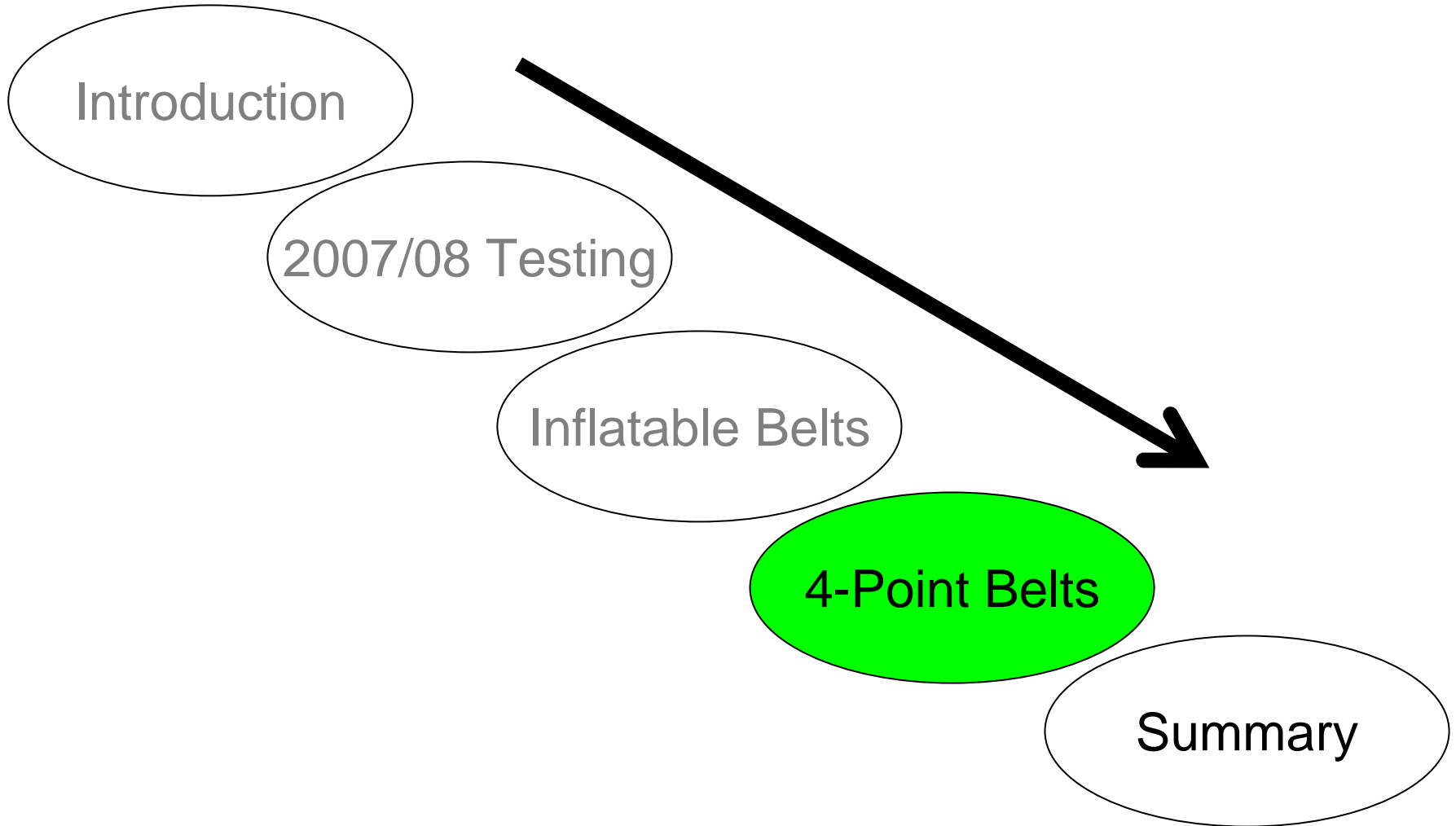
50th, 5th, 95th Comparison Configuration K

Inflatable

Z-Direction



4-Point Belts

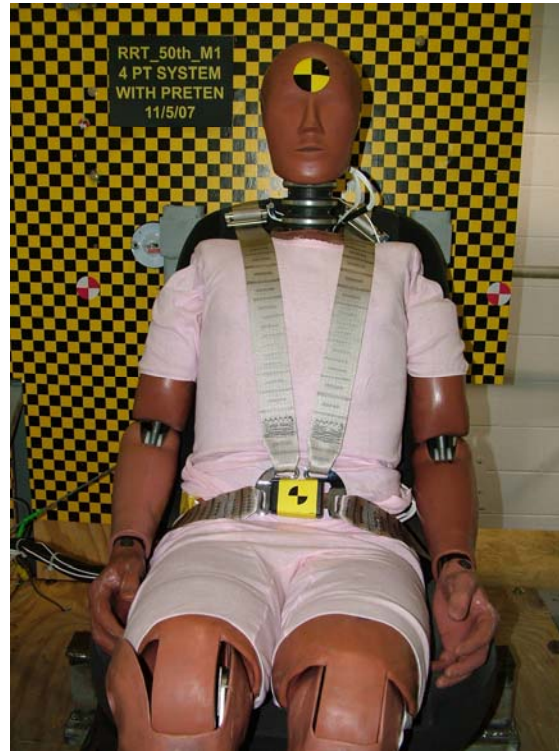


50th, 5th, 95th Comparison Configuration M

4-Point



5th Female



50th Male



95th Male

5th Female vs. 95th Male Configuration M

4-Point



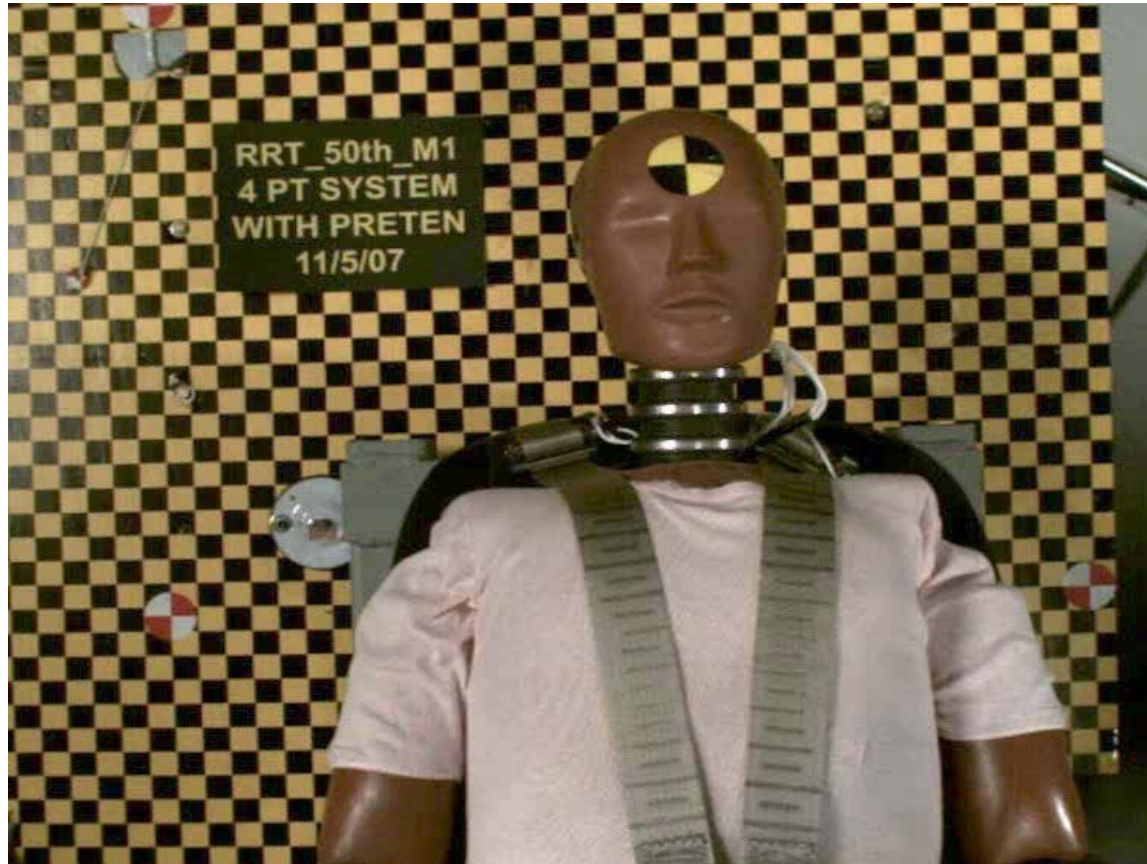
**5th Female
Video**



**95th Male
Video**

4-Point

50th Male Configuration M



50th Male

4-Point

5th Female Configuration M vs. C 5th Female



M

4-point

W/Pretensioning



C

Baseline

No Pretensioner

4-Point

5th Female Configuration M vs. I



I

**Motorized Retractor
W/Buckle Pretensioner**

M

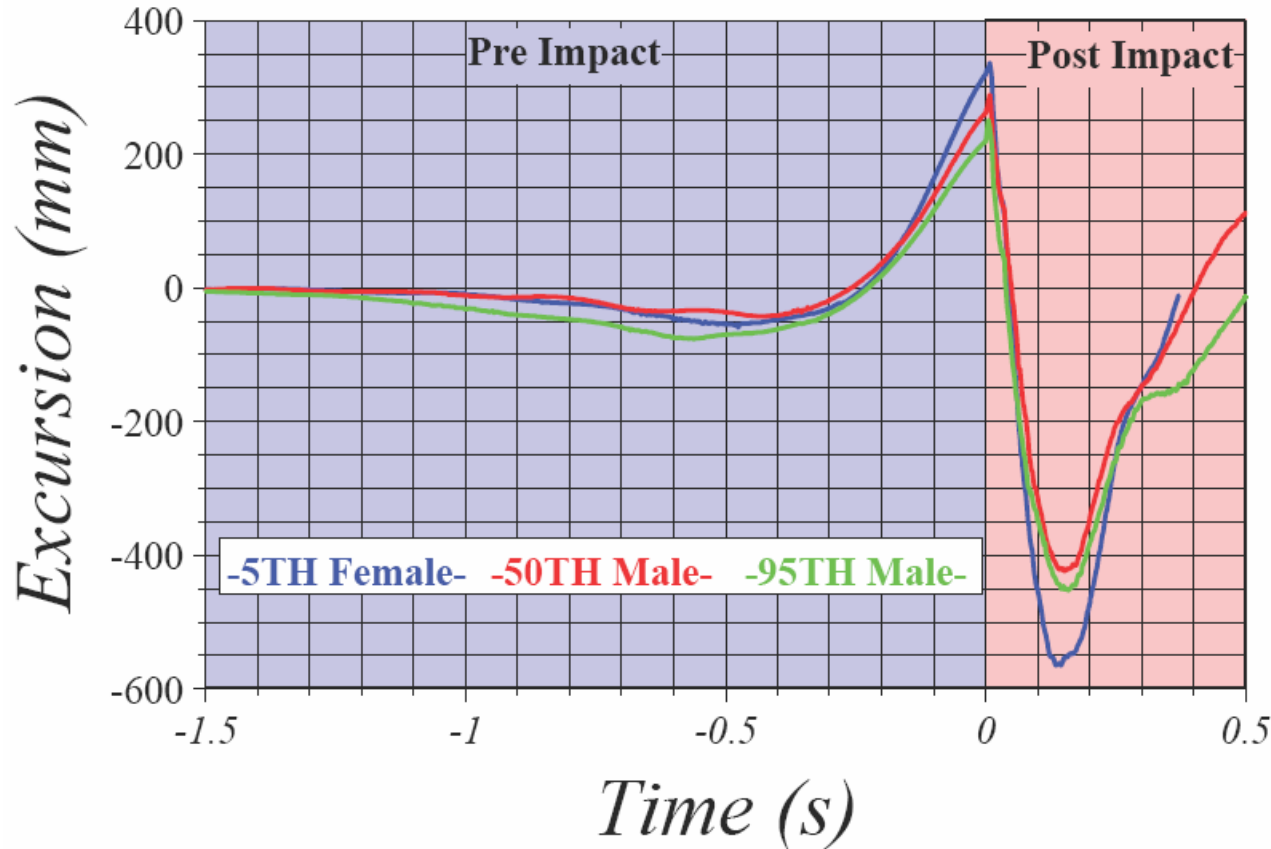
**4-point
W/Pretensioning**

50th, 5th, 95th Comparison

4-Point

Configuration M

Y-Direction

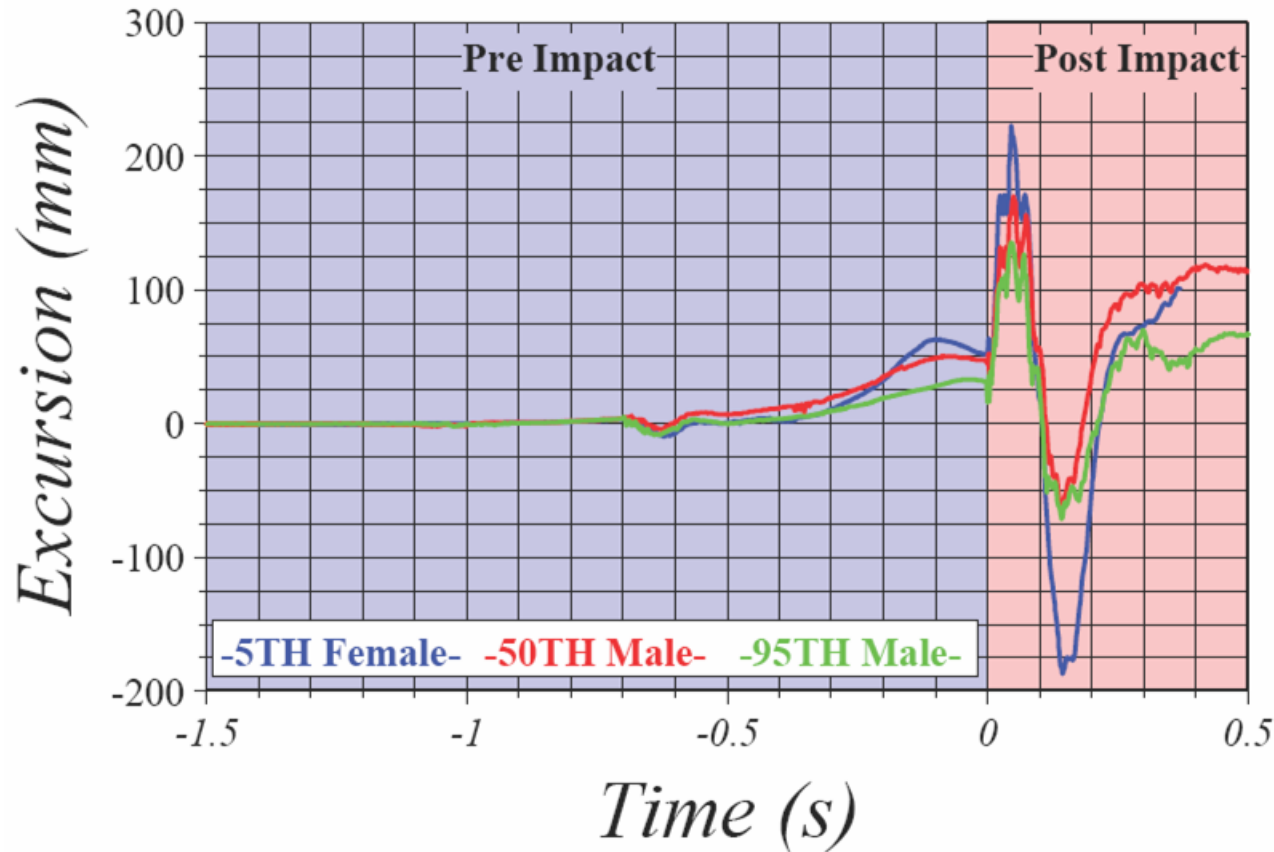


50th, 5th, 95th Comparison

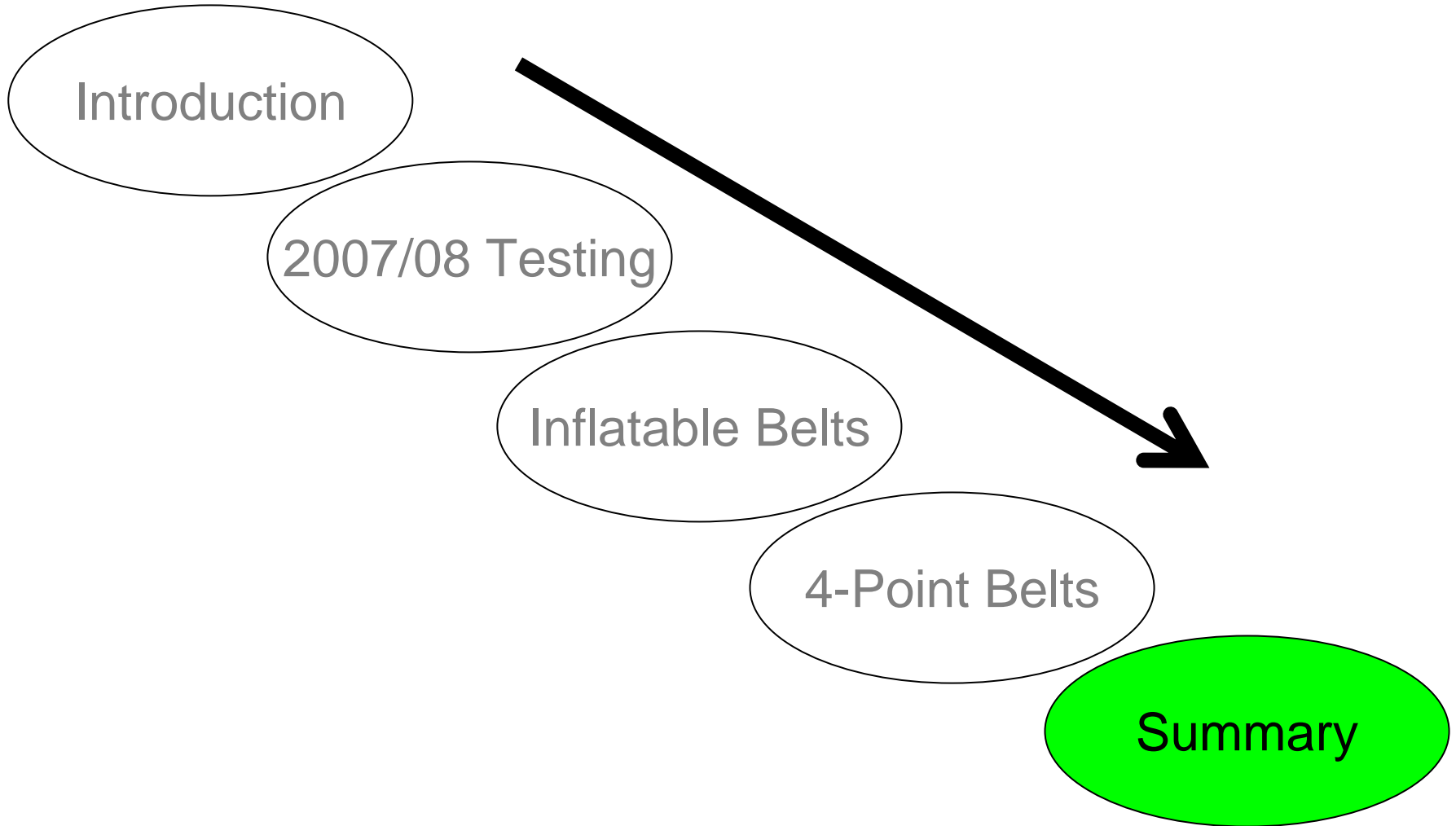
4-Point

Configuration M

Z-Direction



Summary



Summary

- Pretensioning appears to reduce head excursion in both the Y and Z directions of all size dummies
- 95th male testing followed trends similar to prior testing
- 5th female appear to demonstrate more excursion when compared to equivalent 50th male tests

Summary

- Inflatable belts were effective in reducing dummy excursion when compared to baseline.
- 4-point belts were effective in reducing Z-direction for excursion but less effective in Y- direction compared to baseline

Future Work

- Future testing to include incorporation of a reaction surface to replicate the roof interior
- Full Scale Dynamic Rollovers to evaluate advanced restraints (J211 Dolly)
- Work with OEMs, suppliers and test labs to explore other rollover test devices or restraint evaluation

Thank You

NHTSA Research on Improved Restraints in Rollovers

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