EFFECTS OF PRE-IMPACT BRAKING ON REAR SEAT OCCUPANT KINEMATICS

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Aloke K. Prasad, NHTSA

Douglas Weston, TRC, Inc.

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Background

- Study pre-crash environment
  - Integration of CA and CW
  - CIB
  - Interaction of pre-crash events (braking) w restraints and occupants
- Generate data for occupant simulations
  - Tests (sled)
  - CAE
- Effect of braking on kinematics, shoulder belt loading
  - Time to peak belt loading
  - Peak shoulder belt force
  - Delta-V during shoulder belt loading
  - Distance of vehicle travel during shoulder belt loading
  - Repeatability

Test Method

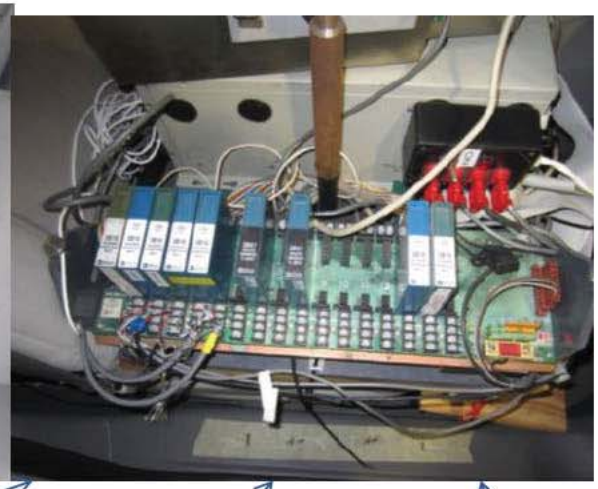
- Select typical midsize or large car
- Medium (0.6 g) and hard braking
- 50th male and 5th female occupants
  - THOR 50th male dummy
  - Hybrid III 5th female dummy
- Shoulder belt load cell
- Camera for head tracking

Pre-impact Braking Study Setup – Vehicle

2011 Buick Lacrosse

Pre-impact Braking Study Setup - Instrumentation

DAS (data acquisition system) records data from instrumentation



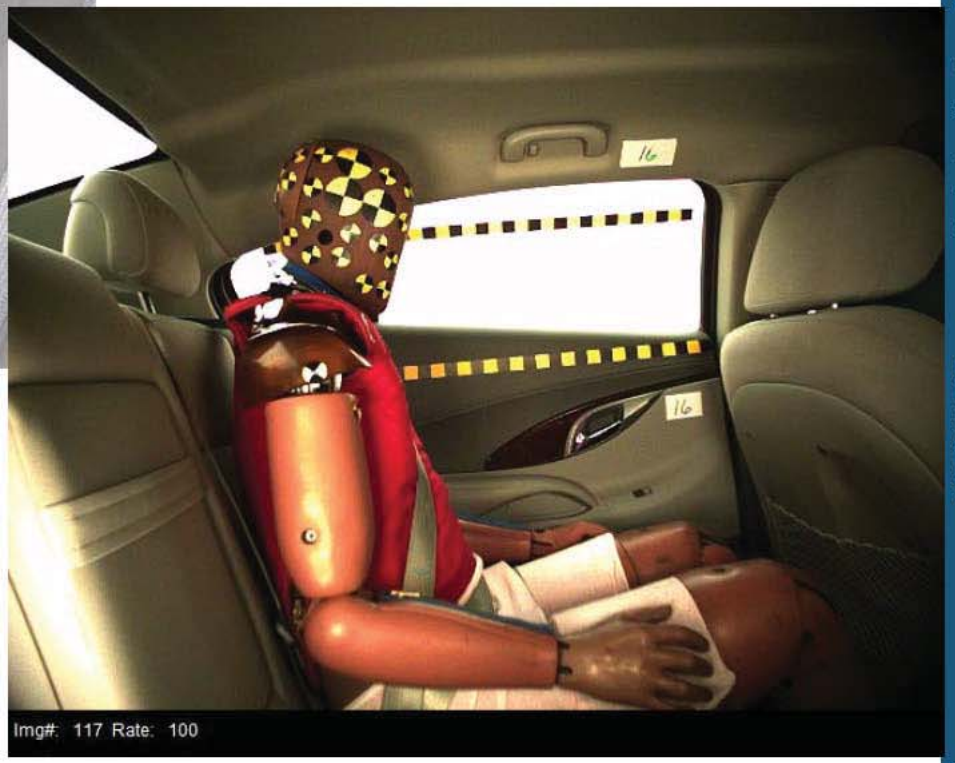
Lap and Shoulder load cells – forces on belts

VBOX – provides velocity data from GPS.

Accelerometer – provides vehicle deceleration data

Pre-impact Braking Study Setup - Video

Vision Research – Phantom Miro camera illuminated with 2 LED light panels.



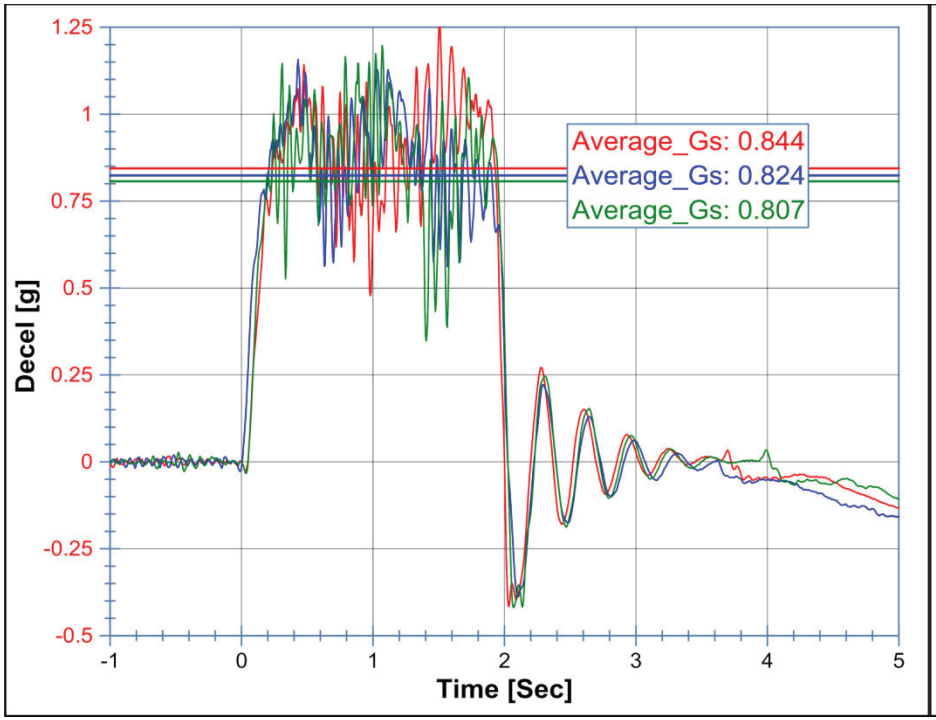
TEMA video analysis software was used to determine occupant forward excursion.

Test Matrix

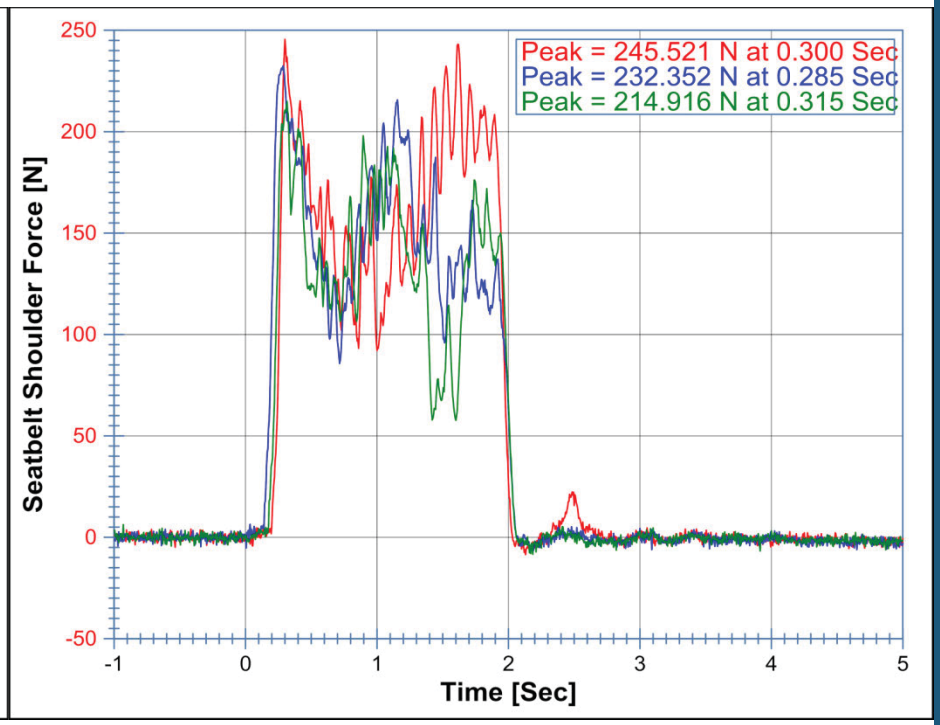
Number of tests for each condition

	0.8-1.0 g			.6 g			.4 g		
	30 mph	35 mph	40 mph	30 mph	35 mph	40 mph	30 mph	35 mph	40 mph
THOR 50th	3	3	2			4			2
H-III 5th	2	3	2			3			3

Repeatability THOR 50th – Hard Stop 35 MPH

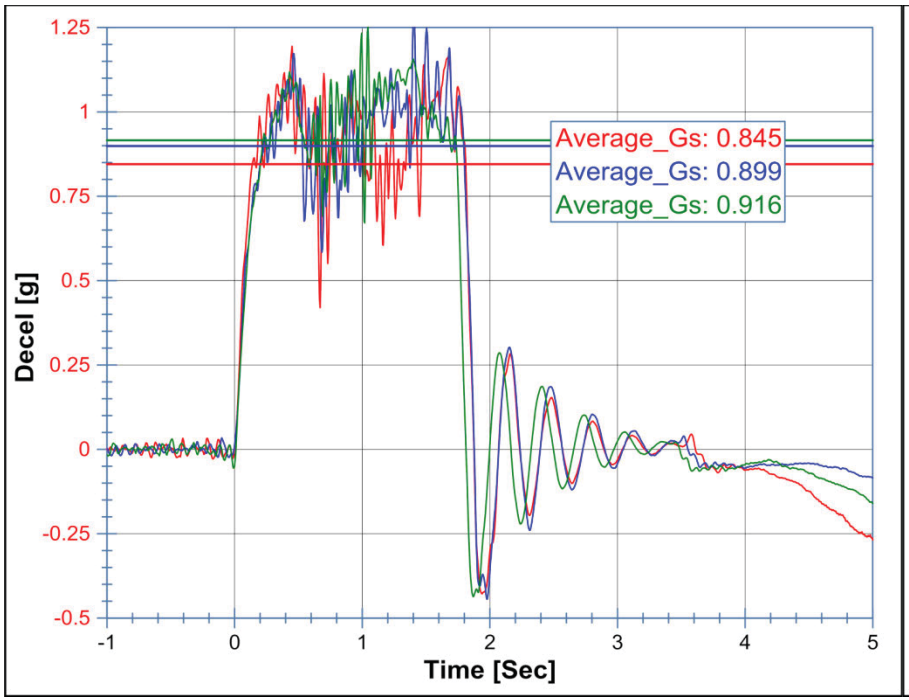


Vehicle Deceleration

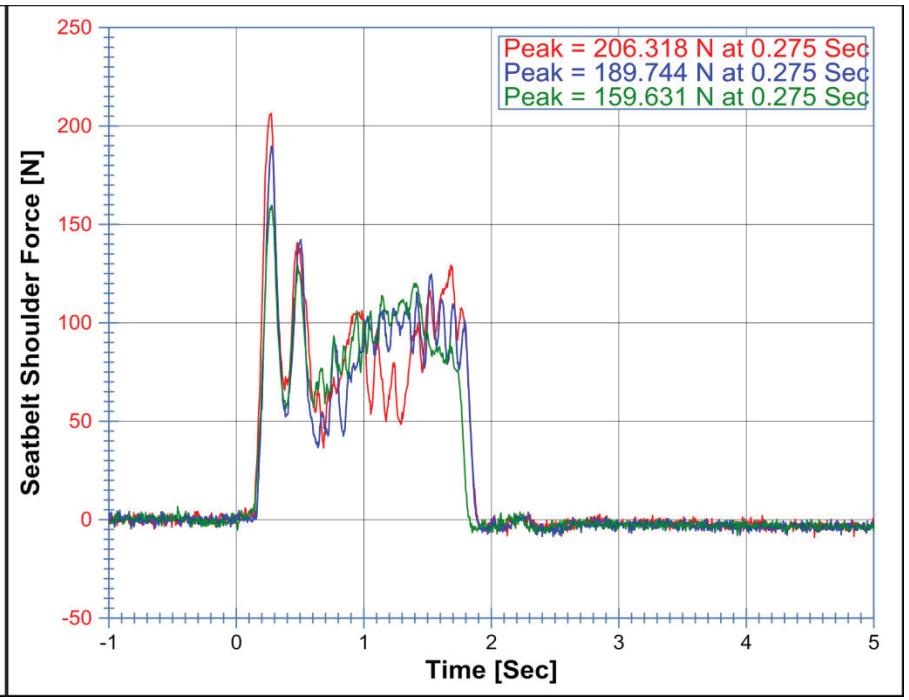


Shoulder Belt Force

Repeatability H-III 5th – Hard Stop 35 MPH

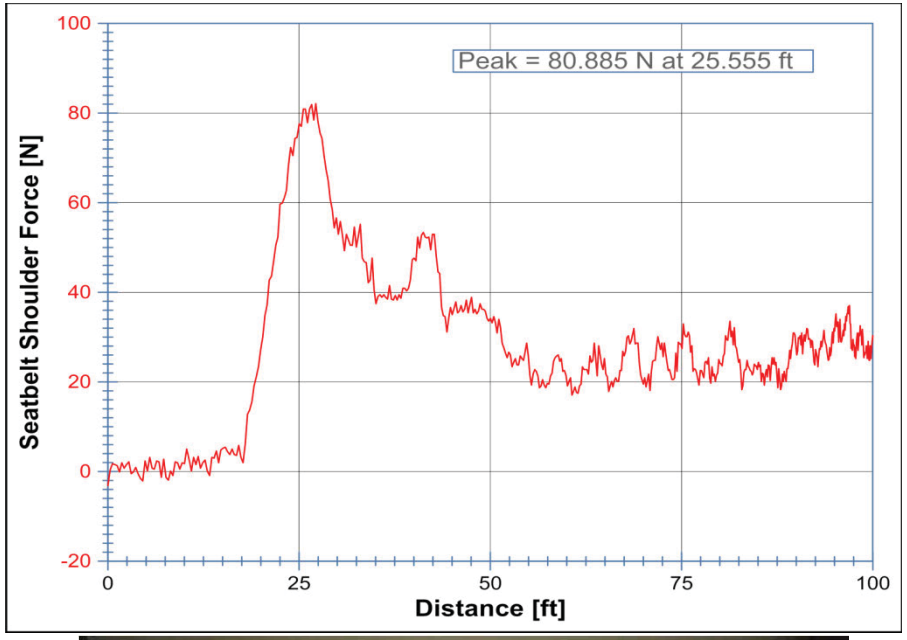


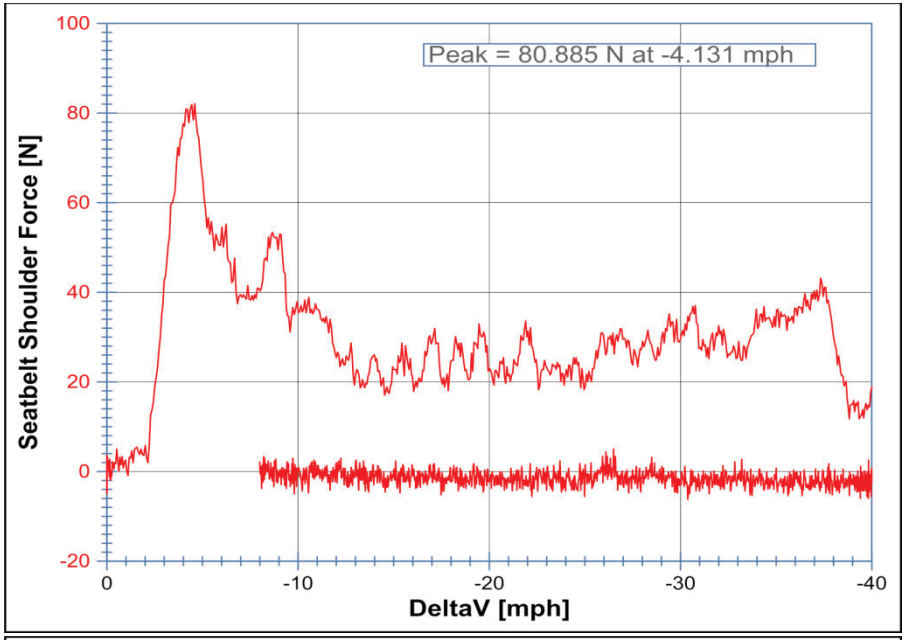
Vehicle Deceleration

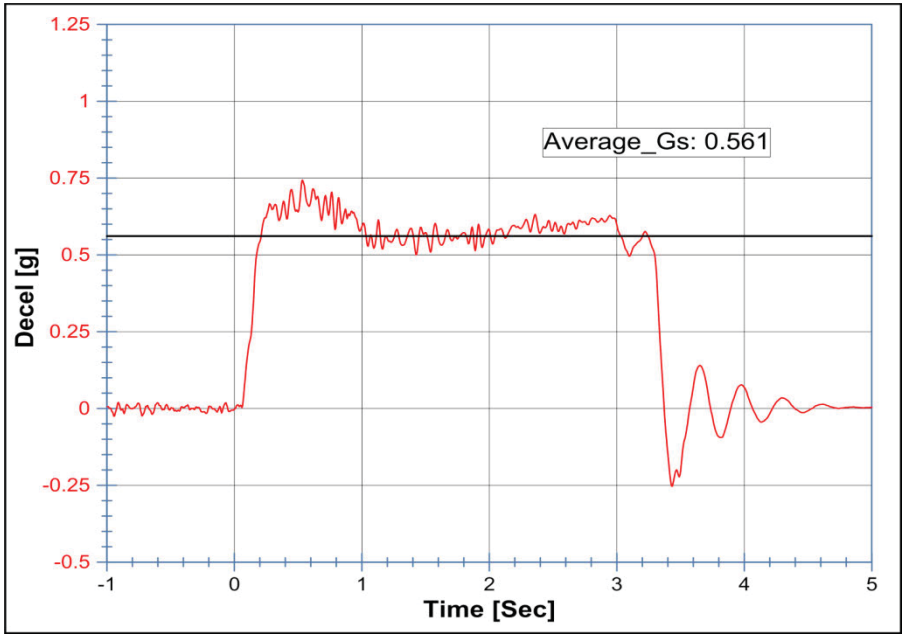


Shoulder Belt Force

50th Male THOR - Medium Braking 0.6g - 40 mph

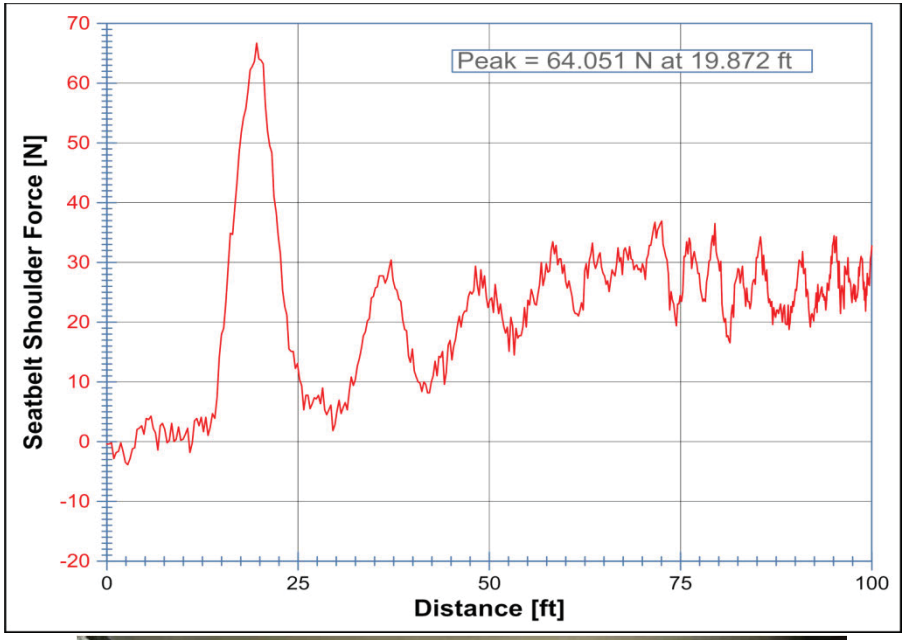


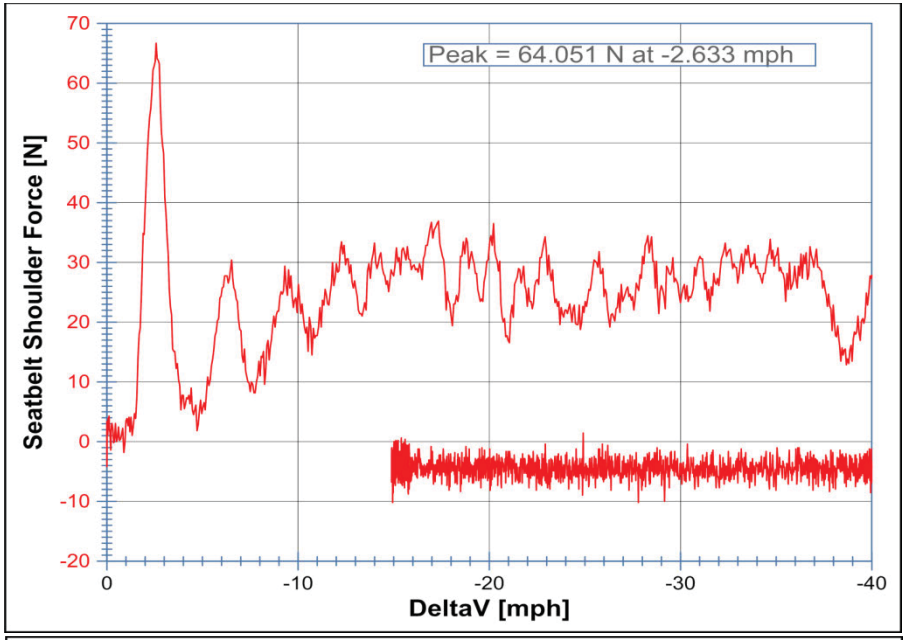


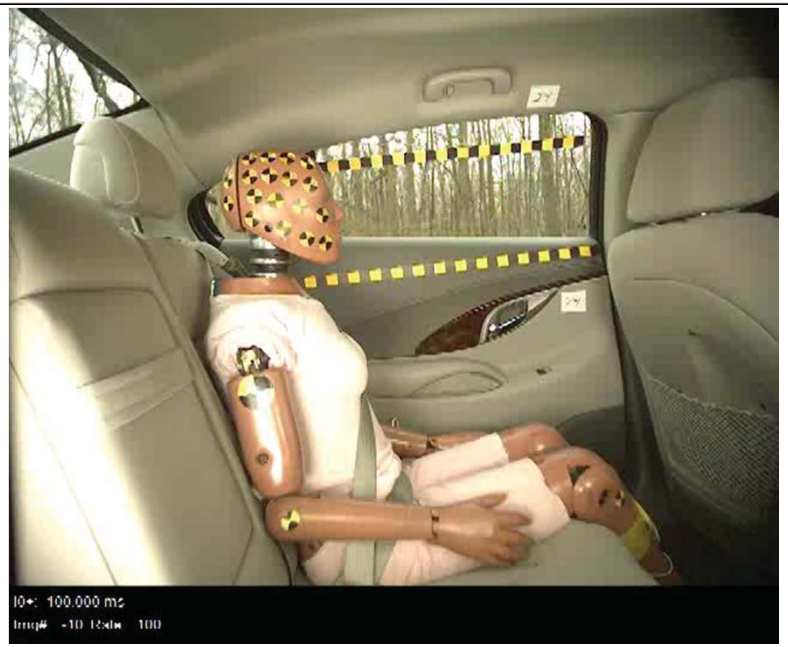


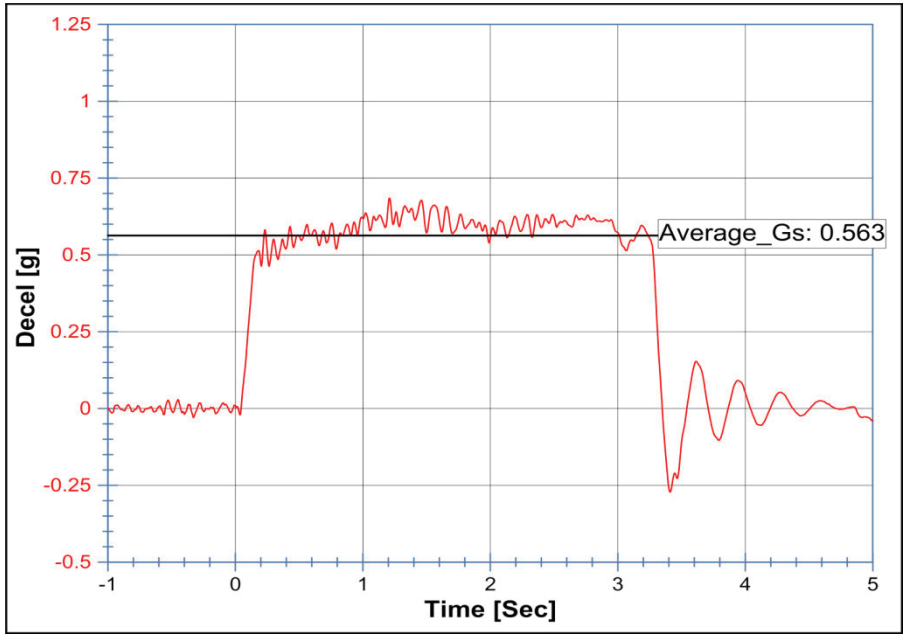
Peak Head Excursion 94 mm

H-III 5th Female - Medium Braking 0.6g - 40 mph



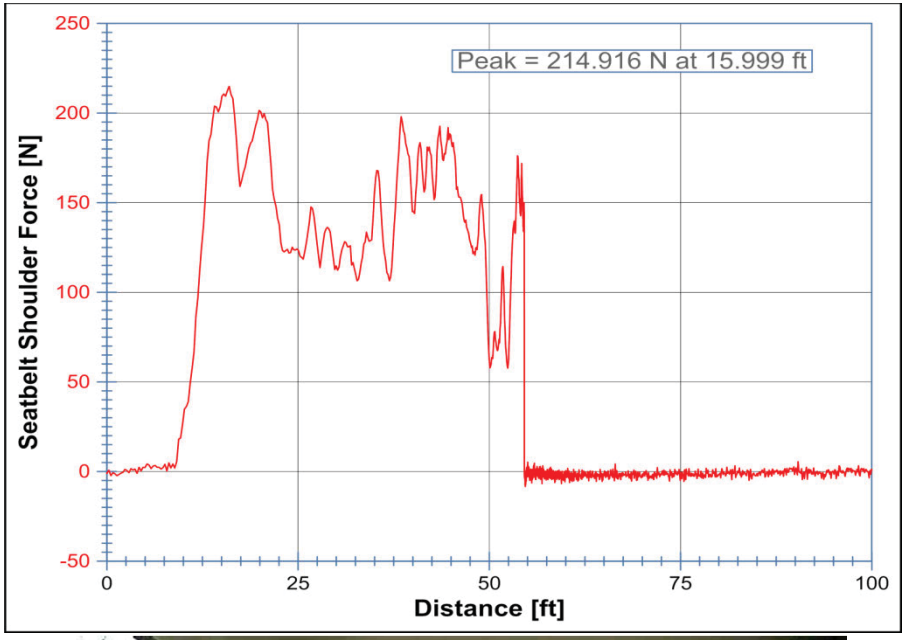


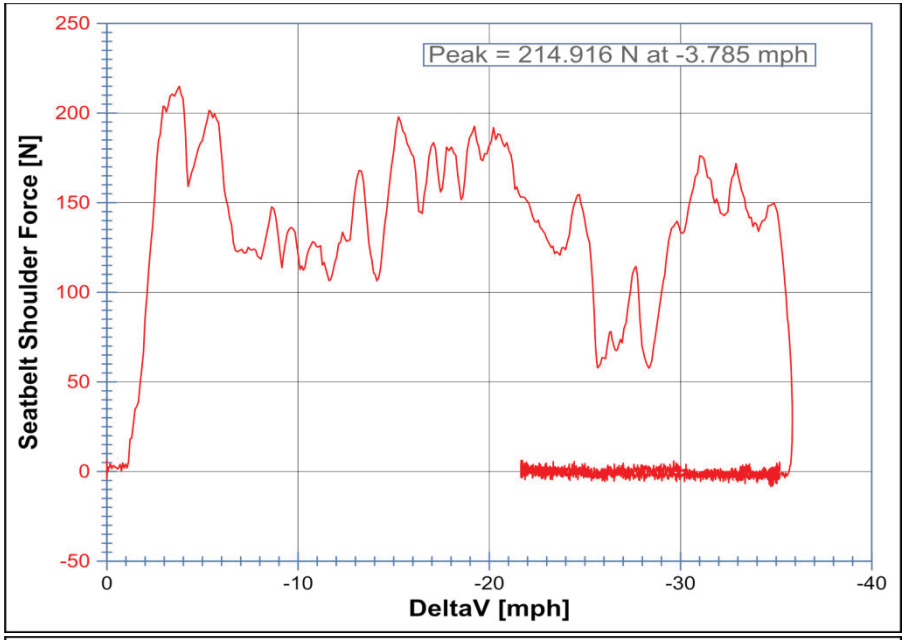


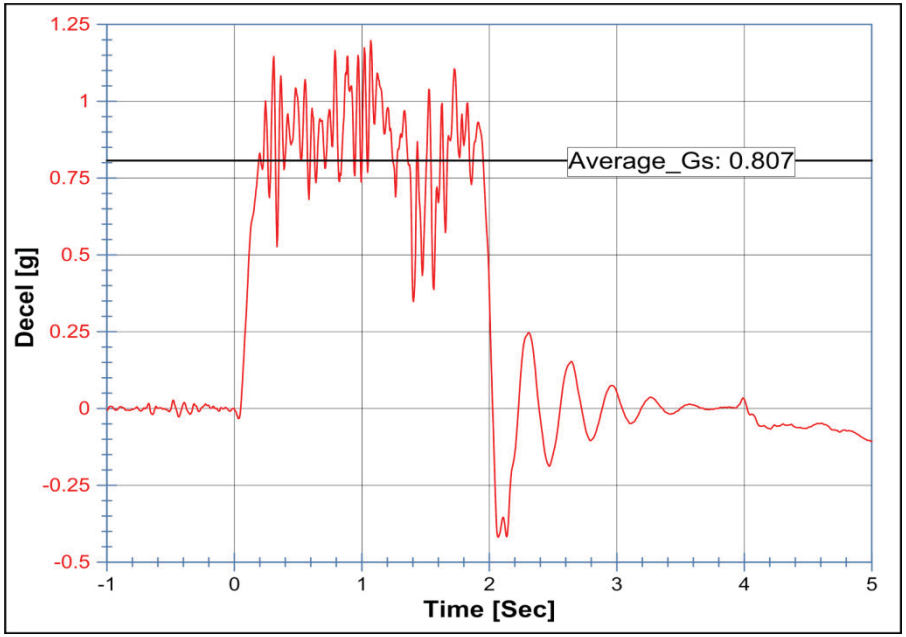


Peak Head Excursion 70 mm

50th Male THOR – Hard Braking 0.8g - 35 mph

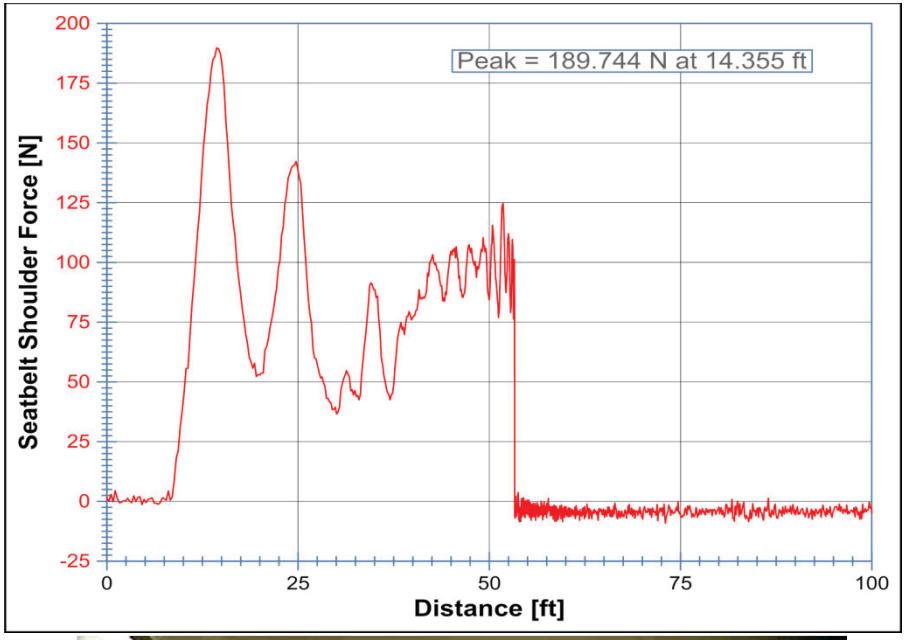


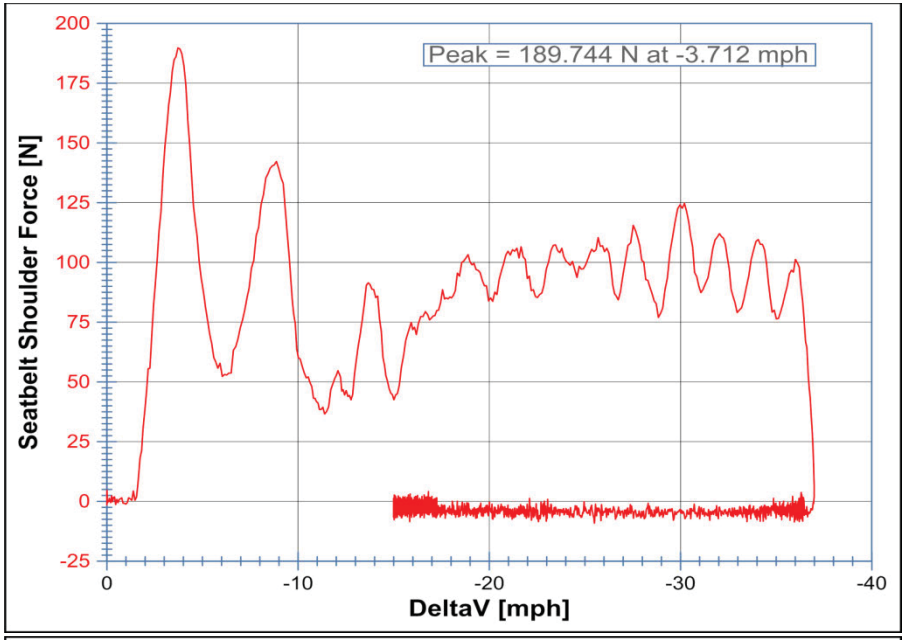


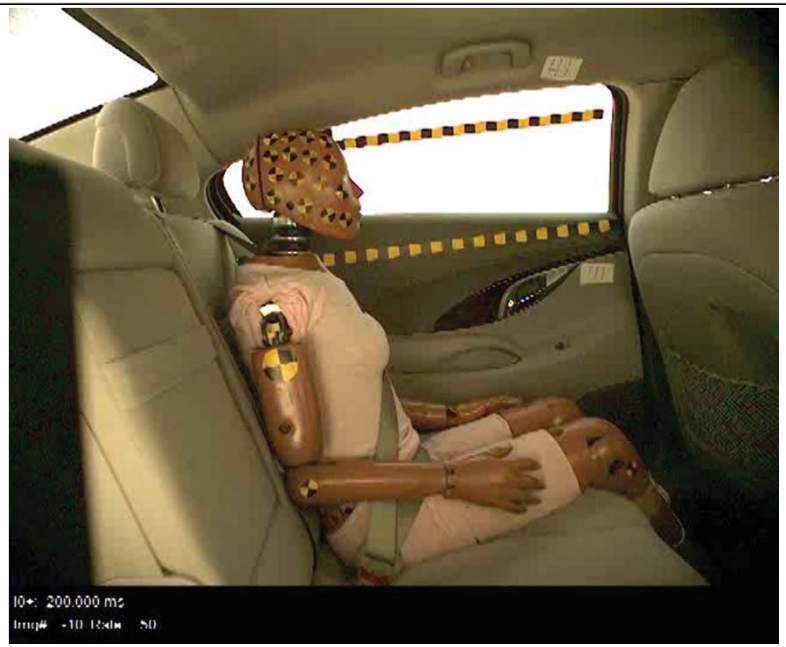


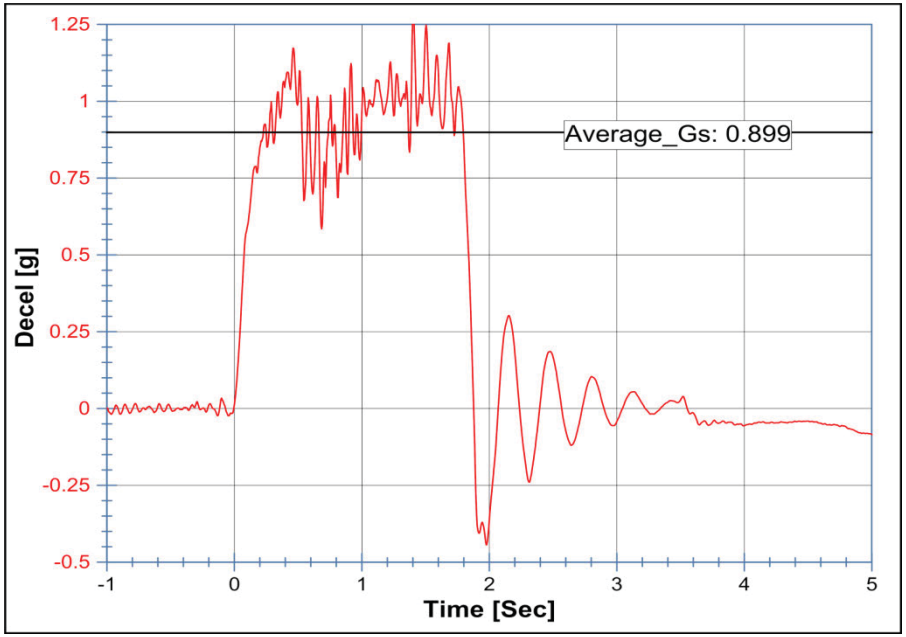
Peak Excursion 146 mm

H-III 5th Female – Hard Braking 0.9g - 35 mph



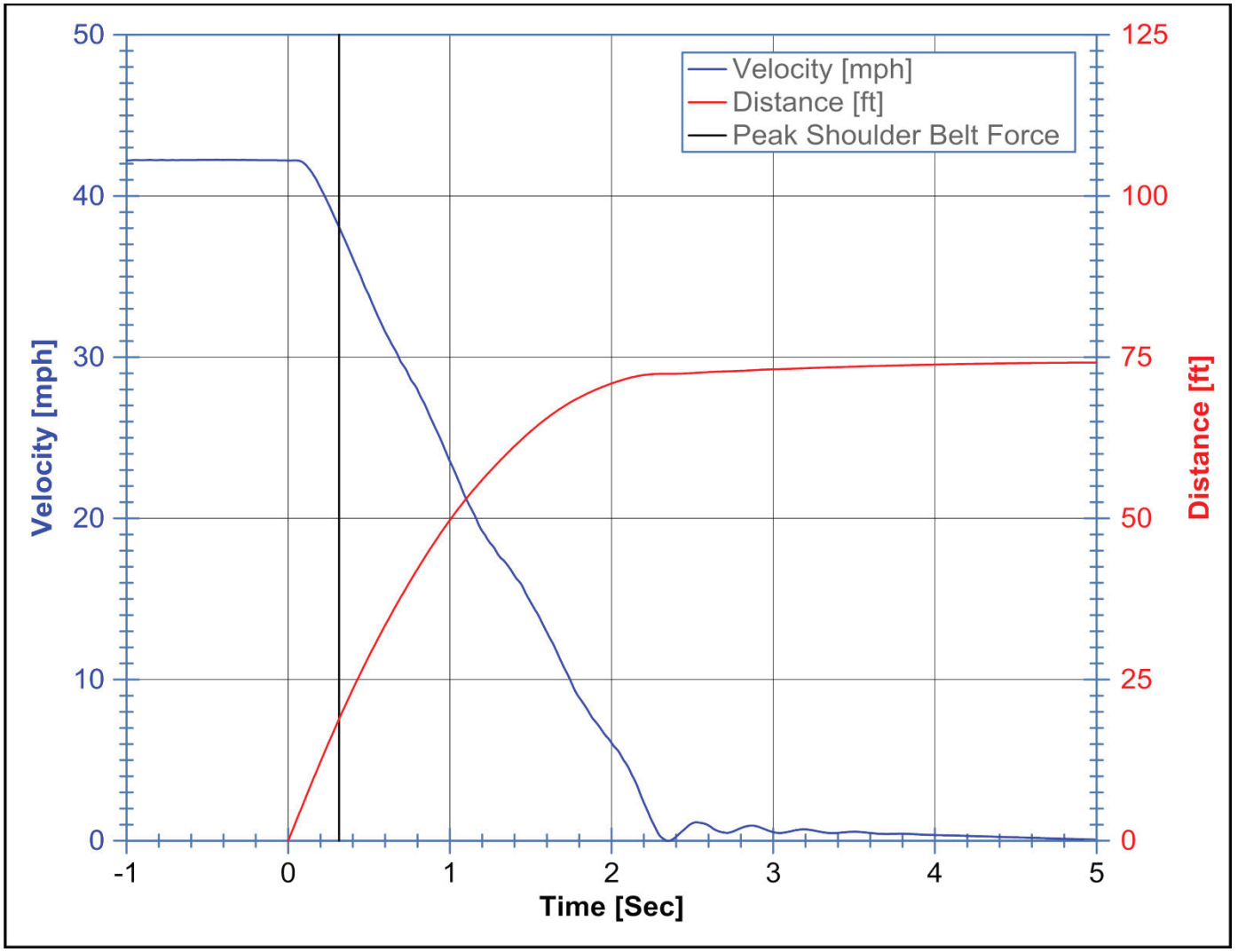






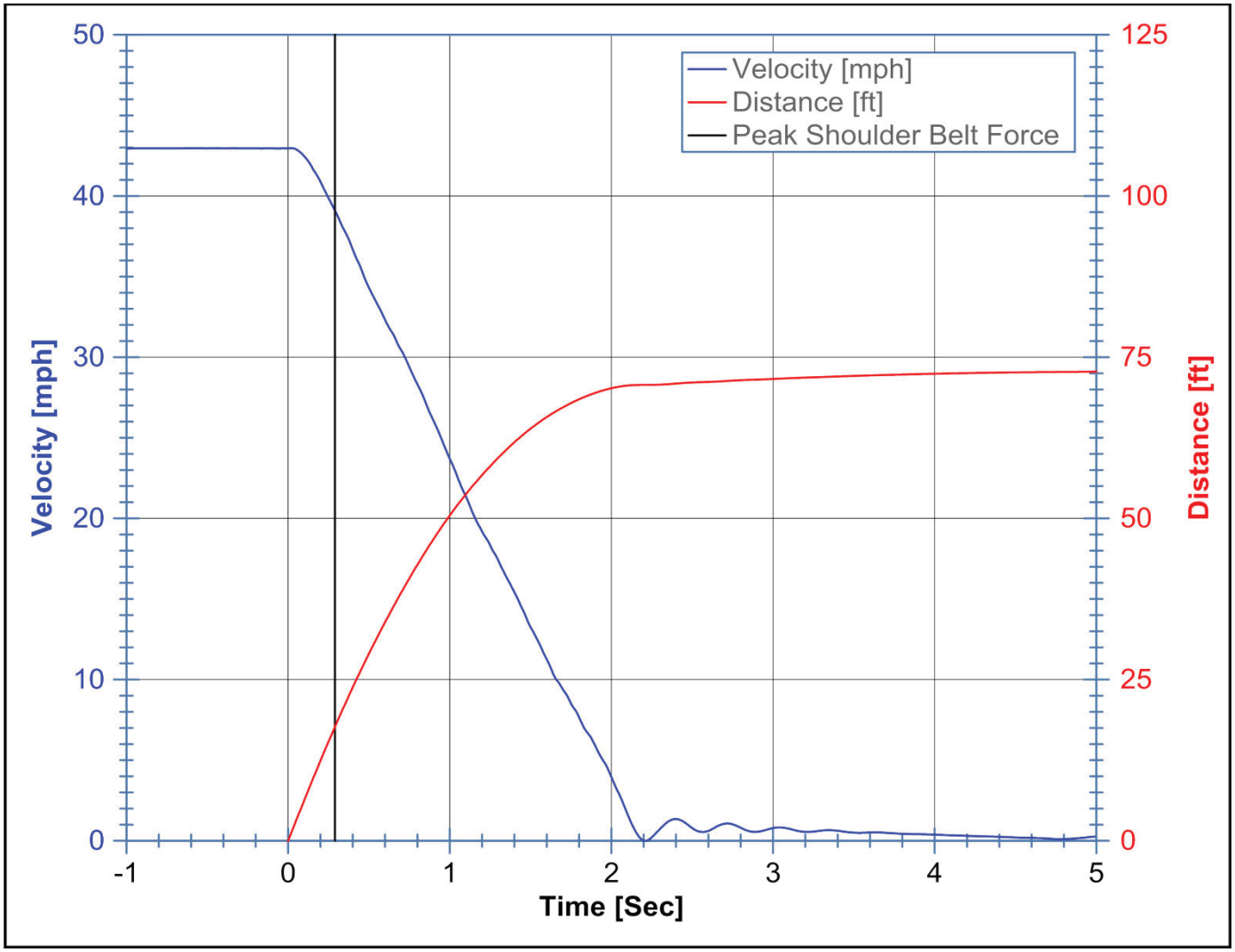
Peak Excursion 114 mm

50th Male THOR - Hard Braking 0.9g - 42 mph



Shoulder belt fully loaded	315 ms	Distance travelled	18.8 feet
Delta-V	4.14 mph	Head excursion	145 mm

H-III 5th Female - Hard Braking 0.82g - 43 mph



Shoulder belt fully loaded	290 ms	Distance travelled	16.7 feet
Delta-V	3.86 mph	Head excursion	97 mm

Hard Stop Summary

Target Deceleration	Hard Stop (0.8 – 1.0 g)									
Rear Seat Occupant	THOR 50th					H-III 5th				
Target speed (mph)	30	35	35	35	40	30	35	35	35	40
Test number	1074	1077	1078	1079	1049	1068	1071	1072	1073	1056
Actual velocity (mph)	31	35	36	34	42	32	35	35	35	43
Average G's	.87	.84	.82	.80	.81	.83	.88	.90	.92	.89
Time to shoulder belt load (sec)	.330	.300	.285	.315	.315	0.305	.275	.275	.275	.29
Max shoulder belt Force (N)	185	245	232	215	240	180	206	190	160	154
Distance to shoulder belt load (Ft)	14.6	15.8	14.7	16.0	18.9	13.6	14.0	14.4	14.2	17.7
Head Excursion (mm)	161	158	147	146	145	112	116	113	94	97
Delta V at Shoulder Belt Load (mph)	3.76	3.25	3.85	3.78	4.14	3.58	4.16	3.71	3.64	3.85

Observations for 0.8 – 1.0 g braking

- First peak shoulder belt loading time was approx. 305 ms
  - HIII 5th female loads quicker than the THOR 50th
- First peak shoulder belt force was approx. 200 N
  - First peak force was higher for the THOR 50th male
- The velocity scrubbed in the time to achieve first peak shoulder belt force was approx. 3.8 mph
- The shoulder belt first peak force was achieved in 13 to 19 feet of travel for hard stopping.
- Tests under identical conditions were repeatable

Limitations

- Results limited to the vehicle selected
  - Dummy kinematics can depend on
    - Braking dynamics
    - Seat characteristics
      - Material
      - Cushion angle
      - Cushion height (feet placement)
    - Retractor performance at low g’s

The End