

NHTSA Evaluation of the Q3s Three Year-Old Side Impact Dummy



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Overview

- History
- Qualification Test R&R
- Sled Test R&R
- Durability Testing
- Conclusions



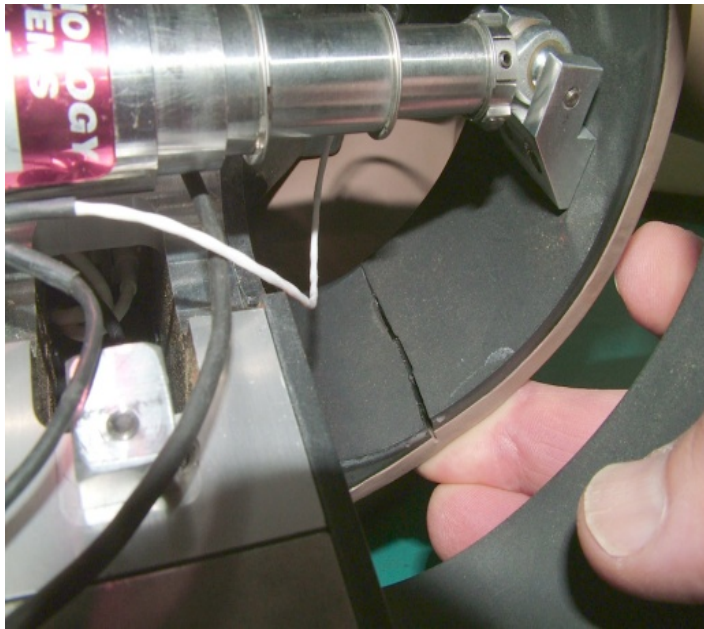
History

- 2000 – NHTSA evaluated Q3
- 2005 – FTSS upgraded Q3s
- 2006 – NHTSA initiated Q3s evaluation



History

➤ Thorax Durability



Urethane (old)



Thermoset (new)

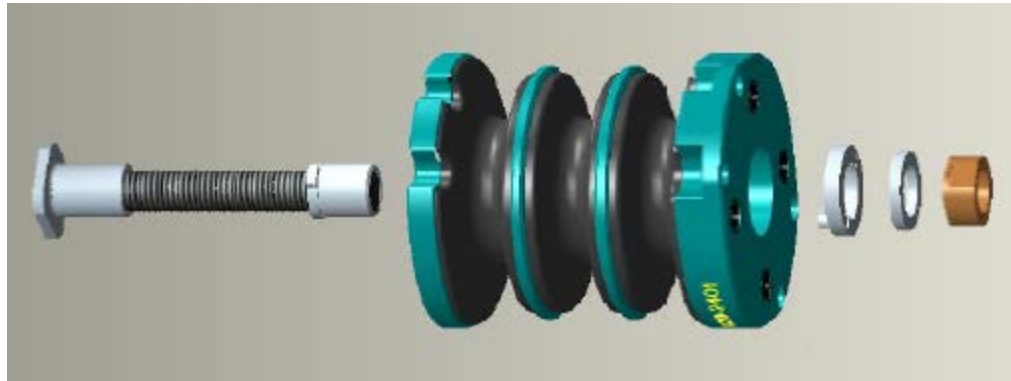
History

➤ Hip/Femur Containment

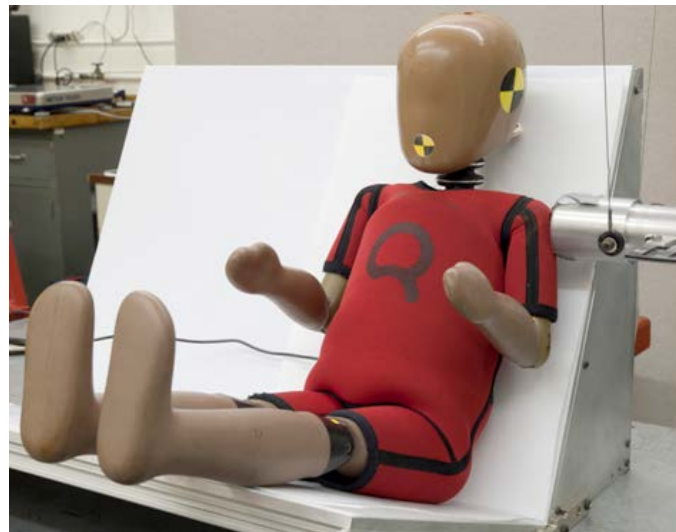
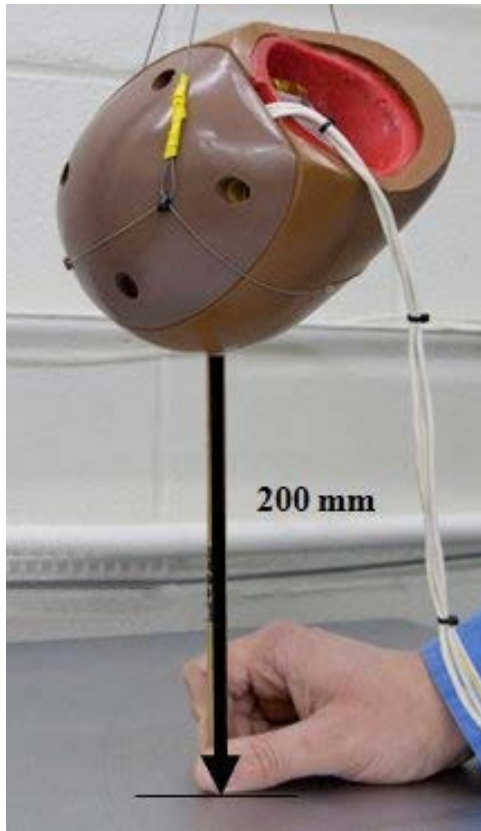


History

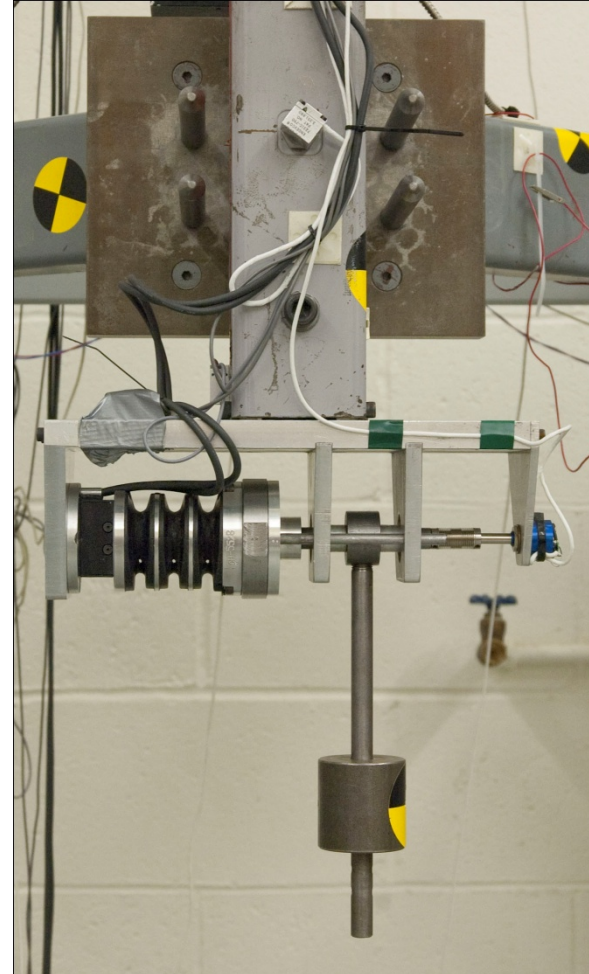
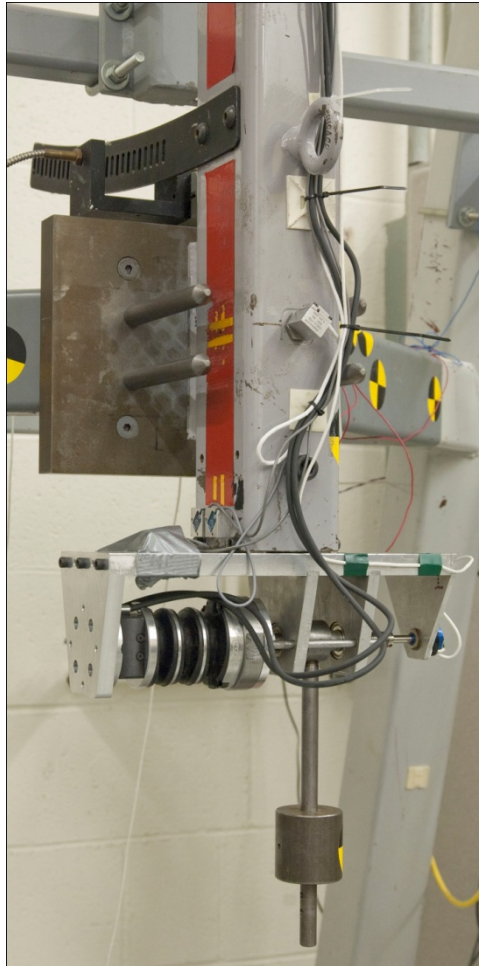
➤ Neck Development



Qualification Testing R&R



Qualification Testing R&R



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Qualification Testing R&R

Component	Condition	Dummy S/N			
		004	006	007	008
Head	Frontal	5	5	5	5
	Lateral Left & Right	5	5	5	5
Neck	Frontal	5	5	5	5
	Lateral Left & Right	5	5	5	5
	Torsion Left & Right	5	5	5	5
Shoulder	Lateral Left & Right	5	5	5	5
Thorax with arm	Lateral Left & Right	5	5	5	5
Thorax without arm	Lateral Left & Right	5	5	5	5
Lumbar	Frontal	5	5	5	5
	Lateral Left & Right	5	5	5	5
Pelvis	Lateral Left & Right	5	5	5	5

Qualification Testing R&R

➤ Repeatability and Reproducibility Analysis

➤ Coefficient of Variation

$$CV(\%) = \frac{\sigma}{\bar{X}} \times 100$$

➤ σ = standard deviation of responses

➤ $\bar{X}$ = mean of responses

➤ Assessment

CV Score	Assessment
$CV \leq 5$	Excellent
$5 < CV \leq 8$	Good
$8 < CV \leq 10$	Marginal
$CV > 10$	Poor

Qualification Testing R&R

Reproducibility CV Scores for All Four Dummies

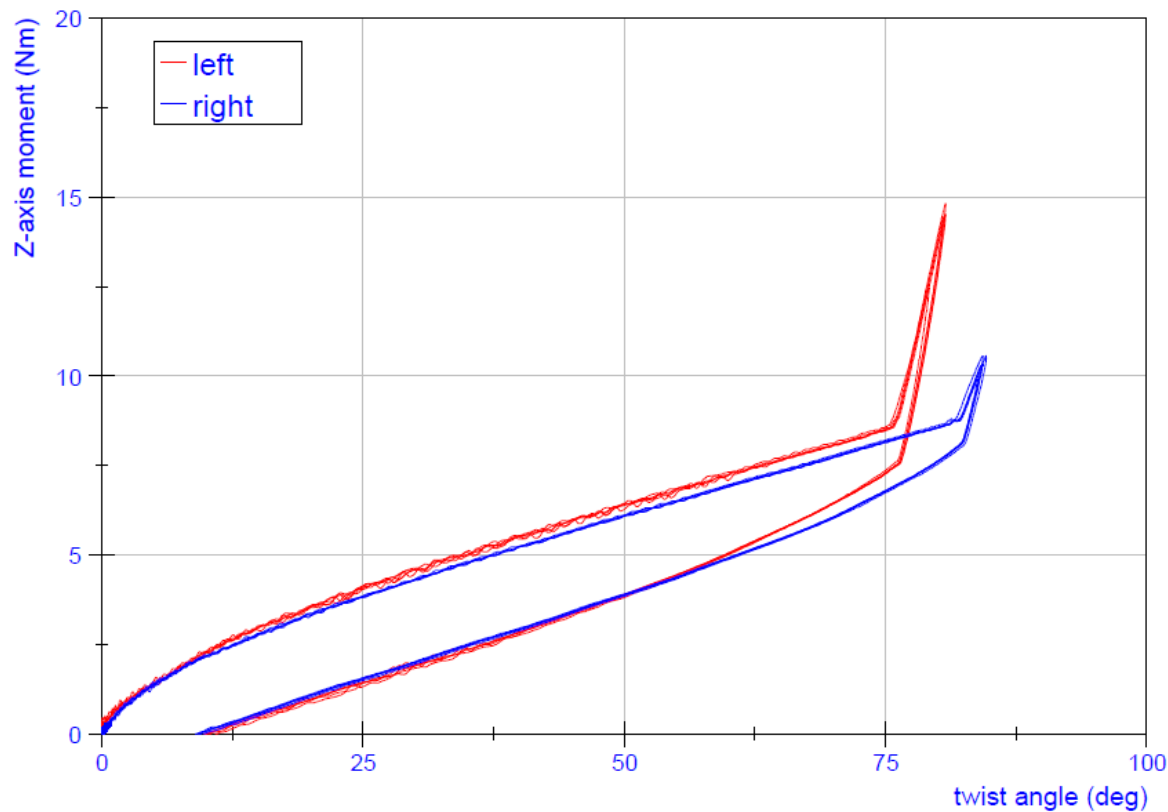
Qualification Test	Criteria	%CV
Head - Frontal	resultant accel	2.80
Head - Lateral	resultant accel	3.78
Neck - Flexion	maximum rotation	5.05
	time of max rotation	0.95
	peak moment (My)	3.71
	time of peak My	1.67
Neck - Lateral	maximum rotation	3.97
	time of max rotation	0.64
	peak moment (Mx)	3.99
	time of peak Mx	4.89
Neck - Torsion	maximum rotation	3.31
	time of max rotation	2.48
	peak moment (Mz)	21.23
	time of peak Mz	2.43
Shoulder	lateral displacement	3.12
	peak probe force	1.22

Qualification Test	Criteria	%CV
Thorax with Arm	lateral displacement	2.46
	peak probe force	3.21
Thorax without Arm	lateral displacement	3.63
	peak probe force	3.99
Lumbar - Flexion	maximum rotation	2.79
	time of max rotation	1.79
	minimum rotation	4.61
	time of min rotation	1.18
Lumbar - Lateral	peak moment (My)	2.78
	maximum rotation	3.63
	time of max rotation	2.36
	minimum rotation	5.22
	time of min rotation	1.56
Pelvis	peak moment (My)	3.38
	peak pubic load	5.39
	peak probe force	2.29

Qualification Testing R&R

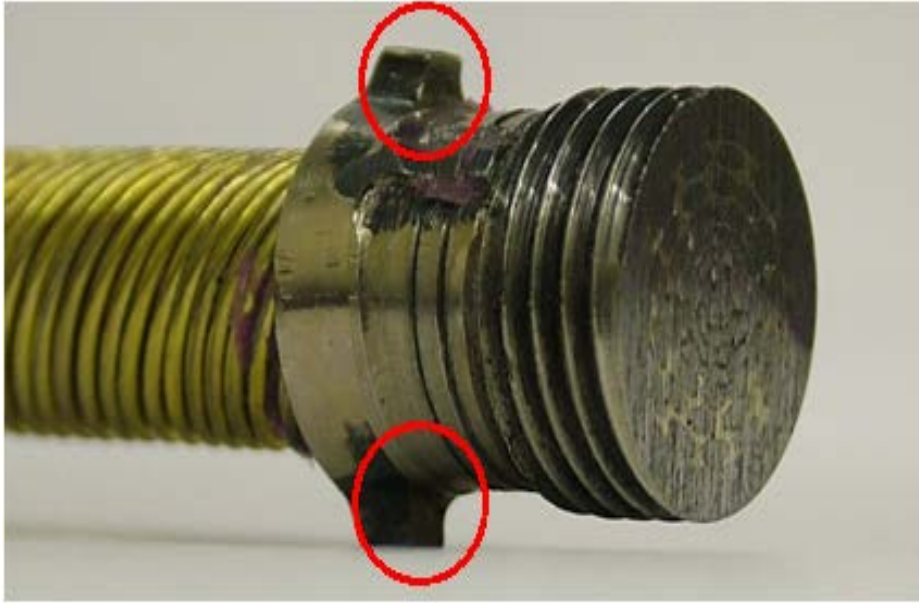
Typical Neck Torsion Responses

Q3s Neck Torsion Response
Chin Right vs Chin Left Response



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Qualification Testing R&R



Torsion tabs on Q3s neck cable



Sled R&R

- Sliding Seat with CRS
- Flat, Padded Wall
- Sled Pulse Target
 - 25.5 g
 - 20 mph
- 2 dummies, five tests each

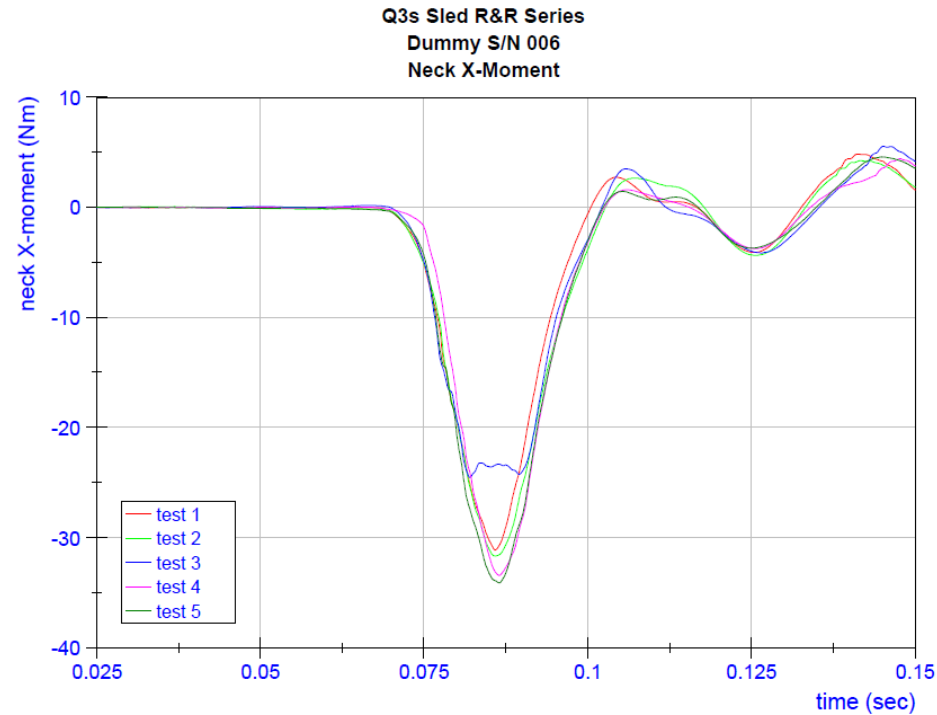
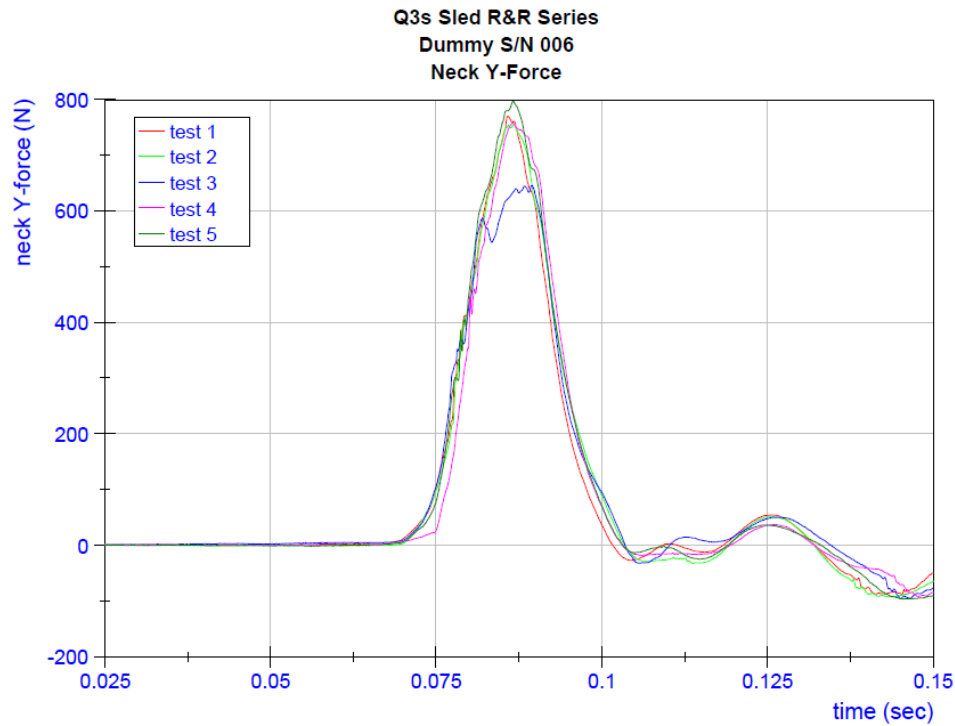


Sled R&R

parameter	unit	Dummy S/N		
		006	007	Both
		%CV	%CV	%CV
head resultant accel	g	2.1%	2.1%	2.1%
HIC-15		2.1%	2.7%	2.4%
neck Y-force	N	7.6%	8.3%	8.6%
neck X-moment	N-m	12.2%	8.3%	11.5%
shoulder Y-displ	mm	4.0%	3.3%	3.5%
upper spine result accel	g	5.0%	12.5%	9.0%
thorax Y-displ	mm	2.2%	8.5%	6.0%
lumbar Y-force	N	6.4%	11.3%	9.3%
pelvis resultant accel	g	15.6%	21.6%	18.1%
pubic Y-force	N	11.2%	23.3%	18.9%

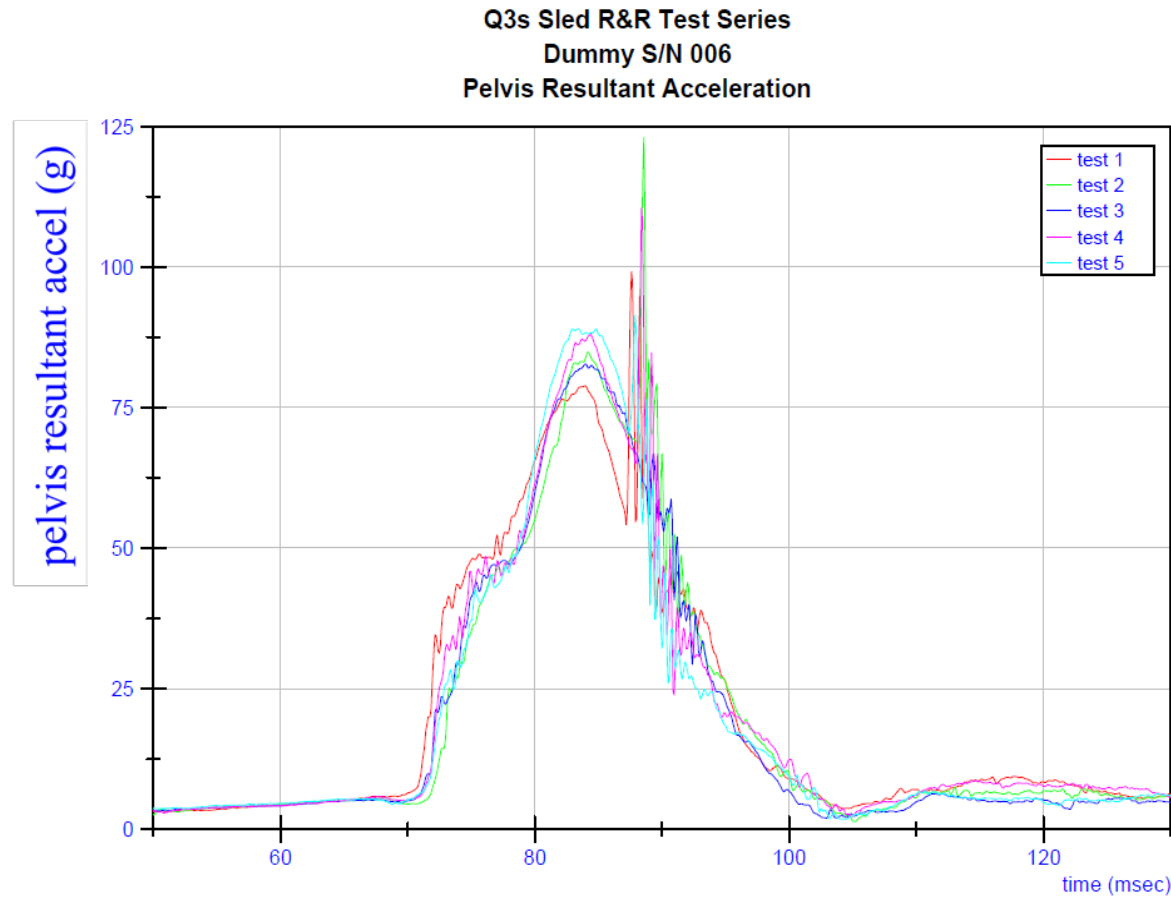
Sled R&R

Neck Responses for S/N 006



Sled R&R

Pelvis and Lumbar Responses

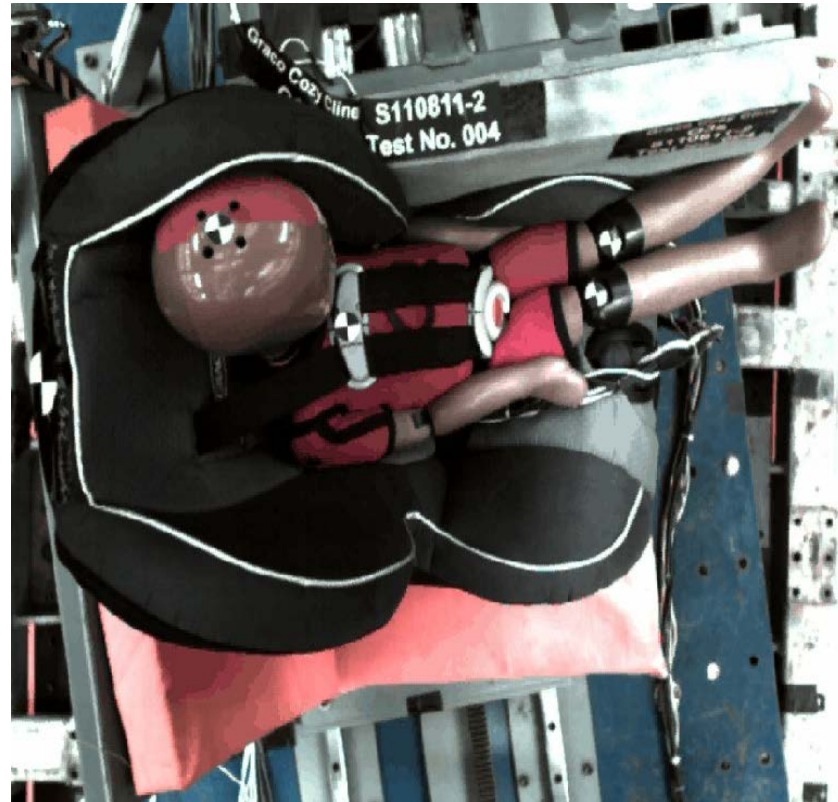


Sled R&R

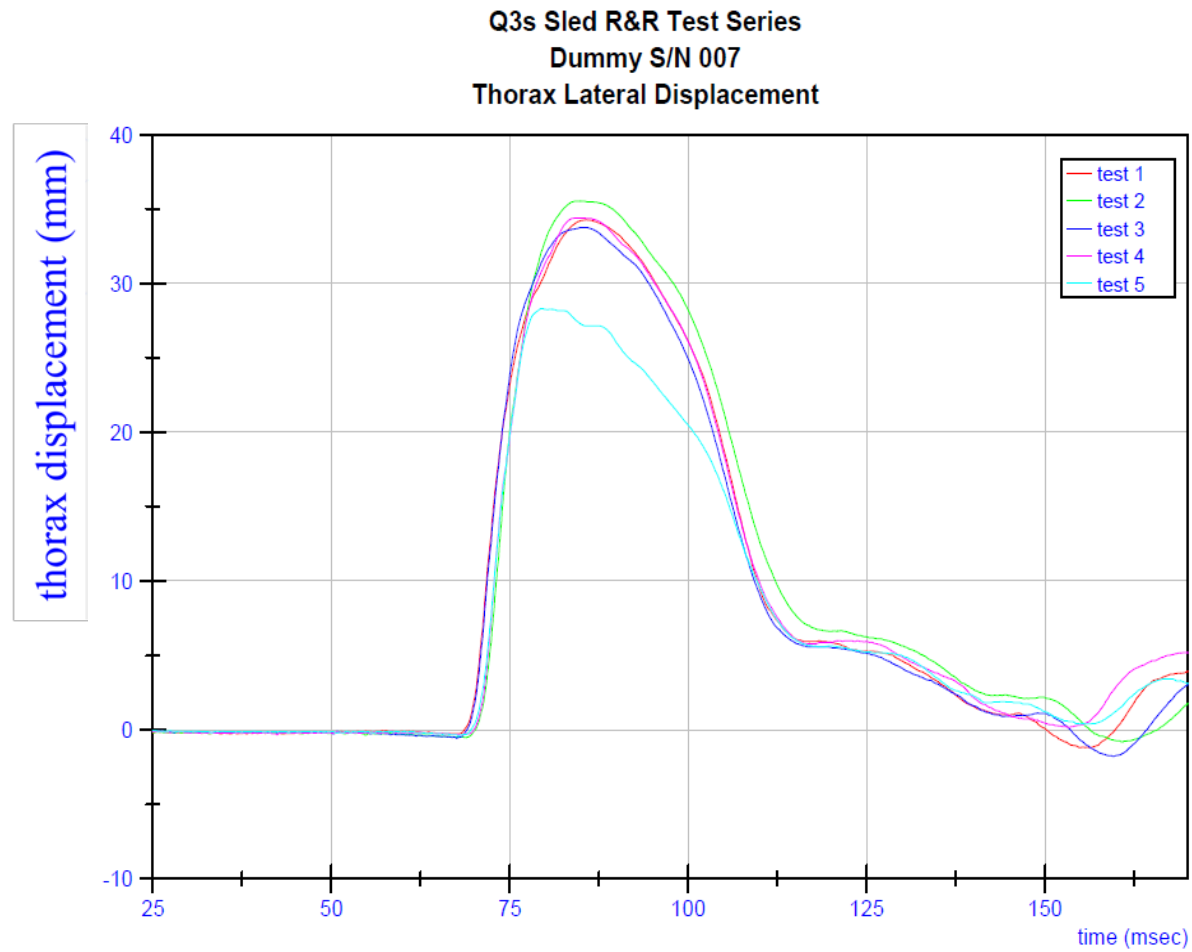
Metal-to-metal contact between the femur ball and hip cups? **NO**



Knee-to-Knee Contact



Sled R&R



Sled R&R

Arm Positioning Feature



Sled R&R

Effect of Repeatable Arm Positioning Mechanism

parameter	unit	Sled Series #1	Sled Series #2
		without shoulder detent	with shoulder detent
		%CV	%CV
head resultant accel	g	2.1%	3.1%
HIC-15		2.7%	3.2%
neck Y-force	N	8.3%	3.8%
neck X-moment	N-m	8.3%	6.7%
shoulder Y-displ	mm	3.3%	1.4%
upper spine result accel	g	12.5%	5.4%
thorax Y-displ	mm	8.5%	4.8%
lumbar Y-force	N	11.3%	6.3%
pelvis resultant accel	g	21.6%	5.9%
pubic Y-force	N	23.3%	13.6%

Durability Tests

- High-Energy Testing
 - Qualification Test Procedures
 - Increased Kinetic Energy
 - Increased Impact Speed
 - Higher Drop Height
 - Generally target +30% KE
 - Thorough post-test inspection



Durability Tests

Damage to Neck Cable



Conclusions

- Generally Good or Excellent R&R
- Generally Good Durability
- Issues to be Resolved
 - Neck
 - Symmetry of right and left torsion responses
 - Durability of neck cable
 - Eliminate Noise Due to Knee-to-Knee Contact
 - Finalize Design of Arm Positioning Feature

Thank You



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