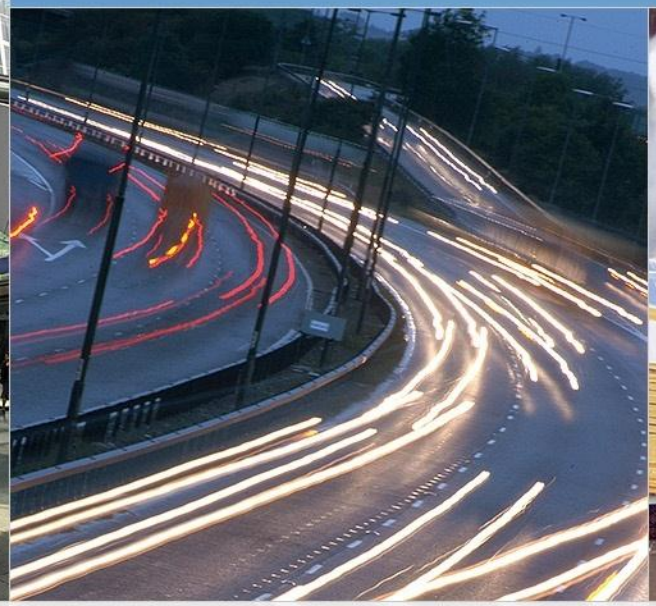

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Research findings for setting dummy injury thresholds for Regulation 129 Phase 2 regarding chest & abdomen loading

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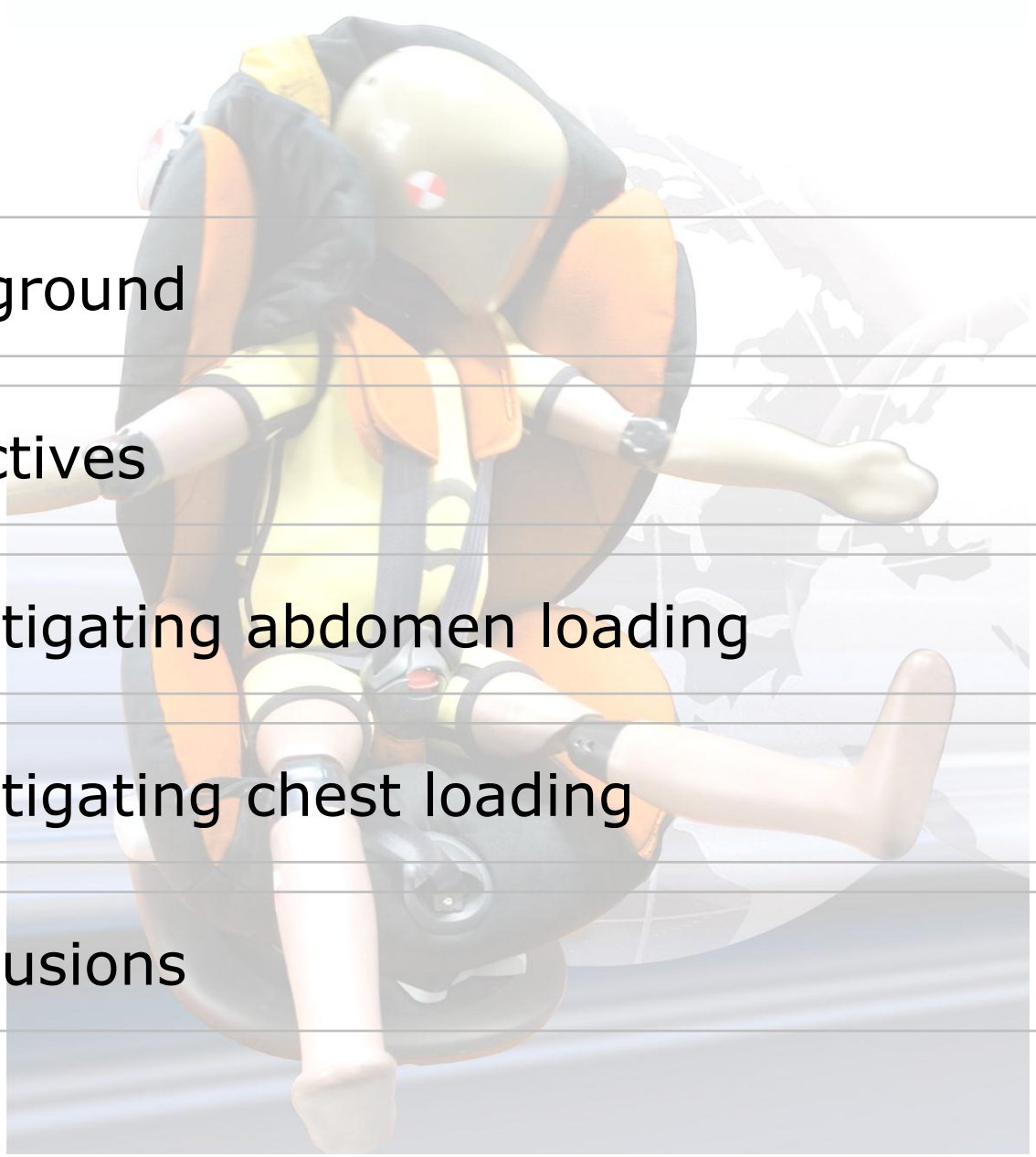
Peter Broertjes (European Commission)
Child Safety Informal Working Group, January 2016

Outline



1. Background
2. Objectives
3. Investigating abdomen loading
4. Investigating chest loading
5. Conclusions

Background

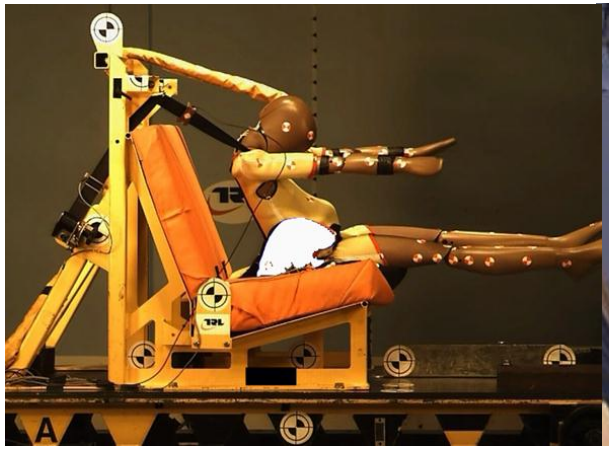
- Work has been conducted on behalf of the European Commission to investigate and validate proposals for Phase 2 of Regulation 129
- Phase 2 - “non-integral” child restraint systems, where a child is positioned on a child seat, but essentially wearing the vehicle seat belt
- Key injury mechanisms for non-integral seats are:
  - Head contact
  - Chest loading
  - Abdomen loading
- Head accelerations & excursions measured as in Phase 1
- Abdomen and chest limits proposed but not validated in R129 test environment

Objectives

Propose solutions that improve the capacity of UN Regulation 129 to differentiate between non-integral child restraint systems

Abdomen loading

- Penetration of the lap part of the seat belt into the gap between the legs and the pelvis (and its implications for the assessment of abdomen injury protection)



Chest loading

- Movement of the diagonal part of the seat belt towards the neck (and its implications for the assessment of chest injury protection)

Abdomen Loading - Tools

Pelvis Inserts / Hip Liner

- Q3/Q10 used DOREL pelvis insert

- Q6 used Humanetics hip liner

Abdomen Sensors

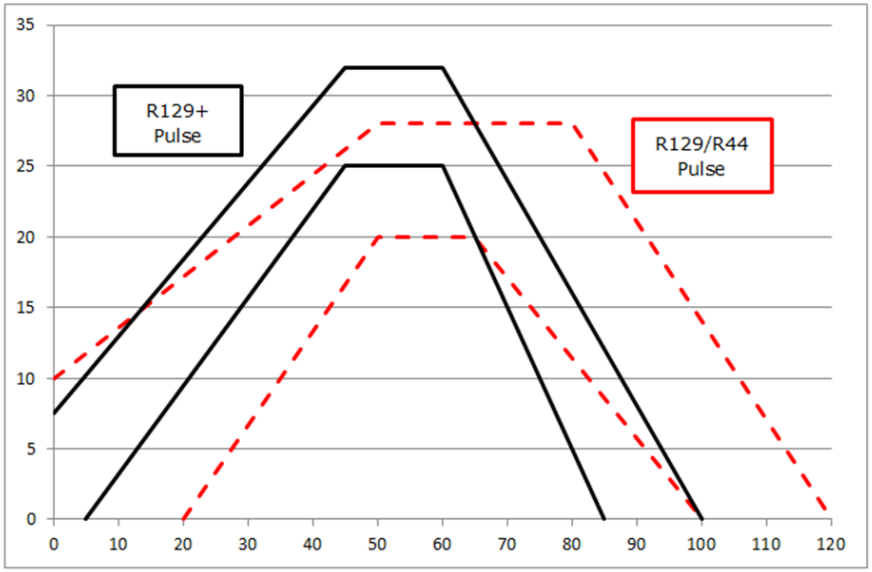
- Humanetics abdomens with moulded slots for APTS
- Q10 used 50mm APTS
- Q3/Q6 used 40mm APTS

Abdomen Loading – Test Conditions

Four different test conditions were used:

R129	UMTRI	R129+ Pulse	UMTRI & R129+

▪ R129 pulse
▪ Standard seat belt installation (50N)
	▪ R129 pulse
	▪ Dummy initially slouched
	▪ Belt tensions ≈15N
		▪ Higher g pulse
		  ▪ 50 km/h
		  ▪ 25-32g
		▪ Standard seat belt installation (50N)
			▪ Higher g pulse
			▪ Dummy initially slouched
			▪ Belt tensions ≈15N



Abdomen Loading – Child restriants

No CRS	Poor CRS	Good CRS
▪ Dummy placed directly on test bench	▪ Modified to remove lower belt guides ▪ P10 submarines using R44 or R129 conditions	▪ Approved to R44 ▪ Lap belt guidance

Abdomen Loading - Results

Q10 Proposed limit – 1.2 bar

- Using DOREL pelvis insert results in:
  - Submarining without CRS & belt loads abdomen
  - Submarining with poor CRS
  - No submarining or abdomen loading with good CRS
- When dummy does submarine, sensors measure >1.2 bar

Test	CRS	Submarine	Belt in Abdomen	Pressure (bar)	
				L	R
R129	N/A	Y	Y	2.01	1.43
	Poor	Y	Y	1.32	1.40
UMTRI	Poor	Y	Y	2.41	1.31
R129+ Pulse	Poor	Y	Y	1.94	1.32
UMTRI & R129+	Poor	Y	Y	2.62	1.44
	Good	N	N	0.60	1.06

Abdomen Loading - Results

Q6 Proposed limit – 1.2 bar

- Using Humanetics hip liner results in:
  - No submarining without CRS, but belt loads abdomen
  - Submarining with poor CRS
  - No submarining or abdomen loading with good CRS
- When dummy does submarine, sensors measure <1.2 bar
- Exception when UMTRI installation used >1.2 bar

Test	CRS	Submarine	Belt in Abdomen	Pressure (bar)	
				L	R
R129	N/A	N	**Y**	0.83	0.89
	Poor	**Y**	**Y**	0.93	0.93
UMTRI	Poor	**Y**	**Y**	**1.21**	1.18
R129+ Pulse	Poor	**Y**	**Y**	1.16	1.13
UMTRI & R129+	Poor	**Y**	**Y**	**1.81**	**1.39**
	Good	N	N	0.32	0.32

Abdomen Loading - Results

Q3 Proposed limit – 1.2 bar

- Using DOREL pelvis insert results in:
  - Belt abdomen loading in poor CRS
  - Submarining with poor CRS using UMTRI & R129+ pulse
  - No submarining or abdomen loading with good CRS
- When dummy did submarine, sensors measured <1.2 bar
  - 1 bar when Q3 submarines
  - 0.39 - 0.58 bar from belt loading abdomen without submarining

Test	CRS	Submarine	Belt in Abdomen	Pressure (bar)	
				L	R
R129	Poor	N	Y	0.39	0.47
UMTRI	Poor	N	Y	0.51	0.56
R129+ Pulse	Poor	N	Y	0.56	0.58
UMTRI & R129+	Poor	Y	Y	1.06	0.95
	Good	N	N	0.22	0.41

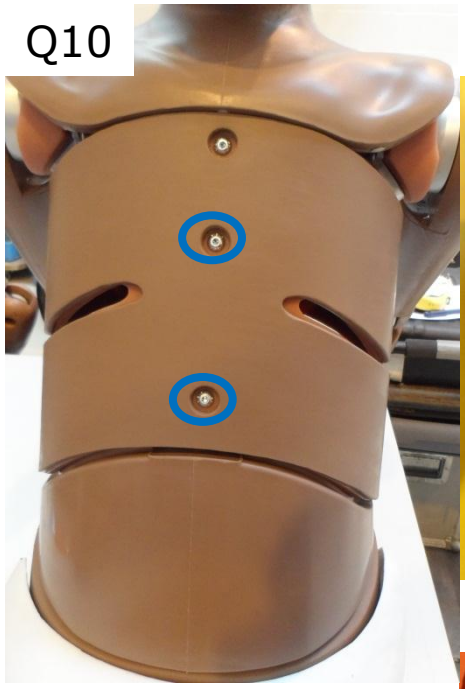
Abdomen Loading – Implications for Regulation 129

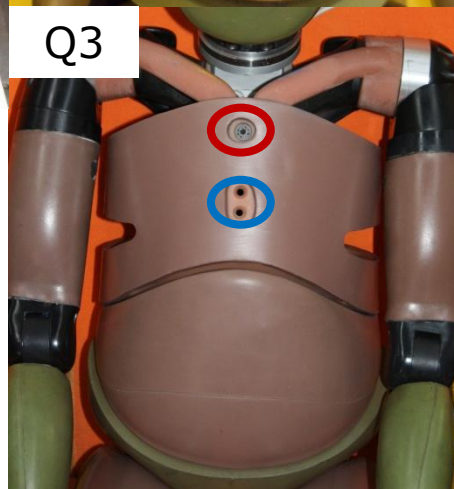
- Q-Series dummies should be used with hip liners
  - Q3 and Q10 versions need to be made ‘production-ready’ by Humanetics
- Abdomen loading thresholds:
  - Q10 could use 1.2 bar
  - Q3/Q6 consider:
    - UMTRI positioning procedure
    - R129+ pulse
    - Revising the limit with current R129 test conditions

Chest Loading - Instrumentation

Deflection sensors

- Q10 has upper & lower chest deflection measurements
- Humanetics developed Q3/Q6 deflection measurement at clavicle





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Clavicle Sensor

Chest Loading – Test Conditions

Two different test conditions were used:

R129	Extreme upper anchorage
▪ R129 pulse ▪ Standard seat belt anchorage positions used	▪ Upper anchorage moved forwards, downwards and outwards ▪ Giving a worse initial position over the shoulder ▪ Belt not directly over the centre of the clavicle

Chest Loading – Child restriants

No CRS	Booster Seat	Booster Cushion
▪ Dummy placed directly on test bench	▪ Booster seat with backrest which has a belt guide	▪ Booster cushion (no backrest)

Chest Loading - Results

Q10 Proposed limit – 56 mm

- Seat belt remains on the shoulder of dummy (no slippage)
- Dummy is able to detect poor belt path as one sensor is severely loaded
- Q10 is able to measure at least 56 mm deflection
- Proposed limit of 56 mm seems appropriate

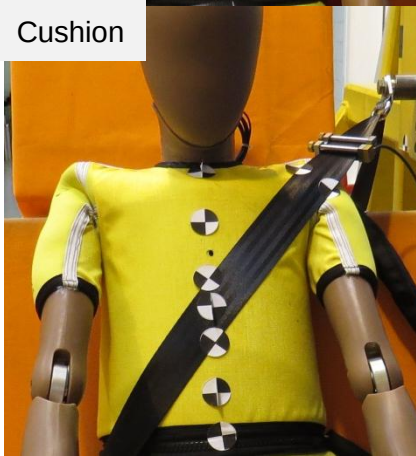
Test	CRS	Belt in Neck	Chest Deflection	
			Upper	Lower
R129	No CRS	**Y***	33.36	29.13
R129	Booster Seat	N	50.41	48.70
R129	Booster Cushion	N	46.18	**74.05**

*Belt slides to neck because dummy submarines

No CRS

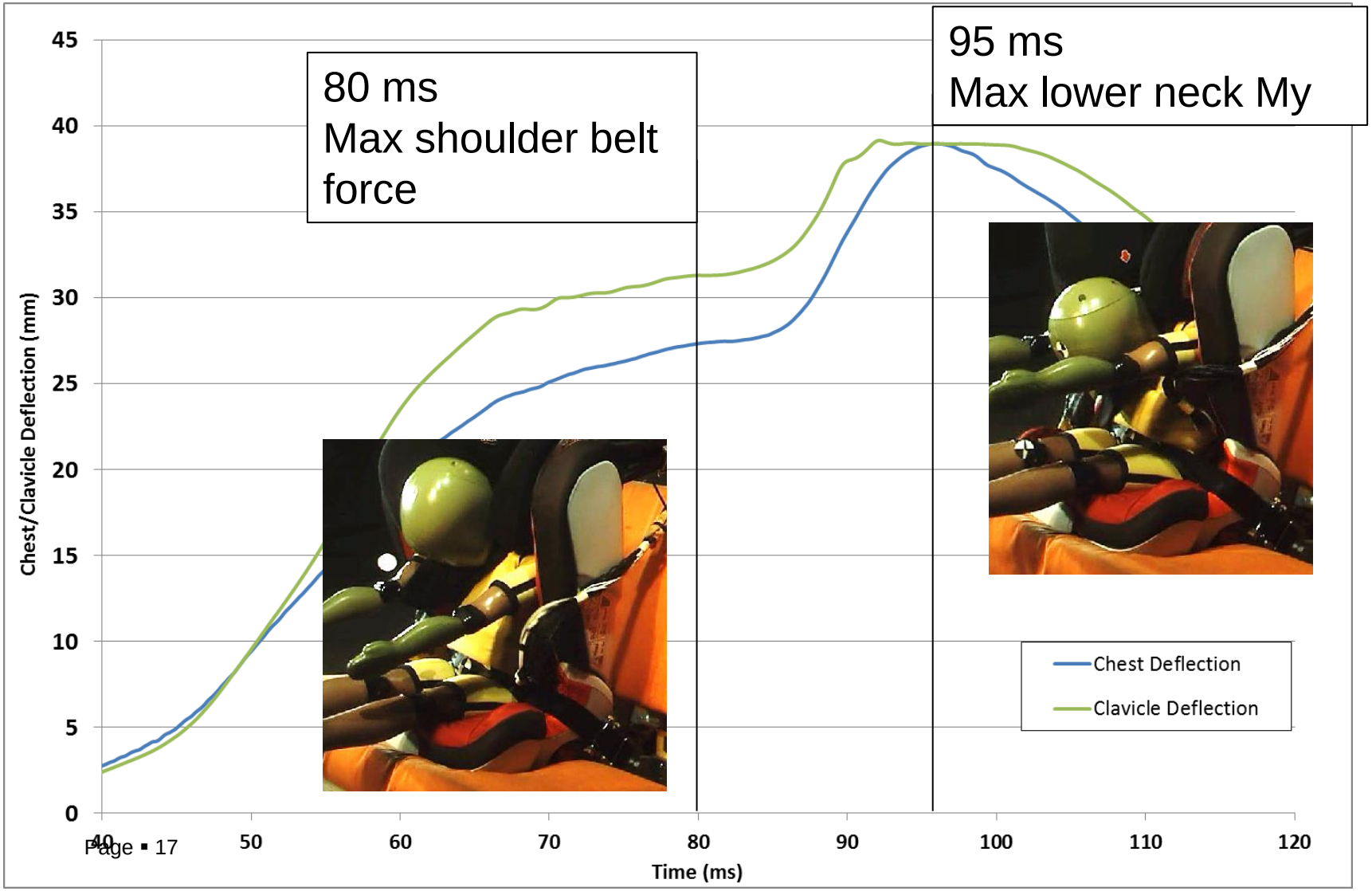
Booster Seat

Cushion



Chest Loading - Results

Chin to chest contact influencing chest deflection measurement:

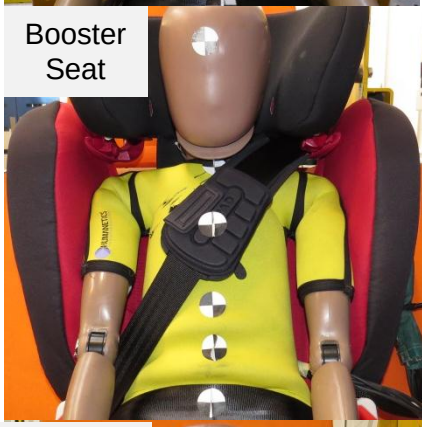


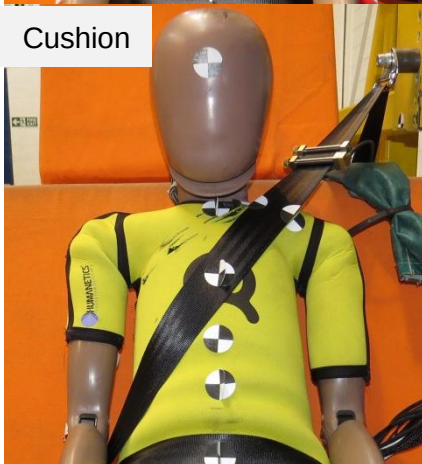
Chest loading - Results

Q6 Proposed limit – 56 mm

- Using R129 position seat belt slips into neck
- Using extreme position seat belt remains on the shoulder of dummy
- Chest deflection reaches physical limit before 56 mm
- Clavicle sensor detects upper ribcage loading but also reaches physical limit

Test	CRS	Belt in Neck	Clavicle (1st Peak)	Clavicle (2nd Peak)	Chest (1st Peak)	Chest (2nd Peak)
R129	No CRS	Started	21.73	23.46	18.86	33.47
Extreme	No CRS	N	34.15	36.84	33.34	37.10
R129	Booster seat	Y	29.73	28.82	23.75	30.98
Extreme	Booster seat	N	31.88	32.91	33.51	34.49
R129	Booster cushion	Y	31.35	31.91	27.46	29.72
Extreme	Booster cushion	N	28.71	-	35.26	35.26





Chest loading - Results

Q3 Proposed limit – 40 mm

- Using R129 position seat belt slips into neck
- Using extreme position seat belt slips into neck in all but 1 test (very wide initial position of belt over shoulder)
- Ribcage reaches physical limit before 40mm chest deflection
- Clavicle sensor detects upper ribcage loading but also reaches physical limit when belt doesn't slip into neck

Test	CRS	Belt in Neck	Clavicle (1st Peak)	Clavicle (2nd Peak)	Chest (1st Peak)	Chest (2nd Peak)
R129	Booster cushion 1	Y	22.57	39.37	16.51	34.25
Extreme	Booster cushion 1	N	32.16	25.07	43.29	37.46
R129	Booster cushion 2	Y	27.09	39.76	21.95	38.25
Extreme	Booster cushion 2	Y	36.73	39.46	33.67	39.61
R129	Booster seat 1	Y	32.16	39.18	27.48	38.98
Extreme	Booster seat 1	Y	35.54	38.18	30.92	38.44
R129	Booster seat 2	Y	13.27	32.04	10.63	29.17
Extreme	Booster seat 2	Y	37.58	38.84	32.56	37.59

Chest loading – Implication for R129

Aim

- Aim to validate proposed chest deflection thresholds
  - Q3 – 40 mm
  - Q6 – 56 mm
  - Q10 – 56 mm
- Determine clavicle sensor threshold for Q3 & Q6

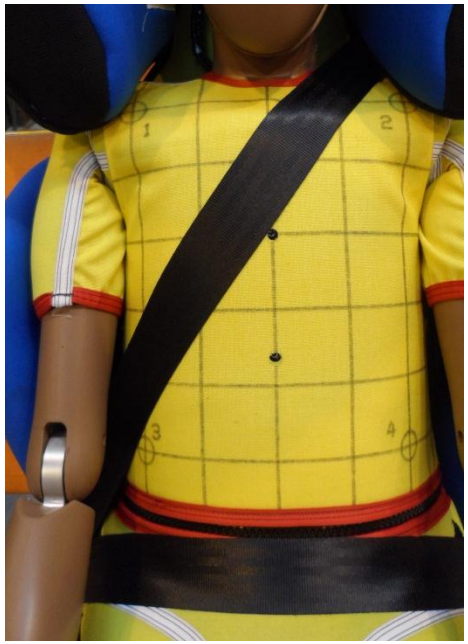
Findings

- Q10 limit seems appropriate
- Q3, Q6 thresholds not realistic
  - Chest or Clavicle deflection bottoms out before limit can be reached
  - Q3 needs dummy modification to allow more deformation without contact
  - Limits may be possible for Q6 only if an extreme belt position used

Belt path assessment

Develop static belt path assessment based on IIHS method

Use for Q3, Q6 & Q10



Too close to neck

Ok

Too wide

Conclusions

For evaluating non-integral CRSs in R129

Abdomen Loading

- Hip liner and pelvis inserts allow Q-Series dummies to submarine
- UMTRI installation method encourages submarining
- R129+ pulse increases abdomen loading
- 1.2 bar abdomen pressure limit may not be applicable for all dummies

Chest Loading

- Q10 limit seems sensible
- Q3, Q6 behaviour not realistic
- Q3, Q6 thresholds not realistic
- A static belt path assessment could be a solution to ensure poor belt routing is avoided

Do You Have Any Questions?

Thank you

Research findings for setting dummy injury thresholds for Regulation 129 Phase 2

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