DG ENTR Framework Contract
New UN Regulation on CRS

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UN Informal Group on CRS 16th April 2013
Terms of Reference for Phase 2 and Phase 3

Adopted text based on GRSP-49-01-Rev.1

- Phase 2 will develop definitions, performance criteria and test methods for **non-integral CRS** with ISOFIX attachments.

- In Phase 2, the **test pulse** for frontal impact (increased severity and CRS integrity) will be reviewed in light of recent accident data.

- In Phase 2, the strict application of recognised and accepted **injury criteria** related to the new generation of baby/child crash test Q-dummies, as supported through EEVC and other EU research programmes, will be reviewed in the light of recent accident data.
Project objectives

- To support the Commission during Phase 2 of draft new Regulation on “Enhanced Child Restraint Systems”

- To contribute to evidence base for technical aspects of new Regulation; including assessments of
  - Definitions, performance criteria and test methods for non-integral CRS with ISOFIX attachments
  - The test pulse for frontal impact
  - How best to apply recognised and accepted injury criteria related to the Q-Series
  - Other issues identified by the Commission related to validation of the Regulation
Work completed so far

First results presented today

- Measuring and assessing abdomen loading in non-integral ISOFIX CRS
  - 12 front impact experiments
  - Q3 and Q10 with abdomen sensors

- Further validation of the side impact test procedure
  - Full-scale car-to-car side impact experiment with Q3 and Q1
  - 8 sled side impact experiments

- Investigation of the front impact test pulse
  - Full-scale car-to-car front impact experiment
Measuring and assessing abdomen loading in non-integral ISOFIX CRS
**Background**

- Abdomen is common injury location in non-integral CRS
- CRS performance assessment made in UN Regulation 44
  - Modelling clay on lumbar spine
- New UN Regulation should maintain (and ideally enhance) CRS performance assessment in abdomen
- No method to detect abdomen loading in Q-Series
  - Modelling clay or instrumentation
  - Prototype sensor(s) developed in CHILD / CASPER
- Shortcomings in lap belt interaction
  - Dummy accessories evaluated in CASPER for Q3
  - Humanetics proposal for Q10
Objectives

- Investigate state-of-the-art of Q-Series dummies and sensors for measuring and assessing abdomen loading
- Propose and validate a solution that can be implemented in the draft new UN Regulation

- Do proposed accessories improve belt interaction?
- Are dummy / sensors sensitive to differences in CRS?
  - Especially those likely to influence abdomen injury risk
- Are changes to the test procedure needed to improve the assessment of non-integral ISOFIX CRS?
## Experiment matrix

<table>
<thead>
<tr>
<th>Dummy</th>
<th>Abdomen sensor</th>
<th>Accessory</th>
<th>CRS attach.</th>
<th>Lap belt guide</th>
<th>Seat cushion 5°</th>
<th>‘UMTRI’ seating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q10</td>
<td>X</td>
<td>X</td>
<td>ISOFIX</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Q10 / Q3</td>
<td>✓</td>
<td>X</td>
<td>ISOFIX</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Q10 / Q3</td>
<td>✓</td>
<td>✓</td>
<td>ISOFIX</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Q10 / Q3</td>
<td>✓</td>
<td>✓</td>
<td>ISOFIX</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Q10 / Q3</td>
<td>✓</td>
<td>✓</td>
<td>Seatbelt</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Q10 / Q3</td>
<td>✓</td>
<td>✓</td>
<td>ISOFIX</td>
<td>X</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Q10</td>
<td>✓</td>
<td>✓</td>
<td>ISOFIX</td>
<td>X</td>
<td>X</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Pelvis inserts (Q3)**

**Hip shields (Q10)**
Child restraint system

- **No lap belt guides**
- **Lap belt guides**

Harness removed for all experiments
Effect of abdomen sensor – Q10

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.72</td>
<td>1.22</td>
</tr>
</tbody>
</table>
Effect of accessory (IFSTTAR pelvis insert) – Q3

<table>
<thead>
<tr>
<th></th>
<th>No pelvis insert</th>
<th>Pelvis insert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left (bar)</td>
<td>0.28</td>
<td>0.21</td>
</tr>
<tr>
<td>Right (bar)</td>
<td>0.21</td>
<td>0.12</td>
</tr>
</tbody>
</table>
### Effect of accessory (Humanetics hip shields) – Q10

<table>
<thead>
<tr>
<th></th>
<th>No hip shields</th>
<th>Hip shields</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Left (bar)</strong></td>
<td>0.72</td>
<td>0.68</td>
</tr>
<tr>
<td><strong>Right (bar)</strong></td>
<td>1.22</td>
<td>1.27</td>
</tr>
</tbody>
</table>

**Table:**

<table>
<thead>
<tr>
<th></th>
<th>No hip shields</th>
<th>Hip shields</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Left (bar)</strong></td>
<td>0.72</td>
<td>0.68</td>
</tr>
<tr>
<td><strong>Right (bar)</strong></td>
<td>1.22</td>
<td>1.27</td>
</tr>
</tbody>
</table>

**Images:**

- No hip shields: A setup where a seat is visible with one leg showing 0.72 bar on the right and 1.22 bar on the left.
- Hip shields: A setup with similar visibility, but the values are 0.68 bar on the left and 1.27 bar on the right.
Sensitivity to CRS (attachment) – Q3

ISOFIX

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.21</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Belt-attached

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.16</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Lap belt force = 1.3 kN

Lap belt force = 3.0 kN

Pelvis inserts fitted in both experiments
Sensitivity to CRS (attachment) – Q10

ISOFIX

<table>
<thead>
<tr>
<th></th>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.68</td>
<td>1.27</td>
</tr>
</tbody>
</table>

Belt-attached

<table>
<thead>
<tr>
<th></th>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.79</td>
<td>1.37</td>
</tr>
</tbody>
</table>

Lap belt force = 3.5 kN

Lap belt force = 4.3 kN

Hip shields fitted in both experiments
## Sensitivity to CRS (lap belt guides) – Q3

<table>
<thead>
<tr>
<th></th>
<th>No lap belt guides</th>
<th>Lap belt guides</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Left (bar)</strong></td>
<td>0.21</td>
<td>0.47</td>
</tr>
<tr>
<td><strong>Right (bar)</strong></td>
<td>0.12</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Pelvis inserts fitted in both experiments
**Sensitivity to CRS (lap belt guides) – Q10**

<table>
<thead>
<tr>
<th></th>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No lap belt guides</td>
<td>0.68</td>
<td>1.27</td>
</tr>
<tr>
<td>Lap belt guides</td>
<td>0.74</td>
<td>1.25</td>
</tr>
</tbody>
</table>

*Hip shields fitted in both experiments*
Effect of seat cushion angle – Q3

Standard seat cushion

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.21</td>
<td>0.12</td>
</tr>
</tbody>
</table>

5° seat cushion

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.19</td>
<td>0.27</td>
</tr>
</tbody>
</table>

CRS lifted off cushion on sled release – repeat pending

Pelvis insert fitted in both experiments
### Effect of seat cushion angle – Q10

<table>
<thead>
<tr>
<th></th>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>0.68</td>
<td>1.27</td>
</tr>
<tr>
<td>5° seat cushion</td>
<td>0.71</td>
<td>1.25</td>
</tr>
</tbody>
</table>

**Hip shields fitted in both experiments**
Effect of positioning procedure – Q10

Standard procedure

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.68</td>
<td>1.27</td>
</tr>
</tbody>
</table>

UMTRI procedure

<table>
<thead>
<tr>
<th>Left (bar)</th>
<th>Right (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.56</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Hip shields fitted in both experiments
Summary

- Dummy kinematics and abdomen measurements reasonably consistent regardless of conditions

- Current procedure (dummy AND test bench) may not discriminate between non-integral ISOFIX CRS

- Will non-integral ISOFIX CRS be enhanced?
  - Test procedure may not encourage desirable features

- There may be benefits for other CRS types
  - E.g. impact shields

- We don’t know real human response in these conditions
  - Is there a role for human body simulation?
Further validation of the side impact test procedure
Background

- Static intrusion panel
  - Max. intrusion 250 mm
- Replicates intrusion velocity at time of max. head loading
- ISOFIX anchorages free to move
  - Unrealistic?
- Comparison with real vehicle promising (Johannsen et al., 2011)
  - Not worst-case vehicles
  - Severity has reduced

Objectives

- Investigate whether side impact test procedure is broadly comparable to a real side impact collision
- Investigate whether the side impact test procedure is capable of distinguishing between child restraints with different levels of side impact protection
- Can the side impact test procedure predict dummy loads in a typical collision?
- Will the side impact test encourage CRS features that are desirable for side impact?
Full-scale side impact experiment

Overview

- Based on UN Regulation 95
  - Deformable barrier replaced by second car
  - Front seat moved forwards approx. 20 mm

- Identical cars – typical supermini (probable worst-case)

<table>
<thead>
<tr>
<th>Car</th>
<th>Seating position</th>
<th>Dummy</th>
<th>Child restraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vauxhall Corsa #1 (target)</td>
<td>Front left</td>
<td>Q3</td>
<td>FF ISOFIX integral (Maxi-Cosi PrioriFix)</td>
</tr>
<tr>
<td></td>
<td>(struck side)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vauxhall Corsa #1 (target)</td>
<td>Rear left</td>
<td>Q1.5</td>
<td>RF ISOFIX integral (Britax Baby-Safe)</td>
</tr>
<tr>
<td></td>
<td>(struck side)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vauxhall Corsa #2 (bullet)</td>
<td>No dummies</td>
<td></td>
<td>(moderate front impact only)</td>
</tr>
</tbody>
</table>

Corsa not equipped with side impact air bags
Full-scale side impact experiment
Full-scale side impact experiment

Vehicle damage

Bullet car – Vauxhall Corsa

Target car – Vauxhall Corsa
Comparison with side impact test procedure

Q3 dummy in FF ISOFIX integral CRS

Door to CRS contact at 24 ms

Door to CRS contact at 21 ms
Comparison with side impact test procedure

Q1.5 dummy in RF ISOFIX integral CRS

Door to CRS contact at 31 ms

Door to CRS contact at 22 ms

Rear seat
Comparison with side impact test procedure

Principal dummy measurements

Q3 in FF ISOFIX integral CRS
Front seat in car

Q1.5 in RF ISOFIX integral CRS
Rear seat in car
Summary

- Side impact sled test procedure reproduced head load levels from a full-scale side impact collision
  - Head Res. 3ms and HIC15
  - Performance requirements in new UN Regulation
- Some differences observed in neck load levels
  - Sled underestimated Neck Fz for Q3 in front seat
  - Sled overestimated Neck Fy and Fz for Q1.5 in rear seat
  - No neck performance requirements in new UN Regulation
- Sled test procedure loaded chest differently
  - Sled underestimated chest acceleration but overestimated chest compression
  - No chest performance requirements in new UN Regulation
Sensitivity of side impact test procedure

Experiment matrix

<table>
<thead>
<tr>
<th>Dummy</th>
<th>CRS Type</th>
<th>Side impact features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3</td>
<td>FF ISOFIX integral</td>
<td>Baseline experiment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No EPS foam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced side wings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extra EPS</td>
</tr>
<tr>
<td>Q1.5</td>
<td>RF ISOFIX integral</td>
<td>Baseline experiment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No EPS foam</td>
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<tr>
<td></td>
<td></td>
<td>Reduced side wings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extra EPS</td>
</tr>
</tbody>
</table>
Child restraint system – TRL modifications

Baseline

Reduced wings

No EPS

Extra EPS
Q3 in FF ISOFIX integral CRS

Baseline

No EPS

Reduced wings

Extra EPS
Q1.5 in RF ISOFIX integral CRS

- Baseline
- No EPS
- Reduced wings
- Extra EPS
Principal dummy measurements

Q3 in FF ISOFIX integral CRS

Q1.5 in RF ISOFIX integral CRS
Summary

- Dummy measurements displayed some trends consistent with changes to baseline CRS
  - Results repeatable in body regions not affected by changes

- Head contained with minimal side structure on CRS
  - FF and RF CRS with reduced wings met minimum depth requirement (80 mm, for RF CRS)
  - Will test procedure encourage desirable features for head containment?

- We don’t know whether head would have been contained in real vehicle
Investigation of the front impact pulse
Vehicle stiffness has increased since UN Regulation 44
- Is the pulse representative of modern cars?

Previous comparisons made with 40% offset tests only
- Test of vehicle structure
  (lower deceleration than full-width test)

A full-width test pulse is more appropriate for testing restraint systems

**NHTSA data cars vs. full-width barrier (50 km/h) (source: Hynd et al., 2010)**

Objectives

- Investigate the acceleration pulse characteristics of a typical vehicle
- Compare typical vehicle pulse characteristics with front impact corridor in new UN Regulation
- Is the sled pulse consistent with a typical vehicle in a full-width collision?
- What are the implications of any differences?
- How do the ISOFIX anchorages behave?
Full-scale front impact experiment

Overview

- Moving car to moving car
  - 50 km/h
  - Full-width

- Identical cars – superminis (worst-case)

<table>
<thead>
<tr>
<th>Car</th>
<th>Seating position</th>
<th>Dummy</th>
<th>Child restraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfa Romeo MiTo #1</td>
<td>Rear left</td>
<td>Q3</td>
<td>ISOFIX non-integral</td>
</tr>
<tr>
<td></td>
<td>Rear right</td>
<td>Q3</td>
<td>ISOFIX integral</td>
</tr>
<tr>
<td>Alfa Romeo MiTo #2</td>
<td>Rear left</td>
<td>Q6</td>
<td>ISOFIX non-integral</td>
</tr>
<tr>
<td></td>
<td>Rear right</td>
<td>Q6</td>
<td>Non-integral</td>
</tr>
</tbody>
</table>
Full-scale front impact experiment
Full-scale front impact experiment
Full-scale front impact experiment

Belt only

ISOFIX
Full-scale front impact experiment
Full-scale front impact experiment
Vehicle deceleration
Full-scale front impact experiment

ISOFIX anchorage deformation – ISOFIX integral CRS
Any Questions?
Thank you

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