Research Context

Crashworthiness research is conducted in support of regulations. This includes:

- Monitoring current regulations & proposed test protocols to ensure that they address the safety needs of Canadians;
- Investigating test methodologies including the biofidelity of crash test dummies and the introduction new technologies;
- Providing the Department with the necessary scientific basis on which to base policy decisions and future regulatory initiatives.

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Research Context cont'd

Child restraints & booster seats are installed in test vehicles to

- Compare dummy types and evaluate dummy capabilities;
- Help in the development of test methodologies
- Describe how design features/ characteristics influence dummy responses

The research programs are not intended to rate or rank the effectiveness of vehicles, child restraints or booster seats.

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Tests Conducted

1. Full frontal rigid barrier
2. Moving car-to-moving car frontal crash tests
   - full frontal engagement of the two vehicles
   - 40 % frontal offset
3. Vehicle buck on sled
4. Canadian/ US regulatory compliance bench

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Selection Process

1. Vehicles

   Selected on the basis of popularity and purchased from car dealerships

2. Child restraints & booster seats

   - Selected on the basis of design features
   - May or may not be admissible for sale in Canada
   - Purchased from shops or the internet

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Protection of children in cars 2016

- Foldable
- Inflatable
- Latch-able

<u>ALL</u>
PASSED COMPLIANCE
BENCH TEST

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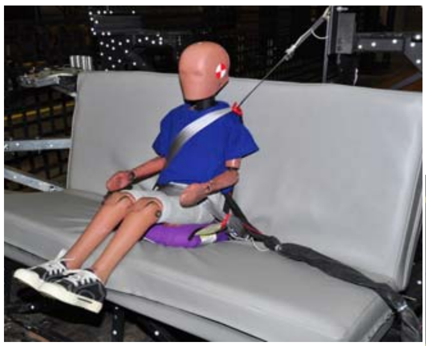
Objectives of the 2016 Study

To evaluate whether the capabilities of current child crash test dummy instrumentation and the associated metrics are adequate for the evaluation of booster seat performance.



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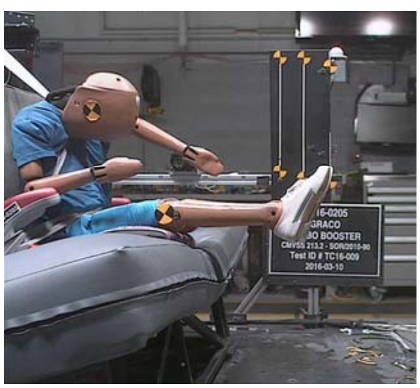
C/FMVSS 213.2 Compliance



DIFFERENCES

- No retractor
- Anchor at the rear
- Seatbelt is **locked and pre-loaded**
- Cushion is flat, soft & sticky
- Seat back is unyielding

CRITERIA

- Excursion (*not representative of in-vehicle use since the dummy is held in place by the pre-loaded belt on the test bench*)
- Chest acceleration *(not representative of in-vehicle use since the dummy is held in place by the pre-loaded belt on the test bench)*
- Head acceleration (*inertial only*)

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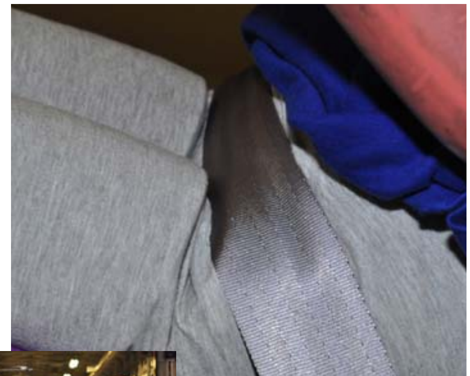
HIII 6-year-old is a mini adult dummy



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2016 Conclusions

- Movement of the HIII and the Q6 and the interactions with restraints are notably different
- Dummy measures/ traditional injury metrics were not predictive
- Variables worthy of further consideration:
    - frontal excursion functional seat belt
    - pressure sensors in the Q6

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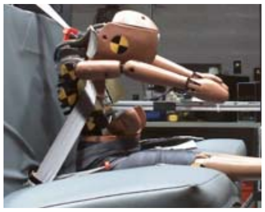
Research activities since 2016

1. Exploratory regulatory-like tests using the C/FMVSS 213 sled buck.
   - To identify test parameters and methods that are more sensitive to booster seat designs and that could be introduced to regulatory testing;
   - To gain a better understanding of the ATD responses
2. Paired comparisons on a vehicle buck
   - To confirm that the test parameters and methods identified during C/FMVSS 213 sled tests are reproducible
3. In-vehicle test comparisons
   - To confirm that the test parameters and methods identified during sled tests are identifiable in actual vehicles.



CMVSS 213 buck: exploratory tests

Chose a selection of booster seats as a function of lap belt placement
- Distance of belt edge from pubis 0 to 44 mm

Measured
- lap & shoulder belt loads
- upper spine acceleration
- chest acceleration
- pelvis acceleration
- thorax rotation

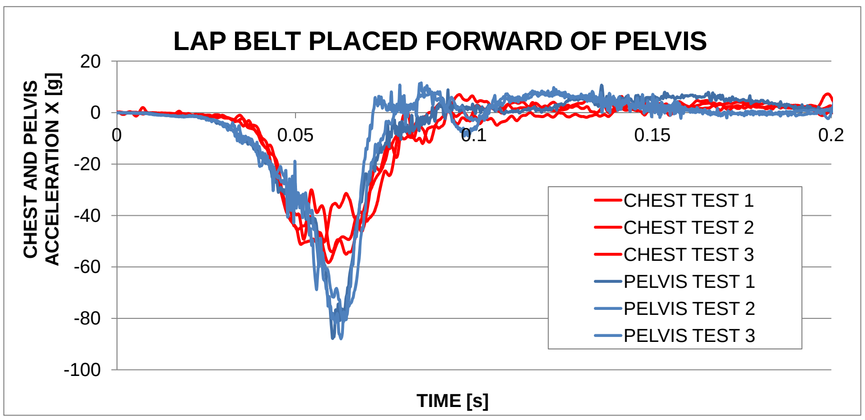
Freeze frame

Seat belt will behave as a rope when tension is applied.
This means that the seat belt will straighten and align itself with the true anchorage point.

With belt loads that are of the order of 6 kN plastic guides, velcro and or webbing are not sufficiently strong to overcome the forces and maintain the belt in position.

Interim Findings

The further the lap belt is located ahead of the pelvis the greater the pelvic acceleration is relative to the chest. This implies that the pelvis is displaced forward while the chest is held back. Forward excursion is increased.



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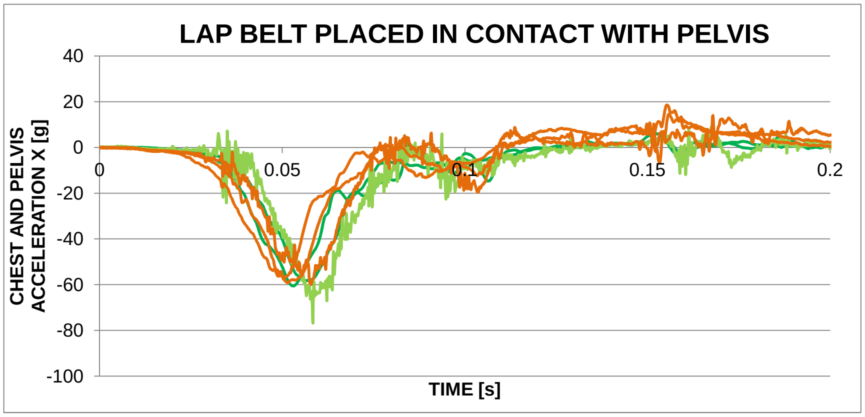
Interim Findings

With the lap belt placed on or close to the pelvis the greater the chest and pelvic accelerations are comparable. This implies that the pelvis and the chest are held back together. Forward excursion is reduced.



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STEP 1 DOES IT FIT YOUR CHILD **AND** THE VEHICLE THEY RIDE IN?

STEP 2 DOES IT FIT YOUR CHILD?

STEP 2 DOES IT FIT YOUR CHILD?

COMFORT:

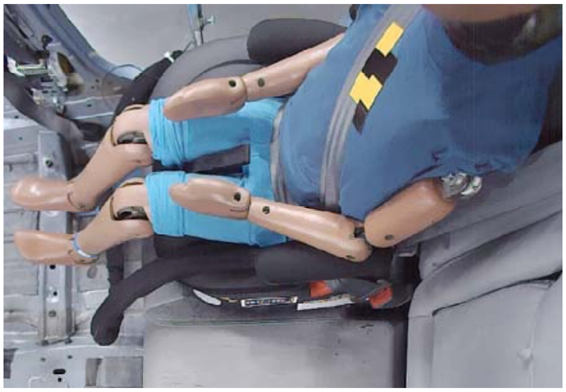
1. Can your child sit up straight, with his or her back against the seatback?
2. Do his/her knees bend over the edge of the booster seat or vehicle seat?

BELT FIT:

1. Does the shoulder belt cross the middle of the shoulder
2. Is the lap belt snug against the front of the hips

STEP 2 DOES IT FIT YOUR CHILD?

1. Engage the pelvis quickly to reduce forward excursion
2. Share the belt forces



Conclusions that still hold true

- A harmonized child dummy capable of reproducing human posture and motion in a realistic vehicle environment is needed.
- Test programs should explore alternative test methods
- Reliance on minimum requirements and the associated test methodologies may not be conducive for the development or for the optimization of child safety

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