NHTSA's WheelChair Safety Testing

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Wheelchair Safety - Background

• CFR Title 49, Part 595 - allows modifications to vehicle to facilitate mobility for those with disabilities
  – For wheelchair seated driver, Part 595 allows air bags to be disabled if a securement device for the wheelchair and Type-2 safety belts (3 point belts) are installed

• UMTRI study (June 2016) - Wheelchair Occupant Studies -
  – Crash data study
  – 21 disabled drivers seating study
  – Sled tests
  – Computer simulations
    • Properly restrained wheelchair seated drivers benefit from the air bag

• VRTC Study - Crash tests to verify benefits of air bags
Crash Test Setup

- 2 identical crash tests - With and without air bag
- 2015 Dodge Caravan Braun EVII Conversion Vans
- Quantum Q6 Edge 2.0 Wheelchair (WC19 compliant)
- Hybrid III 50th percentile male dummy
- Q’straint QLK-150 docking base (SAE J2249/WC 18) compliant
**Dummy Seating**

- Replicate the average occupant position from the UMTRI study
Real-time Video
Dummy Kinematics – Upper
Dummy Kinematics - Head
Dummy Kinematics - Lower
### Dummy Injury Assessments
(No airbag vs. with airbag vs. FMVSS208)

<table>
<thead>
<tr>
<th>Dummy IAV</th>
<th>IARV</th>
<th>Without air bags</th>
<th>With air bags</th>
<th>Percent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIC15</td>
<td>700</td>
<td>368</td>
<td>101</td>
<td>- 72 %</td>
</tr>
<tr>
<td>BrIC*</td>
<td>1.0</td>
<td>0.80</td>
<td>0.55</td>
<td>- 31 %</td>
</tr>
<tr>
<td>Nij</td>
<td>1.0</td>
<td>0.37</td>
<td>0.37</td>
<td>--</td>
</tr>
<tr>
<td>Chest g (3 ms)</td>
<td>60</td>
<td>58.4</td>
<td>44.2</td>
<td>- 24 %</td>
</tr>
<tr>
<td>Chest defln (mm)</td>
<td>63</td>
<td>47.5</td>
<td>38.9</td>
<td>- 18 %</td>
</tr>
<tr>
<td>Femur loads (N)</td>
<td>10000</td>
<td>5845</td>
<td>9265</td>
<td>+ 58 %</td>
</tr>
</tbody>
</table>

* - Not in FMVSS
Femur Loads

- Left femur loads - Similar in two tests
- Right femur loads - Higher with air bags
- Reason: Slightly different impact locations

**Left Femur Force**

- Without Airbag: Min = -3931 N
- With Airbag: Min = -3868 N

**Right Femur Force**

- Without Airbag: Min = -5846 N
- With Airbag: Min = -9265 N
Dummy Excursions

With airbag - 368 mm

Without airbag - 429 mm
Head C.G Excursion

- Using photogrammetry (6 - D)
Wheelchair Bracket Performance

-20.0
Wheelchair Seat Back Support Failures

- At ~ 100 ms
- Inertial loading
- Both crash tests
Observations

- Air bags reduced dummy injury assessments for the head, chest
- Head rotation injury (BrIC) reduced from 80% to 55% of IARV (Injury Assessment Reference Value)
- Chest acceleration reduced from 97% to 74% of IARV
- Chest deflection reduced from 75% to 62% of IARV
- Neck injury assessment similar
- Right leg femur injury assessment higher with the airbags - possibly because the knees contact different structures
- Wheelchair seat back failure from inertial loading

Test reports, data, videos in VEHDB at https://one.nhtsa.gov/Research/Databases-and-Software
Test # 10029, 10030