Project Acknowledgement

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Presented at the 2018 SAE Government & Industry in Washington DC
Agenda

- Project Definition
- Countermeasures
- Driver Side
- Passenger Side
- Summary
# Agenda

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Project Definition
Load Case Definition

- Movable Deformable Barrier (~2490 kg / 90 km/h)
- Impact angle 15° - Overlap 35%
- THOR dummy on driver and passenger side
- IAVs like BrIC, Multiple chest deflection measurements
Evaluate vehicles that meet the following requirements

- Small and midsize cars
- Good or acceptable small overlap structural rating
- FMVSS 226 Capable Curtain Air Bag

Seven vehicles met the requirements

- Nissan Versa
- Dodge Dart
- Honda Accord
- Mazda 3
- Honda Civic
- Honda Fit
- Volvo S60
Baseline Vehicle and Sled Tests

- B-Segment interior and restraints with 18° sled angle
- Occupant kinematics, contact points, and injury measures in the sled tests matched the general trends in the full vehicle OMDB tests
  - Driver near (left) side: head rolls off bag, door contact, high BrIC and chestD
  - Driver far (right) side: belt rollout, IP contact, high BrIC and chestD
  - Passenger near (right) side: head rolls off bag, high BrIC and chestD
  - Passenger far (left) side: belt rollout, IP contact, high BrIC and chestD
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<td>Summary</td>
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</table>
## Countermeasures Investigated

<table>
<thead>
<tr>
<th>Seat Belts</th>
<th>3-Pt Belt</th>
<th>'X-type' 4-Pt Belt</th>
<th>Suspender 4-Pt Belt</th>
<th>Rerouted 3-Pt Belt</th>
<th>Relocated Retractor</th>
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</thead>
<tbody>
<tr>
<td>Seat Belts Pre-tensioner (PT) Load Limiter (LL)</td>
<td>DLT</td>
<td>Buckle PT</td>
<td>Anchor PT</td>
<td>Digressive LL</td>
<td>Switchable LL</td>
</tr>
<tr>
<td>Passenger Air Bags</td>
<td>V64 PAB</td>
<td>V13 PAB</td>
<td>Clapper PAB</td>
<td>Parallel Cell PAB</td>
<td>Kickstand PAB</td>
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<tr>
<td>Driver/Knee/Side Air Bags</td>
<td>Cone DAB</td>
<td>SQS DAB</td>
<td>Support Bag</td>
<td>Inboard SAB</td>
<td>Passenger KnAB</td>
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<tr>
<td>Curtain Air Bags</td>
<td>Three Small Chamber CAB</td>
<td>Two Medium Chamber CAB</td>
<td>Single Large Chamber CAB</td>
<td>Buckle CAB</td>
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</table>
Driver 4-Pt Belt Option

- In a left side oblique collision, seat belt retractor #2 would have a larger load limiting force than retractor #1.
- In a frontal collision, both seat belt retractors (#1 & #2) would have the same load limiting force.
- In a right side oblique collision, seat belt retractor #1 would have a larger load limiting force than retractor #2.
Passenger Kickstand Bag

• In the oblique crash condition, the passenger bag tends to tip over because the occupant pushes the bag over.
• The kickstand bag works like a kickstand on a bike. It gives lateral support so the bag doesn’t have the tendency to tip over.
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Driver Advanced System

Baseline
- Baseline DAB
- Three Small Chamber CAB
- Baseline KnAB

3-Point System
- Baseline DAB
- Driver Support Bag
- DLL Retractor with Pre-tensions
- Two Medium Chamber CAB
- Baseline KnAB

4-Point System
- SQS DAB
- Baseline KnAB
- TB-1: 8.0mm
- TB-2: 10.5mm
- Two Medium Chamber Curtain
### Driver Far Side

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Technology</th>
<th>Technology</th>
<th>Head</th>
<th>Neck</th>
<th>Chest</th>
<th>Abd.</th>
<th>Acet.</th>
<th>Femur</th>
<th>Pjoint</th>
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<td>Nij</td>
<td>Rmax</td>
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Driver Far Side (Driver Support Bag)

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<tr>
<th>DAB</th>
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<th>BrlC</th>
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Driver Far Side

Baseline

3-Point System

4-Point System
# Driver Near Side

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<tr>
<th>Test No.</th>
<th>Technology</th>
<th>Head</th>
<th>Neck</th>
<th>Chest</th>
<th>Abd.</th>
<th>Acet.</th>
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<td>HIC</td>
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<td>Nij</td>
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Driver Near Side

Baseline            3-Point System            4-Point System
Driver Near Side

Baseline (CAB: 34 ms) 3-Pt System (CAB: 14 ms) 4-Pt System (CAB: 14 ms)
# Agenda

- Project Definition
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Passenger Advanced Systems

Baseline
- Baseline PAB
- Three Small Chamber Curtain

3-Point System
- Kickstand PAB
- Two Medium Chamber Curtain
- DLL Retractor with Pre-tensioner

4-Point System
- V13 PAB
- Three Small Chamber Curtain
- TB-1: 8.0mm
- TB-2: 9.0mm

NHTSA
## Passenger Far Side

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Technology</th>
<th>Head</th>
<th>Neck</th>
<th>Chest</th>
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### Passenger Far Side (Kickstand Bag)

<table>
<thead>
<tr>
<th>PAB</th>
<th>Seat Belt</th>
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<th>BrIC</th>
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</thead>
<tbody>
<tr>
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<tr>
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![Graph showing baseline and relocated positions for passenger far side](image)
Passenger Far Side

Baseline 3-Point System 4-Point System
# Passenger Near Side

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Technology</th>
<th>Head</th>
<th>Neck</th>
<th>Chest</th>
<th>Abd.</th>
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<tr>
<td></td>
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<td>HIC</td>
<td>BrIC</td>
<td>Nij</td>
<td>Rmax</td>
<td>Dmax</td>
<td>Fmax</td>
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<td>2411</td>
<td>4074</td>
</tr>
</tbody>
</table>
Passenger Near Side

Baseline

3-Point System

4-Point System
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**Summary**

- **Far Side Impacts**
  - Driver Support Bag and Passenger Kickstand Bag supported the head and reduced the BrIC and Nij, and eliminated head contact to the instrument panel.
  - The relocated belt (closer to shoulder) and a digressive load limiter reduced shoulder roll out of the belt and the chest compression.
  - The knee air bag on the passenger side reduced the acetabulum loads.
  - The 4-Point belt system reduced the chest compression, BrIC, and acetabulum loads (passenger side) while eliminating head contact to the instrument panel and shoulder roll out of the belt.
Summary

• Near Side Impacts
  – A thicker curtain air bag fired earlier reduced the BrIC.
  – The relocated belt (closer to shoulder) and a digressive load limiter reduced the chest compression.
  – The 4-Point belt system reduced the chest compression while eliminating the head contact to the door.