Evaluation of Advance Compatibility
Frontal Structures Using the Progressive
Deformable Barrier

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Overview

- Introduction
- Vehicle selection
- Test Configuration
- Method of Test Evaluation
- Test results / Comparison
- Conclusion
Introduction

- Bilateral agreement between French DSCR and US NHTSA to enhance cooperation and increase the efficient use of resources to promote the development of improved vehicle safety programs and related regulations.

- Investigate whether barrier deformation using PDB, intrusion, and dummy injury measures can differentiate compatibility performances between vehicles.
  - Evaluates criteria of self protection and partner protection in the offset frontal crash test configuration with vehicles that have structures designed for good partner protection.
  - Compares current tests with prior research conducted under the cooperative agreement.
  - Compares the results to prior car-to-car crash tests and real world crash analysis.
Prior Research

- Prior effort between DSCR and NHTSA (ESV Paper No. 07-0303)
  - PDB Offset tests with a body-on-frame Chevrolet Silverado pick-up truck and a unibody Chrysler Town & Country minivan

- U.S. NCAP Testing
  - Full width rigid barrier at 56 km/h
  - Frontal stiffness and force matching height data available for both Honda Odysseys

- U.S. Vehicle-to-Vehicle Tests
  - Honda Odysseys (with and w/o ACE) were crashed into a Ford Focus in a full frontal crash configuration
Test Configuration

PDB-XT = PDB + 90mm in the back

- Offset PDB+
- 50 % overlap
- 60 km/h

2 Belted 50th percentile males – Driver had Thor-Lx legs
Vehicle Selection

- 2 Honda Odyssey minivans
  - MY 2004 – w/o ACE
  - MY 2005 – with ACE

- Body-in-white showing Honda ACE structure
Method of Test evaluation

- Test Severity Evaluation
  - Equivalent Energy Speed

- Self Protection (Vehicle based metrics)
  - Compartment intrusion
  - Dummy injury criteria

- Partner Protection (Barrier based metrics)
  - AHOD Average Height Of Deformation
  - ADOD Average Depth Of Deformation
  - Dmax Maximum Deformation
## Test Severity

<table>
<thead>
<tr>
<th>Odyssey with ACE</th>
<th>Odyssey without ACE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="test_severity_odyssey_with_ace.png" alt="Image" /></td>
<td><img src="test_severity_odyssey_without_ace.png" alt="Image" /></td>
</tr>
<tr>
<td>• PDB Energy Absorbed by the barrier: 104 kJ</td>
<td>• Energy Absorbed by the barrier: 97 kJ</td>
</tr>
<tr>
<td>• EES: 49.6 km/h</td>
<td>• EES: 50.6 km/h</td>
</tr>
</tbody>
</table>
## Self Protection

### Odyssey with ACE vs. Odyssey without ACE

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>HIC36</td>
<td>290</td>
<td>284</td>
<td>283</td>
<td>273</td>
</tr>
<tr>
<td>Chest Def</td>
<td>26.6</td>
<td>26.5</td>
<td>28.7</td>
<td>33.4</td>
</tr>
<tr>
<td>Chest Gs</td>
<td>39.2</td>
<td>27.4</td>
<td>37.1</td>
<td>28.7</td>
</tr>
<tr>
<td>Left Femur</td>
<td>4.76</td>
<td>2.03</td>
<td>1.61</td>
<td>2.78</td>
</tr>
<tr>
<td>Right Femur</td>
<td>1.21</td>
<td>0.97</td>
<td>0.75</td>
<td>1.36</td>
</tr>
</tbody>
</table>

### Intrusion Injury Measures

- **Honda Odyssey - ACE/PDB-XT**
  - Dashboard: 0-20 mm
  - A Pillar Waist: 0-20 mm
  - Pedal Axle: 0-150 mm
  - Footwell: 0-150 mm
  - A Pillar Sill: 0-150 mm

- **Honda Odyssey - No ACE/PDB-XT**
  - Dashboard: 0-50 mm
  - A Pillar Waist: 0-50 mm
  - Pedal Axle: 0-200 mm
  - Footwell: 0-200 mm
  - A Pillar Sill: 0-200 mm
<table>
<thead>
<tr>
<th>Odyssey with ACE</th>
<th>Odyssey without ACE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Frame Rail" /></td>
<td><img src="image2" alt="Frame Rail" /></td>
</tr>
<tr>
<td><img src="image3" alt="Vertical Connections" /></td>
<td><img src="image4" alt="Crossbeam" /></td>
</tr>
</tbody>
</table>

**Deformation**

- **Y coordinate**
  - 0 to 1000
- **Z coordinate**
  - 0 to 700

**Legend**

- **Frame Rail**
- **Crossbeam**
- **Vertical Connections**
Partner Protection: Parameters

<table>
<thead>
<tr>
<th>Odyssey with ACE</th>
<th>Odyssey without ACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Town &amp; Country Minivan</td>
<td>Chevrolet Silverado Pick-up Truck</td>
</tr>
<tr>
<td>Vertical Connections</td>
<td>Frame Rail</td>
</tr>
<tr>
<td>Crossbeam</td>
<td>Crossbeam</td>
</tr>
</tbody>
</table>
## Vehicle-to-Vehicle Crashes: Stiffness

<table>
<thead>
<tr>
<th>Model and Year</th>
<th>KW400* N/mm</th>
<th>Accel. At CG in Focus (m²/s)</th>
<th>Accel. At CG in Striking Vehicle (m²/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002 Ford Focus</td>
<td>934</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bullet Vehicles</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005 Chrysler Town &amp; Country</td>
<td>1,137</td>
<td>90.5</td>
<td>47.6</td>
</tr>
<tr>
<td>2003 Honda Odyssey w/o ACE</td>
<td>1,448</td>
<td>108</td>
<td>32.1</td>
</tr>
<tr>
<td>2005 Honda Odyssey w/ACE</td>
<td>1,456</td>
<td>113.5</td>
<td>40.3</td>
</tr>
<tr>
<td>2003 Chevrolet Silverado</td>
<td>1,619</td>
<td>86.2</td>
<td>32.9</td>
</tr>
</tbody>
</table>

* KW400 is the stiffness-related crush energy absorbed by a vehicle in the first 400 mm of crush (also called work stiffness).
Vehicle-to-Vehicle Crashes: Performance

- Bullet: Odyssey with ACE
- Bullet: Odyssey without ACE
- Bullet: Town & Country Minivan
- Bullet: Chevrolet Silverado P/U Truck

Target Vehicle is a 2002 Ford Focus

Focus Frontal Crush Profile

- Without ACE
- With ACE
- T&C

Measures not taken for Silverado
Real World Performance of ACE

- NASS CDS Case No. 2007-04-0137
- Minor severity crash
- CDC code of 01FYEW02
- Principle direction of force: 20°
- Honda Odyssey
  - $\Delta V = 15 \text{ km/h}$
  - Airbags deployed
  - Driver sustained minor injuries
- Ford Escape
  - Airbags did not deploy
  - Driver sustained minor injuries
- Intrusion in both vehicles likely insignificant (based on photos)

2005 Honda Odyssey (2,102 kg)

2006 Ford Escape (1,545 kg)
Homogeneous deformation of the PDB suggests good horizontal and vertical engagement with a partner vehicle, as shown by the vehicle-to-vehicle tests.

Analysis of compatibility metrics indicates stiffness alone may not indicate aggressivity.

Further evaluation is needed to address both the stiffness of the vehicle as well as the homogeneity of that stiffness.
Full Analysis can be found in ESV Paper 09-0329

The End