VRTC Rear Impact Sled Testing Status

BioRID II vs. Hybrid III and
FMVSS 202a vs. ENCAP-Annex 9

Edward Probst, NHTSA
James Stricklin, TRC

March 2011
Overview –

Rear Impact Sled Testing

• Objective
  – Compare the responses of the BioRID II (g) with those of the Hybrid III when subjected to FMVSS 202a and ENCAP-A9 pulses

• Methods
  – Utilize the side-by-side VRTC rear impact research buck on the TRC HYGE sled.
  – Vary seat configuration from “perceived” good to poor by varying head restraint backset.

• Results
  – BioRID II – Good discrimination with A9 pulse and ENCAP evaluation criteria
  – Hybrid III – Head/T1 angle correlates with backset; little discrimination with other 202 or A9 parameters
  – Results affected by mass and rigidity of research buck seat/head restraints

• Follow-up Activities
  – Additional sled tests planned utilizing “good-rated” OEM seat design (March/April)
Test Methods –

ATDs

• BioRID II 50th
  – Fully certified by Humanetics (Denton) prior to test
  – Configured to change level “G”

• Hybrid III 50th
  – Pre-test certified head and neck
Test Methods - Rear Impact Sled Testing

Buck and Seat Setup

• Experimental rear impact test buck
  – Repeatable/reusable test environment
  – 1999 Toyota Camry seat configuration/geometry
  – Realistic seat back rotation response
  – Side-by-side configuration (mirror image belt configurations)
Test Methods -
Buck and Seat Setup (cont.)

- Head restraint designed to produce varying degrees of backset
  - 25, 50, 75 and 100 mm
    - Good → Poor
- Seats “Oscar’d” at beginning of each pulse sequence
  - Establish seat H-pt
  - Check for seat cushion compression
- Camera positions:
  - Full view and upper torso close-up
  - 1000 fps
Test Methods -
Sled Pulse

- FMVSS 202a
Test Methods -
Sled Pulse (cont.)

- ENCAP – Annex 9
  - Issues
    - Evaluated several existing pins
    - Best option onset too fast
    - 4-5 weeks -$5K for new pin

Rear Impact
Sled Testing

March 2011
Test Methods – Instrumentation

- **BioRID II**
  - 26 channels
    - Accels – head, T1, T8, lumbar, pelvis
    - Load – skull cap, upper & lower neck, lumbar
    - Moment - upper & lower neck, lumbar
    - ARS – head, T1, pelvis

- **HIII**
  - 18 channels
    - Accels – head, T1, pelvis
    - Load – upper & lower neck, lumbar
    - Moment - upper & lower neck, lumbar
    - ARS – head, T1, pelvis

- **Sled**
  - 25 channels
    - Acceleration
    - Head contact
    - Seat pan and seat back load cells, accels, and ARS

March 2011
Test Methods – Rear Impact

Test Matrix

- Pulses segregated to minimize pin changes
- Backsets randomized
- Dummies assigned seating position

<table>
<thead>
<tr>
<th>Test number</th>
<th>Pulse</th>
<th>Backset (mm)</th>
<th>H3 50th</th>
<th>BioRID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>202a</td>
<td>75</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>2</td>
<td>202a</td>
<td>100</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>3</td>
<td>202a</td>
<td>75</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>4</td>
<td>202a</td>
<td>25</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>5</td>
<td>202a</td>
<td>50</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>6</td>
<td>202a</td>
<td>100</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>7</td>
<td>202a</td>
<td>25</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>8</td>
<td>202a</td>
<td>50</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>9</td>
<td>Annex 9</td>
<td>50</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>10</td>
<td>Annex 9</td>
<td>75</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>11</td>
<td>Annex 9</td>
<td>100</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>12</td>
<td>Annex 9</td>
<td>25</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>13</td>
<td>Annex 9</td>
<td>100</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>14</td>
<td>Annex 9</td>
<td>75</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>15</td>
<td>Annex 9</td>
<td>50</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>16</td>
<td>Annex 9</td>
<td>25</td>
<td>Right</td>
<td>Left</td>
</tr>
</tbody>
</table>

March 2011
Typical Test –
202a Pulse, 75 mm Backset

Rear Impact
Sled Testing

March 2011
Results –
Evaluation Criteria

- **FMVSS 202a**
  - Head-to-T1 angle
    *(less than 12° extension)*
  - HIC$_{15}$
    *(Less than 500)*

- **ENCAP** *(Whiplash assessment)*
  - Upper Neck Shear, Fx
  - Upper Neck Tension, Fz
  - T1 Acceleration
  - NIC \([f(\text{relative head-T1 accel & vel})]\)
  - Nkm \([f(\text{UPNK Fx & My})]\)
  - Time to Head Restraint First Contact
  - Rebound velocity
Results –  
Evaluation Criteria (cont.)

**Analysis: EuroNCAP**

High, Low and Capping limits – medium pulse

<table>
<thead>
<tr>
<th>Euro NCAP Criteria</th>
<th>Units</th>
<th>Medium Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIC</td>
<td>m/s²</td>
<td>11.00 24.00 27.00</td>
</tr>
<tr>
<td>Hkm</td>
<td>-</td>
<td>0.15 0.55 0.69</td>
</tr>
<tr>
<td>Rebound velocity</td>
<td>m/s</td>
<td>3.20 4.80 5.20</td>
</tr>
<tr>
<td>Upper Neck Shear Fx</td>
<td>N</td>
<td>30.00 190.00 200.00</td>
</tr>
<tr>
<td>Upper Neck Tension Fz</td>
<td>N</td>
<td>360.00 750.00 900.00</td>
</tr>
<tr>
<td>T₁ acceleration</td>
<td>g</td>
<td>9.30 13.10 15.55</td>
</tr>
<tr>
<td>Time to head restraint first contact</td>
<td>ms</td>
<td>57.00 82.00 92.00</td>
</tr>
</tbody>
</table>

ENCAP method of rating seat performance for whiplash protection

Slides from B. Donnelly presentation at GTR meeting Sept., 2010.

March 2011
### Results –
*Data Observations*

<table>
<thead>
<tr>
<th>HIII</th>
<th>BioRID</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>202a</strong></td>
<td></td>
</tr>
<tr>
<td>Backset</td>
<td>Backset</td>
</tr>
<tr>
<td>⬇️ Head to T1 angle</td>
<td>⬆️ Head to T1 angle</td>
</tr>
<tr>
<td>⬆️ HIC</td>
<td>⬇️ HIC &lt; 400</td>
</tr>
<tr>
<td>• Time to contact: HIII &lt; BioRID</td>
<td></td>
</tr>
</tbody>
</table>

| **Annex 9** |
| Backset | Backset |
| ⬇️ Head to T1 angle | ⬆️ T1XG, T1ZG, HIC, HDXG, NIC |
| ⬆️ A9 Eval Criteria | |
| • Time to contact: HIII < BioRID | • Highest sensitivity combination |
Conclusions –

- BioRID does not appear to display meaningful discrimination with respect to 202a assessment criteria
  - Head-to-T1 angle
  - HIC
- HIII better in 202a with this seat configuration
  - Shows expected discrimination wrt Head-to-T1 rotation
  - No discrimination shown wrt HIC
- Choice of buck appears to have affected the results
  - Head restraint too hard
  - Seat pan and seat back may be too stiff (inadequate suspension)

March 2011
New Test Plan –

1. New Side-by-side Buck with OEM seats
   – 2011 Chevy Cruze driver seats
     • Rated “Good” in ENCAP and IIHS rear impact assessments
   – Devise backset adjustability to produce “Good” and “Poor”

2. Fabricate new A9 HYGE gun metering pin
   – Designed specifically for new buck
   – Goal is to achieve better compliance with A9 corridors

3. Proposed Matrix – eight tests (two repeats of each condition)

<table>
<thead>
<tr>
<th>Test No</th>
<th>Pulse</th>
<th>Backset</th>
<th>HII</th>
<th>BioRID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>202a</td>
<td>Good</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>A9</td>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Good</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

March 2011
Thank you