NHTSA Evaluation of the Hybrid III 10 Year Old Dummy

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Overview

- Why a “10 year old” dummy?
- History/background
- NHTSA role in HIII-10C development
- HIII-10C dummy features
- VRTC evaluation program
- Future work
Why a “10 Year Old”?

- NHTSA, advocates pushing booster use
- Boosters made to protect kids up to 80 lbs
  - Meet state requirements for use
  - No dummy to test these larger CRS
Background

- SAE initiates HIII-10C development
- TREAD enacted
- 1st HIII-10C prototype is evaluated
- VRTC begins Part 572 evaluation
- Anton’s Law enacted
NHTSA’s Role

- Attended/participated in SAE meetings
- Evaluated 1st prototype dummy
- Evaluating “production-intent” dummies
Dummy Description

Weight = 77.6 lbs (35.3 kg)
Sitting Height = 28.5 in (72.4 cm)
Theoretical Standing Height = 51 in (129.5 cm)

FEATURES:

Instrumented shoulders with more realistic shape
Dummy Description

Weight = 77.6 lbs (35.3 kg)
Sitting Height = 28.5 in (72.4 cm)
Theoretical Standing Height = 51 in (129.5 cm)

FEATURES:

Thoracic instrumentation optional to chest ball-slider mechanism
Dummy Description

Weight = 77.6 lbs (35.3 kg)
Sitting Height = 28.5 in (72.4 cm)
Theoretical Standing Height = 51 in (129.5 cm)

FEATURES:

Adjustable lumbar angle to simulate slouch posture in children
Inspection

- Received drawings from each manufacturer
  - Reviewed them for completeness, accuracy
- Acquired two dummies
  - Conducted part-by-part inspection vs. drawings
- Reviewed external dimensions & weights
Component Testing

- Tested head, neck, thorax, knees, torso flex
  - SAE-proposed test procedure and response corridors (Mertz et al, 2001 Stapp)

Components within corridor, repeatable
Booster Seat Testing

• Two dummies per test
• Five seating configurations
  – Two boosters, three non-booster (upright, slouched, belt misuse)

Booster

No Booster (Slouched)
Booster Seat Testing

<table>
<thead>
<tr>
<th></th>
<th>Boosters</th>
<th>Non-Booster (Upright)</th>
<th>Non-Booster (Slouch)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIC Unlimited</strong></td>
<td>653</td>
<td>965</td>
<td>1306</td>
</tr>
<tr>
<td><strong>Neck Occipital Moment (Nm)</strong></td>
<td>40 (F)</td>
<td>49 (E)</td>
<td>45 (E)</td>
</tr>
<tr>
<td><strong>Lower Neck Y Moment (Nm)</strong></td>
<td>256 (F)</td>
<td>375 (F)</td>
<td>308 (F)</td>
</tr>
<tr>
<td>Chest Deflection (mm)</td>
<td>39</td>
<td>37</td>
<td>36</td>
</tr>
<tr>
<td>Chest Acceleration (g)</td>
<td>50</td>
<td>54</td>
<td>52</td>
</tr>
<tr>
<td><strong>Lumbar Shear Force (N)</strong></td>
<td>1999</td>
<td>3743</td>
<td>4917</td>
</tr>
</tbody>
</table>

** (F) = Flexion    (E) = Extension

Booster Seat Testing

- Boosters make a difference
- Minor durability problems solved
Vehicle Sled Testing

- 2000 Model Year Large SUV
- NCAP-derived crash pulse (25 g, 35 mph)
- Booster and non-booster situations
Vehicle Sled Testing

<table>
<thead>
<tr>
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<th>Boosters</th>
<th>Non-Booster (Upright)</th>
<th>Non-Booster (Slouch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIC Unlimited</td>
<td>1188</td>
<td>1332</td>
<td>1450</td>
</tr>
<tr>
<td>Neck Occipital Moment (Nm)</td>
<td>44 (F)</td>
<td>50 (F)</td>
<td>39 (F)</td>
</tr>
<tr>
<td>Upper Neck Tensile Force (N)</td>
<td>3087</td>
<td>3898</td>
<td>4648</td>
</tr>
<tr>
<td>Chest Deflection (mm)</td>
<td>42</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>Chest Acceleration (g)</td>
<td>55</td>
<td>57</td>
<td>53</td>
</tr>
<tr>
<td>Lumbar Shear Force (N)</td>
<td>1462</td>
<td>2083</td>
<td>5494</td>
</tr>
</tbody>
</table>

“Submarining” = high lumbar forces
Some rib delamination present
Static OOP Airbag Testing

- Durability of neck structure/instrumentation
  - Setup in head and chest-to-IP
- Utility of IR-Tracc system
Static OOP Airbag Testing

<table>
<thead>
<tr>
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<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Neck Tensile Force (N)</td>
<td>4544</td>
</tr>
<tr>
<td>Upper Neck X Shear Force (N)</td>
<td>2395</td>
</tr>
<tr>
<td>Neck Occipital Moment (Nm)</td>
<td>170 (E)</td>
</tr>
<tr>
<td>Lower Neck Tensile Force (N)</td>
<td>4259</td>
</tr>
<tr>
<td>Chest Deflection (mm)</td>
<td>23</td>
</tr>
<tr>
<td>Chest Acceleration (g)</td>
<td>70</td>
</tr>
</tbody>
</table>

- Neck load cells have sufficient capacity
- Neck components durable
- IR-Tracc displayed no problems
Two-Dummy R&R Testing

- Assess repeatability and reproducibility
- Rigid 213 seat, 75% energy pulse, 5 tests
  - Minimize non-dummy variation
Two-Dummy R&R Testing

<table>
<thead>
<tr>
<th></th>
<th>Dummy #1</th>
<th></th>
<th>Dummy #2</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>AVG</td>
<td>CV</td>
<td>AVG</td>
<td>CV</td>
</tr>
<tr>
<td>HIC Unlimited</td>
<td>456</td>
<td>6.0%</td>
<td>431</td>
<td>3.9%</td>
</tr>
<tr>
<td>Neck Occipital Moment (Nm)</td>
<td>34.3</td>
<td>6.6%</td>
<td>34.8</td>
<td>3.6%</td>
</tr>
<tr>
<td>Lower Neck Y Moment (Nm)</td>
<td>186</td>
<td>7.9%</td>
<td>170</td>
<td>2.4%</td>
</tr>
<tr>
<td>Chest Deflection (mm)</td>
<td>31</td>
<td>5.4%</td>
<td>26</td>
<td>5.4%</td>
</tr>
<tr>
<td>Chest Acceleration (g)</td>
<td>41</td>
<td>4.4%</td>
<td>39</td>
<td>1.6%</td>
</tr>
<tr>
<td>Lumbar Shear Force (N)</td>
<td>1225</td>
<td>9.7%</td>
<td>1168</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Repeatability (88% of channels < 10% CV)
Reproducibility (59% of channels < 10% CV)
Three-Dummy R&R Testing

- Assess reproducibility
  - One full dummy from each manufacturer, one with half (upper and lower torso) built by each manufacturer
- Rigid 213 seat, FMVSS 213 pulse, 4 tests
Three-Dummy R&R Testing

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<tr>
<td>Neck Occipital Moment (Nm)</td>
<td>37.6</td>
<td>10.0%</td>
</tr>
<tr>
<td>Upper Neck Tensile Force (N)</td>
<td>1797</td>
<td>6.1%</td>
</tr>
<tr>
<td>Chest Deflection (mm)</td>
<td>32</td>
<td>6.6%</td>
</tr>
<tr>
<td>Chest Acceleration (g)</td>
<td>39</td>
<td>5.8%</td>
</tr>
<tr>
<td>Lumbar Y Moment (Nm)</td>
<td>83</td>
<td>5.6%</td>
</tr>
<tr>
<td>Pelvis Acceleration (g)</td>
<td>45</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

Good reproducibility

Dummy parts are interchangeable
Summary

• Three HIII-10C conformed to drawings
• Components meet SAE corridors
• Boosters reduce head, neck, lumbar loads
• Durable in severe airbag/sled environments
• Good repeatability and reproducibility
• Mixing parts doesn’t affect performance
Remaining Work

- Put dummy in a crash test environment
- Evaluate IR-Tracc more thoroughly
- Develop injury criteria
THANK YOU!!!