VALIDATION OF THE 5TH PERCENTILE HYBRID III ATD FINITE ELEMENT MODEL

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• Human System Interface Requirements (HSIR)
• Objective
• Finite Element and physical Anthropomorphic Test Dummies (ATD)
• Wright Patterson Air Force Research Laboratory Horizontal Impact Accelerator (sled)
• Test matrix
• Test and simulation results for case 8924
• Next steps
### Anthropomorphic Test Device Limits

#### Injury Assessment Reference Values (IARV) Limits

<table>
<thead>
<tr>
<th>ATD Metric</th>
<th>ATD Size¹</th>
<th>Non-Deconditioned</th>
<th>Deconditioned</th>
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<tr>
<td></td>
<td></td>
<td>Nominal</td>
<td>Off-Nominal</td>
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<tr>
<td>HIC 15</td>
<td>5ᵗʰ Female</td>
<td>375</td>
<td>525</td>
</tr>
<tr>
<td></td>
<td>95ᵗʰ Male</td>
<td>325</td>
<td>450</td>
</tr>
<tr>
<td>Head Rotational Acceleration [rad/sec²]</td>
<td>5ᵗʰ Female</td>
<td>2,500</td>
<td>4,200</td>
</tr>
<tr>
<td></td>
<td>95ᵗʰ Male</td>
<td>2,100</td>
<td>3,600</td>
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<td>Nᵢ</td>
<td>5ᵗʰ Female</td>
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<td>95ᵗʰ Male</td>
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<td>Peak Neck Axial Tension Force [N]²</td>
<td>5ᵗʰ Female</td>
<td>890 – 1,840</td>
<td>765 – 1,580</td>
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<td>95ᵗʰ Male</td>
<td>2,000 – 3,390</td>
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<td>95ᵗʰ Male</td>
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<td>7,800</td>
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</table>

¹The following ATDs shall be used to evaluate the metrics:
5ᵗʰ percentile female automotive Hybrid III
95ᵗʰ percentile male automotive Hybrid III with straight spine

²Values in table are evaluated at varying time durations as specified in J

³Required only if Occupant Response Amplification ground rule is not met by the design
Objective

- Characterize performance of Livermore Software Technology Corporation (LSTC) COTS 5th percentile female HIII and 95th percentile male HIII Finite Element ATD models
  - Determine Model Uncertainty Factor (MUF) for available COTS FE models using test data from physical ATD testing.
    - What is utility of COTS FE ATD models for program status, design iteration, and selection of conditions for physical ATD compliance testing?
- Develop best modeling practices.
Hybrid III 5th Percentile Female

The model of the Hybrid III 5th Percentile Female dummy is a joint development with the National Crash Analysis Center (NCAC) at The George Washington University. The current release is an ALPHA version. Some documentation is provided at the beginning of the keyword file. Separate and detailed documentation will be included in a later release.

All current models can be obtained through our webpage in the LSTC Models download section or through your LS-DYNA distributor.

To submit questions, suggestions, or feedback about LSTC's models, please send an e-mail to atds@lstc.com. Also, please contact us if you would like to help improve these models by sharing test data.
LSTC FE model and aerospace 5th percentile female H3
LSTC FE model and aerospace 5th percentile female H3
ACES Helmet

ACES helmet finite element model
Suited aerospace 5th percentile female H3
Sample Test Conditions

Unsuited NASA automotive ATD

Spinal impact

Rear/lateral impact

Rear impact (launch abort)
Impact Orientations

- **X/Z**
  - Tilt Angles
    - 0, 22.5, 45, 67.5, 90°
  - G Levels
    - 10, 15, 20, 25 G
  - Rise Times
    - 30, 60, 90, 120, 150 ms
  - 100 possible cases

- **X/Y**
  - Rotation Angles
    - 0, 15, 30, 45°
  - G Levels
    - 5, 10, 15 G
  - Rise Times
    - 30, 60, 90, 120, 150 ms
  - 60 possible cases
## Test Matrix

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<thead>
<tr>
<th></th>
<th>Cell</th>
<th>Run Number</th>
<th>Impact Vector</th>
<th>Impact Direction</th>
<th>Orientation</th>
<th>Impact Level G</th>
<th>Rise Time (ms)</th>
<th>Measuring Pin</th>
<th>Manikin Type</th>
<th>Manikin Provider</th>
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</tbody>
</table>
Positioning Targets

H5  H6

H4  H7  H8

H1  H2  H10

H3  H9  H11
Test: 8924

Hybrid III Aero 5th Percentile Female ATD Test Results
8924 Video
Head Rotational Acceleration and Velocity

Case: 8924, H3AERO_5TH_ATD, Pulse: 1

Case: 8924, H3AERO_5TH_ATD, Pulse: 1

Case: 8924, H3_5TH_LSTC, Pulse: 1

Case: 8924, H3_5TH_LSTC, Pulse: 1
Head Injury Criteria

Case: 8924, H3AERO_5TH_ATD, Pulse: 1

Case: 8924, H3_5TH_LSTC, Pulse: 1

Case: 8924, H3_5TH_LSTC, Pulse: 1

Case: 8924, H3AERO_5TH_ATD, Pulse: 1

HIC Score

Time [sec]

Filter: 1000

Filter: 180

Filter: 108

Filter: 108
Neck Axial Force Duration

Case: 8924, H3AERO_5TH_ATD, Crew Position: 1

Axial Compression

- Significant Neck Injury Likely
- Significant Neck Injury Unlikely

Response
- Non-Deconditioned Limit
- Deconditioned Limit

Axial Tension

- Significant Neck Injury Likely
- Significant Neck Injury Unlikely

Response
- Non-Deconditioned Limit
- Deconditioned Limit
Chest Acceleration

Case: 8924, H3AERO_5TH_ATD, Pulse: 1

Case: 8924, H3_5TH_LSTC, Pulse: 1
Pelvis Acceleration

Case: 8924, H3AERO_5TH_ATD, Pulse: 1

Case: 8924, H3_5TH_LSTC, Pulse: 1
Next Steps

• Generate simulation results for remainder of test cases using
  - Measured target locations to help position ATD in seat
  - Measured HIA (sled) impact accelerations to drive model
• Compare test and analysis for
  - Uns suited ATD
  - Suited ATD
• Resolve differences between WPAFRL aerospace and NASA automotive 5th percentile H3
• Determine best modeling practices
• Determine modeling uncertainty factor (MUF)