Status of WorldSID
50th Male and 5th Female ATDs

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WorldSID 50th Male
Background

- NHTSA has participated in a collaborative effort to evaluate the WorldSID 50th male

  - NHTSA worked closely with the WorldSID Task Group using 2 dummies provided by OSRP

  - several improvements were made to the dummy during the evaluation
Objectives

- Assess suitability of the WorldSID 50th male dummy for possible incorporation into Part 572 of CFR
  - Drawing Package
  - Certification
  - Durability
  - Repeatability & Reproducibility
  - Biofidelity
  - User’s Manual (PADI)
50th Male Evaluation

- **Certification**
  - Tests conducted before and after FMVSS tests to ensure dummy’s components are functioning properly
  - Evaluate components whose response are of consequence to the FMVSS application
50th Male Evaluation

- **Certification**
  - ISO/CD 15830-2, rev. 25-Oct-04
  - Tests includes:
    - Head drop, frontal and lateral
    - Neck lateral flexion
    - Shoulder impact
    - Thorax impacts, with and without half-arm
    - Abdomen impact
    - Pelvis impact
50th Male Evaluation

- **Durability**
  - Survive various test conditions and provide accurate response measures
  - Withstand repeated tests with minimal maintenance and repair
  - When problems are observed, either the test conditions or the dummy need to be modified
50th Male Evaluation

- Durability Problems Addressed
  - Rib Damping Material
  - Pelvis DAS Docking Station
50th Male Evaluation

- Repeatability & Reproducibility
  - Regulatory testing requires the dummy to have an acceptable level of R&R to instill confidence in the responses
  - Preliminary R&R evaluation
    - Certification tests
    - Sled tests
  - Preliminary R&R results are acceptable
50th Male Evaluation

- **Biofidelity**
  - How well does dummy replicate the response of a human.

- **Biofidelity Rank System – BioRank**
  - Objectively quantifies biofidelity
  - Accounts for:
    - Internal biofidelity
    - External biofidelity
Internal Biofidelity (IB)

- Ability to replicate human internal response in a crash

- Internal measurements used for injury criteria
External Biofidelity (EB)

- Ability to replicate human loading of its environment in a crash

- Measurements made externally to human and dummy
Ranked Body Regions

- HEAD
- NECK
- SHOULDER
- THORAX
- ABDOMEN
- PELVIS
Response Measurement Comparison (R)

\[ \text{DCV} = \sum_{t=0}^{n} (\Delta D_t)^2 \]
\[ \text{CCV} = \sum_{t=0}^{n} (\Delta C_t)^2 \]
\[ R = \frac{\text{CCV}}{\text{DCV}} \]

* Morgan et al. 1986
<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Test Name</th>
<th>Reference</th>
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<tbody>
<tr>
<td>200 mm Rigid Lateral Head Drop</td>
<td>Head Test 1</td>
<td>ISO 9790 - Head Test 1</td>
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<tr>
<td>7.2 g Restrained Occupant Sled</td>
<td>Neck Test 1</td>
<td>ISO 9790 - Neck Test 1 &amp; Shoulder Test 2</td>
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<td>12.2 g Restrained Occupant Sled</td>
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<td>6.8 m/s Rigid Wall Sled</td>
<td>Heidelberg Sled Test</td>
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## Bio Rank Test Matrix & References

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<td>NHTSA Shoulder Test</td>
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<td>Maltese et al. 2002</td>
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≈ **90 Impactor Tests**

≈ **40 Sled Tests w/ 2 occupant sled buck**
External Biofidelity

![Bar chart showing external biofidelity scores for different body regions and overall. The chart compares WorldSID and ES-2re biofidelities.](chart.png)

Better Biofidelity

NHTSA

www.nhtsa.gov
Internal Biofidelity

![Graph showing biofidelity ratings for different body regions and overall.](image)

- **WorldSID**
- **ES-2re**

* w/o Abdomen

Better Biofidelity
BioRank Conclusions & Observations

- **WorldSID** overall internal and external biofidelity is better than **ES-2re**

- **WorldSID** shoulder has improved ROM, measures displacement

- **WorldSID** shoulder & thorax have more realistic motion and improved external oblique biofidelity response

![External Biofidelity Chart](chart1)

![Internal Biofidelity Chart](chart2)
The WorldSID 50th male dummy is more biofidelic than the ES-2re dummy and its level of biofidelity is acceptable for regulatory purposes.
50th Male Evaluation

- PADI
  - Procedures for Assembly, Disassembly, and Inspection
  - Illustrates how the dummy is put together, taken apart, instrumented, and inspected
  - Serves as reference to users
50th Male Evaluation

- **Drawing Package**
  - Physical dimensions
  - Weight and CG of segments
  - Must be freely available to public without restrictions
  - Must not endorse any manufacturer

- **Issue: Onboard DAS**
  - Public meeting
  - Suggestion:
    - specify these parameters by body region:
      - Use CAD to determine
        » Mass
        » CG location
        » Mass Moment of Inertia (MMI)
        » Space (volume) where DAS can be mounted
      - Electronic performance requirements
    - define acceptable tolerances based on simulations
WorldSID 5th Female
5th Female Evaluation

- **NHTSA to acquire at least one dummy**
- **Initiate Standard Evaluation**
  - Drawing Package
  - Certification
  - Durability
  - Repeatability & Reproducibility
  - Biofidelity
  - User’s Manual (PADI)
5th Female Evaluation

- APROSYS Work
  - Anthropometry
  - Biofidelity
  - Certification
  - Injury Risk Functions

- ISO Biofidelity Ranking = 7.6

- Apply NHTSA BioRank?
**Project Timing**

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Thank You
Questions?