UPDATE ON CERTIFICATION TEST DEVELOPMENT

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01/29/14
Agenda

• Goal – reminder
• Test Documentation
• Drawings for UN
• Tests under development
  o Current Status
  o Issues
  o Plans
• Finishing dummies for Injury Criteria Development
  o VRTC dummies, BASt dummy
Goal - reminder

• Develop certification tests which can control dummy reproducibility
  o Must control setup of neck muscle substitutes and damper
  o Must detect critical differences between dummies found in vehicle seat R&R work
    ▸ Spine bumper stiffness
    ▸ Jacket stiffness
    ▸ Pelvis stiffness
Test Documentation

• **Spine quasi-static setup** *(have corridors)*
  o Set springs and thorax/lumbar shape adjustment
  o Procedure in Mutual Resolution

• **Jacket only impact** *(have corridors)*
  o Control jacket stiffness
  o Procedure ready for comment in document (1/27/14)

• **Pelvis only impact, bottom** *(have corridors)*
  o Control pelvis stiffness
  o Procedure ready for comment in document (1/27/14)

• **Dummy certification without head restraint** *(reviewing corridors)*
  o Set damper, verify correct spring & shape adjustments
  o Procedure ready for comment in document (1/27/14)
Test Documentation

• Test System Verification (*have corridors*)
  o Make sure ETD is R&R and setup is functioning correctly
  o Procedure ready for comment in document (1/27/14)

• Head Impact Pad Verification (*corridors TBD*)
  o Make sure headrest pad is R&R
  o Procedures under development

• Dummy certification with head rest (*corridors TBD*)
  o Check complete system performance
  o Test & procedures under development
Test Documentation – Inspection Tests

• Pelvis shape verification (**corridors TBD**)  
  o Make sure shrinkage is not too large  
  o Test & procedures under development  

• Bumper compression on spine (**corridors TBD**)  
  o Check change in bumper stiffness  
  o Test & procedures under development  

• Pelvis quasi-static compression check (**corridors TBD**)  
  o Check change in pelvis stiffness  
  o Test & procedures under development
Test Documentation

• Generic procedure for UN MR
  o Draft 1/27/14 provided for review
    ‣ Tried to make generic for regulation
    ‣ Only necessary information
    ‣ Not limit future improvements
  o Please review and comment
    ‣ Procedures themselves
    ‣ Appropriate level of information

• We will do update with comments to provide for inclusion into MR
  o Will leave thorough formatting for after put into MR
Drawings for UN

• Updates in Process
  o Engineer has marked up all drawings based on TEG comments and complete review
    ‣ Entered into our ECO system & provided to CAD
  o Will provide samples for review next week
    ‣ Please review:
      ‣ Formatting, especially assembly & BOM
      ‣ How weldments will be handled
  o Will provide update on timing next week
Tests Under Development

• Current Status
• Issues
• Plans
Test Dev. – Current Status

• Dummy certification without head restraint
  o Finalize corridors
  o Discuss rotation measurement methods for procedure
    ▸ Currently pots
    ▸ Allow other methods in UN procedure?
Dummy certification without head restraint

Tests Under Development
Dummy certification without head restraint

• Overlay data from R&R dummies plus one dummy changed to stiff bumpers (all bumpers in dummy)
  o Pre & post R&R from Huron, some data from HIS Heidelberg, some data from BASt
  o Stiff dummy data different color

• Existing corridors shown

• Time history envelopes calculated
  o +/- 2 std dev of R&R dummies
  o +/- 10% of peak of R&R dummies
Dummy certification without head restraint

• Questions
  o Are current corridors adequate?
  o Should we use some type of time-history corridors?
  o Can we drop some corridors?
  o Do you want to review data and discuss next week?
GR&R Dummies Pendulum Force
GR&R Dummies Pendulum Force

- 2 * Std Deviation
- 10% of Max

Upper Corridor
Lower Corridor
GR&R Dummies Sled Acceleration

![Graph of sled acceleration over time](graph.png)
GR&R Dummies Sled Acceleration
GR&R Dummies Sled Velocity
GR&R Dummies T₁ X Acceleration

Acceleration (m/s²) vs. Time (msec) graph with different lines indicating ±2 * Std Deviation, +10% of Max, -10% of Max, and 100 with stiff bumpers.
GR&R Dummies Upper Neck Moment

MY

+ 2 * Std Deviation
- 2 * Std Deviation
+10% of Max
-10% of Max
100 with stiff bumpers
Box 1
Box 2
GR&R Dummies Pot B - Neck Link
Rotation about T1 - A.xlsx
GR&R Dummies Pot B - Neck Link
Rotation about T1

Time (msec)
Rotation (deg)

+2 * Std Deviation
-2 * Std Deviation
+10% of Min
-10% of Min
+10% of max Peak
-10% of max Peak
Peak 1
Upper Tunnel 1
Upper Tunnel 2
Minimum
GR&R Dummies Total Head Rotation

Rotation (deg)

Time (msec)

+ 2 * Std Deviation
- 2 * Std Deviation
+10% of Min
-10% of Min
100 with stiff bumpers
Tunnel 1
Upper Tunnel
Lower Tunnel
GR&R Dummies Total Head Rotation

![Graph showing total head rotation against time with various curves indicating different deviations and tunnel levels.]

- Rotation (deg)
- Time (msec)
- +2 * Std Deviation
- -2 * Std Deviation
- +10% of Min
- -10% of Min
- Tunnel 1
- Upper Tunnel
- Lower Tunnel
GR&R Dummies Pot C - T1 Rotation

-25 0 25 50 75 100 125 150 175 200 225 250
Rotation (deg)

-25 0 25 50 75 100 125 150 175 200 225 250
Time (msec)

+ 2 * Std Deviation
- 2 * Std Deviation
+10% of Min
-10% of Min
100 with stiff bumpers
Upper Tunnel
Minimum
GR&R Dummies Pot D - Lower Thorax Rotation

Rotation (deg) vs. Time (msec) graph showing data points for different conditions:
- + 2 * Std Deviation
- - 2 * Std Deviation
+10% of Min
-10% of Min
100 with stiff bumpers
GR&R Dummies Total Thoracic Rotation

[Graph showing GR&R Dummies Total Thoracic Rotation with various data points and time in milliseconds.]
Test Development

• Pelvis shape verification
  o Status: collecting data with prototype tool
  o Issues: not sure if R&R yet

• Pelvis quasi-static compression check
  o Status: collecting data with prototype tool
  o Issues:
    ▸ not sure if R&R yet
    ▸ Not sure if provides useful additional information
Test Development

• **Bumper compression on spine**
  
  o **Status:**
    
    ‣ collecting data with prototype tool
      ‣ Done extensive testing on R&R dummies, engineering dummy, VRTC dummies
    
    ‣ Interesting results
    
    ‣ Probably an essential inspection
  
  o **Issues:**
    
    ‣ R&R is poor
    
    ‣ R&R must be improved to finalize procedure and methods
      ‣ Extensive work on this is currently being done
Tests Under Development

Bumper Compression On Spine
Bumper Compression on Spine

Time Series Plot of High Comp
Base Part = ARA-521

- Dummy
- 100 - stiff
- 54
- 71 - stiff
- 73
- 77
- 8599
Bumper Compression on Spine

Time Series Plot of High Comp
Base Part = ARA-520

Dummy
- 100 - stiff
- 54
- 71 - stiff
- 73
- 77
- 8599

Test

0077-1A
0077 #1
0077 #2
0077 #3
8599 #1
0071 #1
0071 #2
0071 #3
0054 #1
0054 #2
0054 #3
0054 #4
0054 #5
Bumper Compression on Spine

Time Series Plot of High Comp
Base Part = ARA-381-37

- Dummy
- 100 - stiff
- 54
- 71 - stiff
- 73
- 77
- 8599

Test
High Comp

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Bumper Compression on Spine

Time Series Plot of High Comp
Base Part = ARA-381-30

- Dummy
- 100 - stiff
- 54
- 71 - stiff
- 73
- 77
- 8599
Bumper Compression on Spine

Time Series Plot of High Comp
Base Part = ARA-227

- Dummy
- 100 - stiff
- 54
- 71 - stiff
- 73
- 77
- 8599

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Bumper Compression on Spine

Time Series Plot of High Comp
Base Part = ARA-220

- Dummy
- 100 - stiff
- 54
- 71 - stiff
- 73
- 77
- 8599

Test

High Comp

0 50 100 150 200
Test Development

• Dummy certification with head rest
  o 2 methods under discussion
    ‣ With Back support – fairly new
    ‣ Without back support – in use for some time
    ‣ At last meeting some objected to dropping older method without more data
  o Status:
    ‣ Collecting data post test on R&R dummies, VRTC dummies, engineering dummy with multiple stiffness bumpers on back support method
    ‣ Collect and review more lower neck data and with several stiffness bumpers on no back support method
    ‣ Data not ready to present yet
  o Issues: need better bumper information
Mini-sled with seat back & head restraint
Tests Under Development

Mini-sled WITH Head Restraint
Test Development

• Bumper stiffness control procedure
  o Historically controlled by hand durometer gage
    ‣ This method has very high variability – wide range of “real” durometers pass
  o Purchased new durometer stand
    ‣ Probably as good as it get
    ‣ On ASTM samples – best corridor possible is about +/- 3.5 points based on R&R study done on gage
  o Anecdotal: I have yet to find any company who has run a GR&R on durometer who will claim to be able to hold tighter than +/- 3 based on the results
  o Working on Compression test of bumpers
Test Development

• Compression test
  o 20% compression test using Universal test machine (UTM)
  o Our old stand has been giving us questionable data at times over last year
  o We have ordered a new, much more sophisticated stand
    ▸ Will be able to do far more extensive material testing
    ▸ Should be delivered in February
Test Development

• Bumper control is important to spine control
  o We have focused much of our time on this problem
  o Are having significant problems

• Two issues:
  o How to manufacture to a tight corridor
    ▸ Humanetics problem
  o How does material change over time
    ▸ Need to understand
    ▸ Need good certification/inspection tests to control dummy
Bumper Control

• Have created targets for compression stiffness based on R&R dummy bumpers
Bumper Control – Status & Issues

ARA-521: I Chart of Avg Force by Part Number

Test Date

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<th>Part Number</th>
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Individual Value

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Bumper Control – Status & Issues

Avg Durometer by Group
ARA-521

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Bumper Control – Status & Issues

ARA-520: I Chart of Avg Force by Part Number

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Individual Value

| 1500 | 1250 | 1000 | 750 |

ARA-520: I Chart of Avg Force by Part Number
Bumper Control – Status & Issues

**Avg Durometer by Group**

ARA-520

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Observation

- Avg Durometer by Group
- ARA-520
Bumper Control – Status & Issues

ARA-381-37: I Chart of Avg Force by Part Number

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ARA-381-37: I Chart of Avg Force by Part Number
Bumper Control – Status & Issues

**Avg Durometer by Group**

ARA-381-37

- **Stiff**
- **Soft**
- **Std**
- **T-1**
- **T-2**
- **T-3**
- **T-4**
- **T-5**
- **T-6**
- **T-7**

**Observation**

- **Durometer**
  - 60
  - 55
  - 50
  - 45
  - 40
  - 37
  - 43

**Avg Durometer by Group**

ARA-381-37
Bumper Control – Status & Issues

ARA-220: I Chart of Avg Force by Part Number

Individual Value

TestDate

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Bumper Control – Status & Issues

**Avg Durometer by Group**

**ARA-220**

- **Stiff**: 65
- **Soft**: 60
- **Std**: 55
- **T-1**: 50
- **T-2**: 45
- **T-3**: 40
- **T-4**: 35
- **T-5**: 30
- **T-6**: 25
- **T-7**: 20

**Observation**

**Durometer**

1. **37**
2. **43**
3. **37**

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Bumper Control – Status & Issues

Plot of Avg Force Change @ 7 Months
ARA-521 Standard

SPEC_ID
L-801
L-806
L-807

SPEC_ID
L-801
L-806
L-807

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Bumper Control – Status & Issues

Plot of Avg Force Change @ 7 Months
ARA-520 Standard

Index
Spec_ID

Plot of Avg Force Change @ 7 Months
ARA-520 Standard
Bumper Control – Status & Issues

Plot of Avg Force Change @ 7 Months
ARA-381-37

SPEC_ID
- T-809
- T-815
- T-827

Index
28-Jan-14
26-Jun-13
131.3
83
Bumper Control – Status & Issues

Plot of Avg Force Change @ 7 Months
ARA-220 Standard

SPEC_ID

Index

Avg Force

Plot of Avg Force Change @ 7 Months
ARA-220 Standard

SPEC_ID

Index

Avg Force

Plot of Avg Force Change @ 7 Months
ARA-220 Standard

SPEC_ID

Index

Avg Force
Bumper Control – Status & Issues

• Hope to have more information by next week’s meetings

• Question for group: does anyone know of a good, standard accelerated aging test for urethane?
  o What standard # (ASTM, ISO, other)?
  o Any experience?
Finishing dummies for Injury Criteria Development

- VRTC dummies, BAST dummy
- Pelvis & jacket work done
- Need to get bumpers right
- Hope to have better update on timing by next week meeting
Questions?