



EEVC WG12-20 Hybrid III Biofidelity Review

Presented by David Hynd, TRL Limited

Chairman, EEVC WG20

GTR Meeting : 8th November, 2007

Hybrid III Biofidelity Review

- **Review of**
 - EEVC research
 - EC project results
 - Published literature
- **Biofidelity of**
 - Head-neck kinematics
 - Seat back interaction



Hybrid III Biofidelity Review

Literature Review

- 1 paper found that Hybrid III head motion *relative to T1* simulated volunteer results (Viano and Davidsson, 2002)
- 1 paper found that Hybrid III *head rotation* biofidelic relative to original Mertz and Patrick design target for the neck (Prasad *et al.*, 1997)
 - Dynamic tests with 1 volunteer and 2 PMHS, plus quasi-static volunteer tests

Hybrid III Biofidelity Review

Literature Review

- **All other references (approx 20) concluded that the Hybrid III was *not* biofidelic in low-speed rear impact**
 - **Some head-neck motion and force parameters OK for some seat designs - but dependent on interaction with seat back**
 - **Affected by thoracic spine and shoulders**
 - **All studies that examined seat back interaction found that Hybrid III not at all biofidelic due to rigid thoracic spine**
- **More flexible spine recommended to ensure good seat interaction**

Hybrid III Biofidelity Review

EC Project Review

- **Comparison with volunteer and PMHS data**
 - Interaction with seat back not satisfactory
- **Tests in real car seats**
 - Better - but no T1 rotation, retraction (S-shaped neck response) or ramping-up

Hybrid III Biofidelity Review

EEVC Biofidelity Testing

- Not yet published, but biofidelity review is complete
- Results clearly support literature review
- [Link to biofidelity presentation](#)

Hybrid III Biofidelity Review

Conclusion

- **Hybrid III not biofidelic in low-speed rear impact seat testing**
 - Thoracic spine too stiff
 - Seat back interaction poor (dependent on seat)
 - No T1 rotation
 - No retraction

Hybrid III Biofidelity Review

- **Why is good biofidelity important in low-speed rear impact seat testing?**
- **Primary benefit of dynamic test option is to allow reactive head restraints**
 - **Head restraint movement actuated by interaction between occupant spine/thorax and seat back**
 - **If seat interaction not biofidelic, actuation with dummy not likely to be same as actuation with human occupant**
 - **Hybrid III (stiff spine box) expected to actuate some reactive head restraints much more effectively than human occupant**
 - **I.e. some seats will pass test, but not work in the real-world**
 - **Expected benefit will not be delivered**

Hybrid III Biofidelity Review

Also, report collates other info presented at previous GTR and GRSP meetings

- **HR-5-12**
 - Volvo WHIPS seat fails Hybrid III test (head angle 19.6°)
 - BUT
 - 'Good' SRA rating (by a large margin)
 - 'Good' IIWPG rating (by a large margin)
 - [NB: Volvo WHIPS also has good insurance claims performance]
- Questions using claims rates for 2 seats to construct risk function
- Mean delta-v for claims 10 km.hr⁻¹
- Conclusion: proposed GTR Hybrid III test design restrictive

Hybrid III Biofidelity Review

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- **HR-7-13**
 - WHIPS seats have 49% claims reduction compared to previous generation Volvo seat (IIHS)
 - Volvo study showed 36% reduction in long-term injury
 - S80 seat fails proposed GTR (average head-torso angle 16.3°)
 - Proposed requirement design restrictive

Hybrid III Biofidelity Review

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- **HR-5-11**
 - Hybrid III seat back interaction poor - affects results for some seats
 - Hybrid III results not well correlated to IIWPG rating

Hybrid III Biofidelity Review

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- **HR-6-7**
 - Shows one seat where
 - Hybrid III deploys head restraint by 90 mm
 - BioRID II deploys head restraint by 35 mm
- For two other seats, actuation similar



End of Presentation

Presented by David Hynd, TRL Limited

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