EEVC WG20 Recommendations for a Low-speed Rear Impact Sled Test Pulse

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Chairman, EEVC WG20
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Scope

- Review of the most up-to-date published information on low-speed rear impact pulses
  - Over 150 sources reviewed

- Not possible objectively to identify whiplash injury
  - Most sources used insurance claims
  - Some verified by interview, some unverified

- Review has assumed that the insurance claims used, at least in the majority, relate to real injuries

- Focus on long-term injury (in line with static cost-benefit)
Information Sources

- Field crash pulse recorder data
  - Shape and magnitude vs. injury
- Accident analysis
  - Magnitude (e.g. delta-v) vs. injury
- Laboratory car-to-car tests
  - Shape
- Laboratory barrier-to-car tests
  - Effect of different bumper systems
  - Change in vehicle stiffness over time
Crash Pulse Recorder Data

- I.e. Folksam

Linder et al., 2003
Crash Pulse Recorder Data

- I.e. Folksam

- Benefits
  - Real-world accidents
  - Link to injury

- Limitations
  - Limited to certain Toyota vehicle models
Accident Analysis Data

- I.e. GDV

- Benefits
  - Link to injury

- Limitations
  - No information on pulse shape
  - Delta-\(v\) determined from photographs (sometimes only one) of the vehicle damage
  - Reliability of estimate not clear - very low weight given to data

Langwieder and Hell, 2002
Laboratory Car-to-Car Tests

- E.g. Heitplatz et al., 2002
Laboratory Car-to-Car Tests

- E.g. Avery, 2001
Laboratory Car-to-Car Tests

- E.g. Avery, 2001
Laboratory Barrier-to-Car Tests

- E.g. Linder et al., 2003
Other Pulse Proposals

- I.e. early IIWPG pulse

Avery 2001
Other Pulse Proposals

- i.e. early IIWPG pulse

Zuby et al., 2003
Volunteer Test Data vs. Proposed Pulses

- Uninjured Volunteers
- Volunteers - Initial Symptoms
- Proposed Pulses
- Zero Injury Risk
- Proposed Pulses

Delta V (km/h)

Mean Acceleration (g)
Conclusions

- Pulses very variable - depending on e.g.
  - Mass ratio, stiffness and structure of the crash partners
  - Degree of overlap
  - Level of engagement (under-ride, over-ride or good engagement)
  - Type of bumper energy absorption system
  - Presence of a tow-bar
Conclusions

- Limitations of the accident data with CPR
  - CPR data only available for a small number of vehicle models from one manufacturer
  - Position of head restraint not known for certain
  - Physical injury may be exacerbated by psychological factors

- Currently not possible to correlate detailed pulse shape, such as the number of peaks and shape of the pulse, with injury risk
  - This would require a great deal more data than is available to date
  - In the absence of this link, it is recommended that any pulse used should be representative of real-world impacts in which injury (or symptoms) occurs
Conclusions

- From evidence reviewed, there is no single typical pulse shape. However, the following shapes are the most supportable:
  - A bimodal shape, with a steep rise and large first peak, followed by a smaller second peak and more gradual drop-off in acceleration
  - A triangular shape, with a steeper initial rise in acceleration and more gradual drop-off in acceleration

- From the evidence reviewed, the trapezoidal pulse proposed for a number of rear impact test programmes does not appear to be representative of real-world pulses

- Increasing $\Delta v$ and increasing mean acceleration both been correlate with an increased risk of reported symptoms
Conclusions

- To target long-term injuries, delta-\(v\) of 20 km.hr\(^{-1}\) and mean acceleration of 5 to 6 g recommended
  - 20 km.hr\(^{-1}\) is approximately the mean delta-\(v\) indicated in the literature for long-term injuries, with a typical range of 16 to 25 km.hr\(^{-1}\)
  - Long-term injuries cost approximately £3 billion per annum in the UK (from static cost-benefit study)

- Recommend second, lower severity, pulse to maintain current good performance at low severity
  - Not evaluated in detail, but 10 km.hr\(^{-1}\) seems to be indicated
  - If a single pulse used, more typical mean delta-\(v\) could be used (e.g. 16 km.hr\(^{-1}\))
    - Risks not maintaining low severity performance and not driving improvement in long-term, high-cost injuries
End of Presentation

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