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

Presented by David Hynd, TRL Limited

Chairman, EEVC WG20

GTR Meeting : 8th November, 2007

Scope

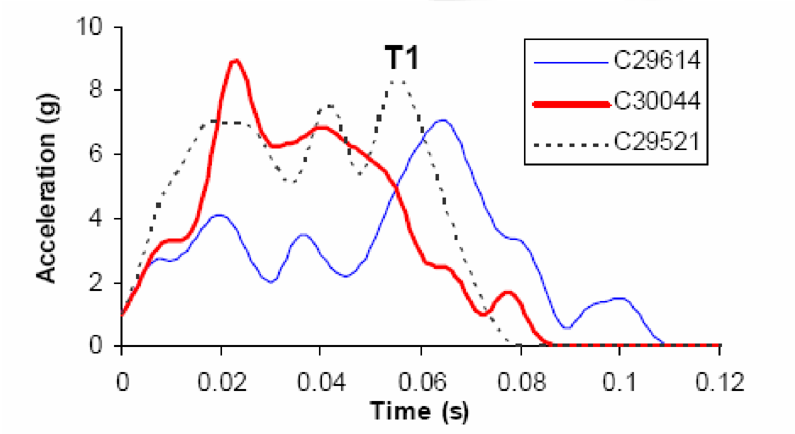
- **Review of the most up-to-date published information on low-speed rear impact pulses**
  - **Over 150 sources reviewed**
- **Not possible objectively to identify whiplash injury**
  - **Most sources used insurance claims**
  - **Some verified by interview, some unverified**
- **Review has assumed 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

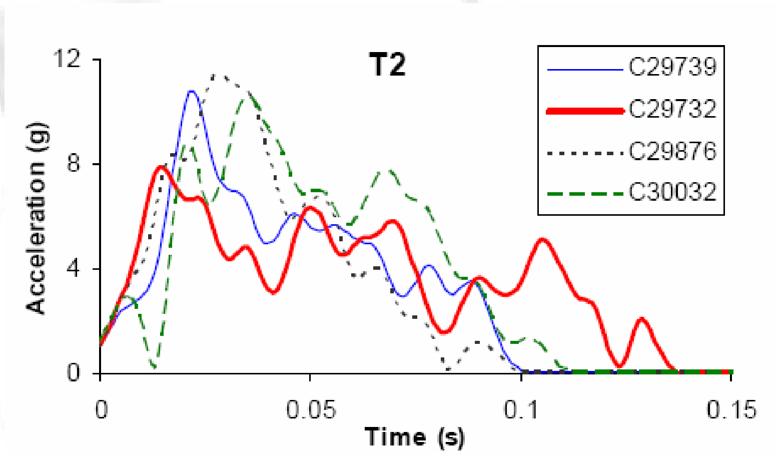
- **Field crash pulse recorder data**
  - Shape and magnitude *vs.* injury
- **Accident analysis**
  - Magnitude (e.g. delta-*v*) *vs.* injury
- **Laboratory car-to-car tests**
  - Shape
- **Laboratory barrier-to-car tests**
  - Effect of different bumper systems
  - Change in vehicle stiffness over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

Crash Pulse Recorder Data

- I.e. Folksam



Linder *et al.*, 2003



Crash Pulse Recorder Data

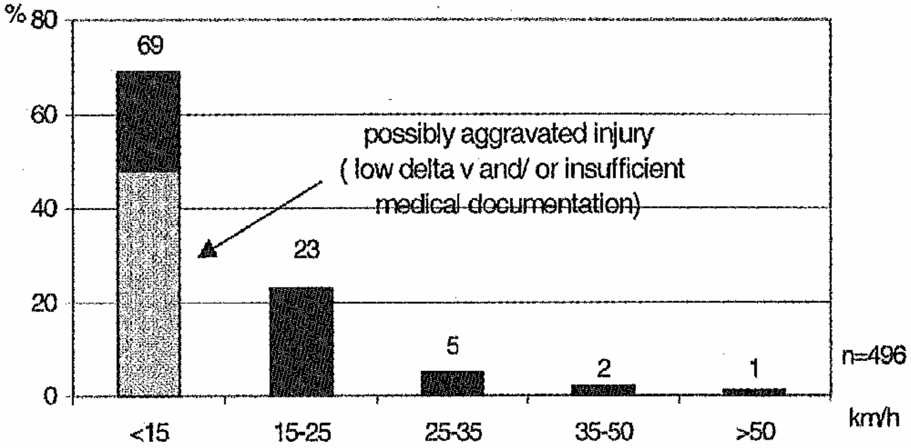
- **I.e. Folksam**

- **Benefits**
  - **Real-world accidents**
  - **Link to injury**

- **Limitations**
  - **Limited to certain Toyota vehicle models**

Accident Analysis Data

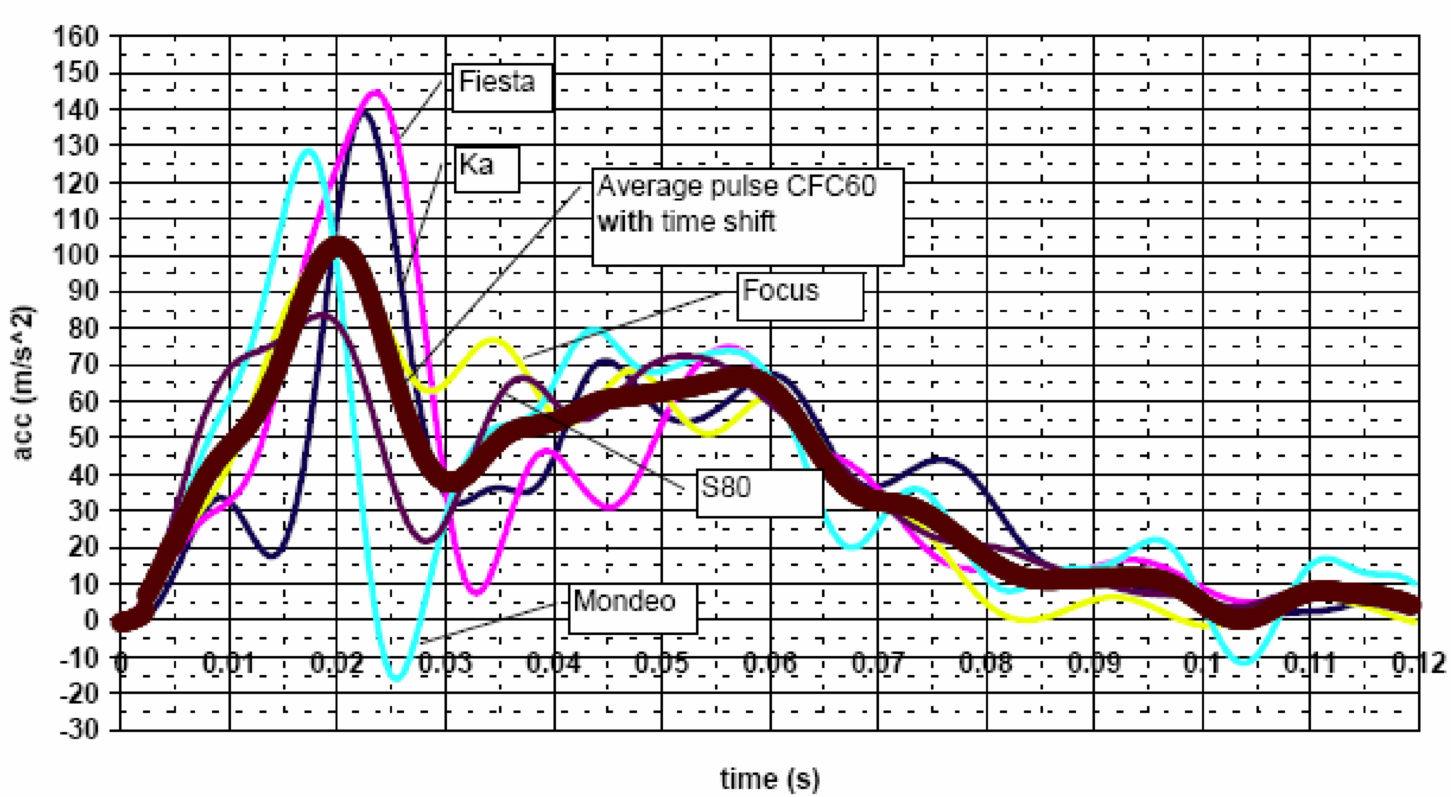
- I.e. GDV
- Benefits
  - Link to injury
- Limitations
  - No information on pulse shape
  - Delta-*v* determined from photographs (sometimes only one) of the vehicle damage
    - Reliability of estimate not clear - very low weight given to data



Langwieder and Hell, 2002

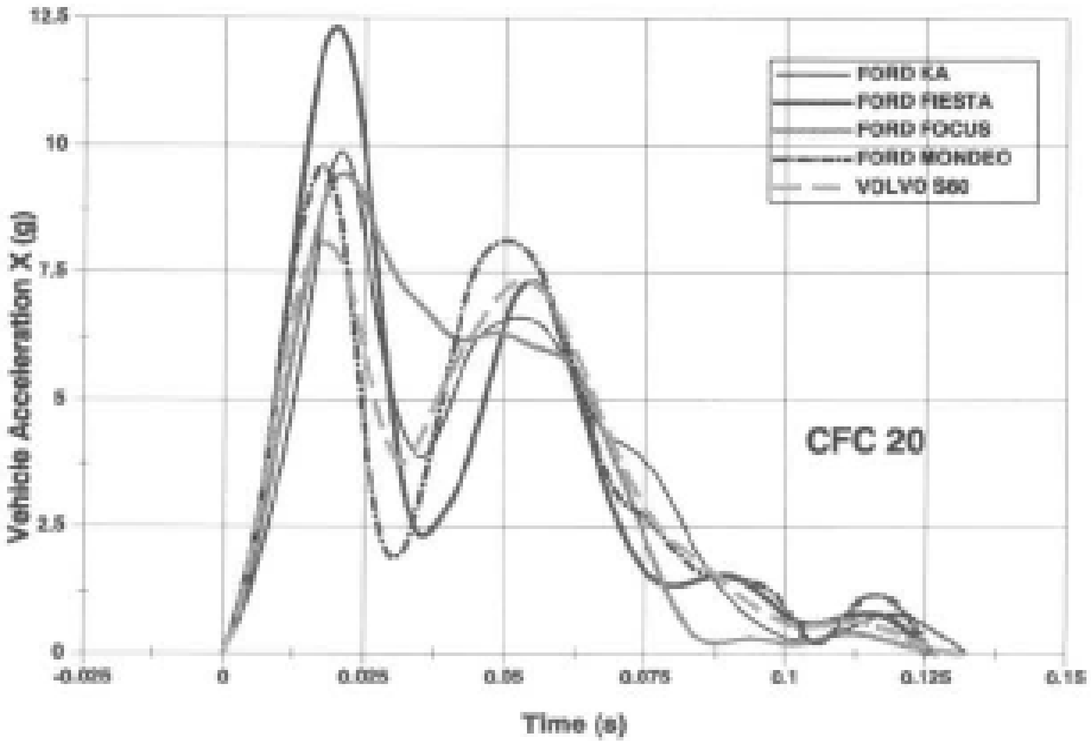
Laboratory Car-to-Car Tests

- **E.g. Heitplatz *et al.*, 2002**



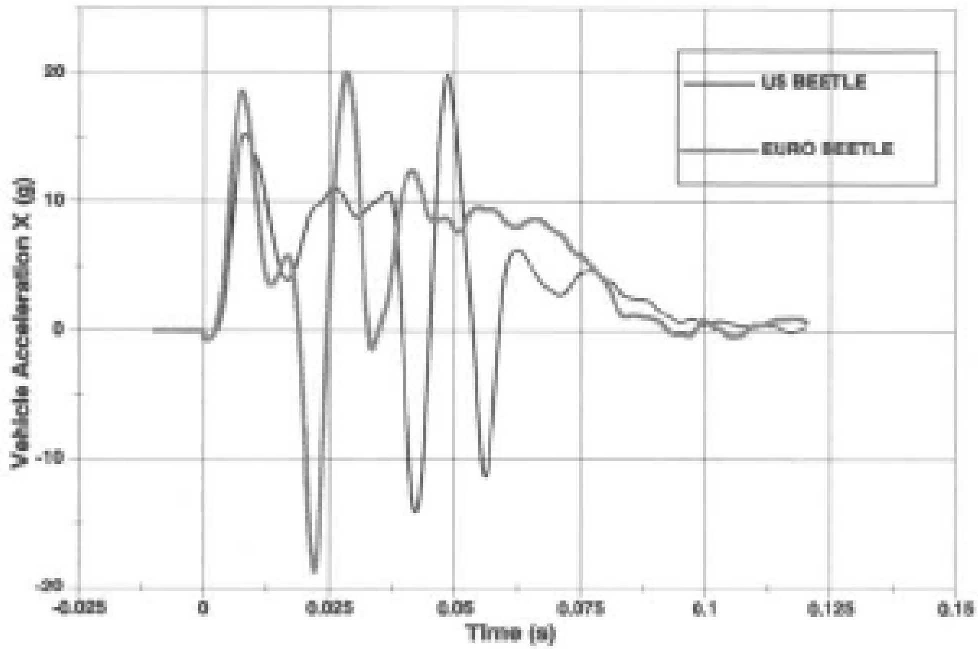
Laboratory Car-to-Car Tests

- **E.g. Avery, 2001**



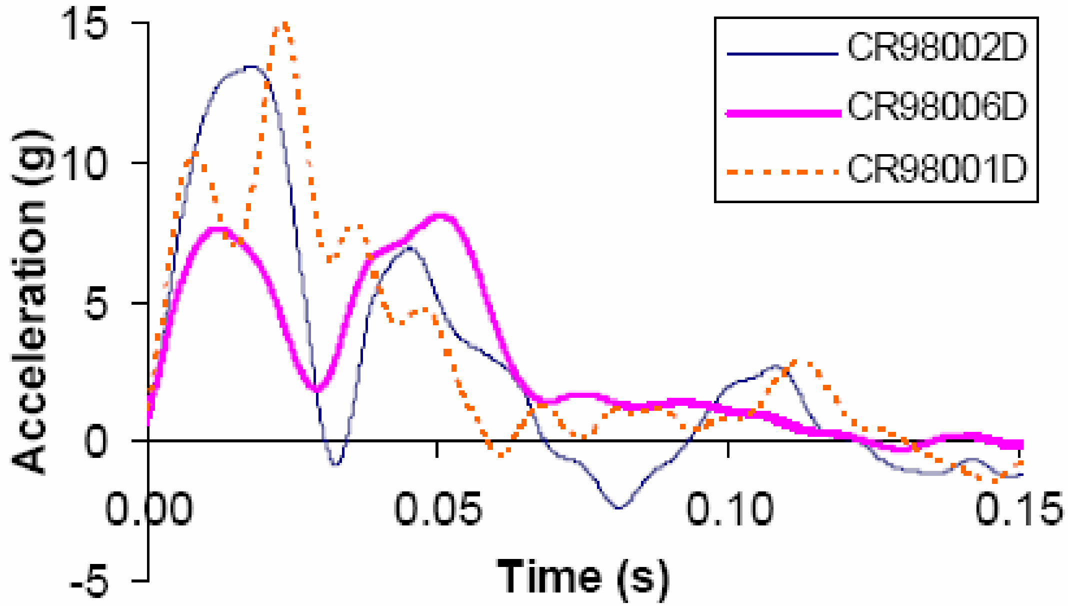
Laboratory Car-to-Car Tests

- E.g. Avery, 2001



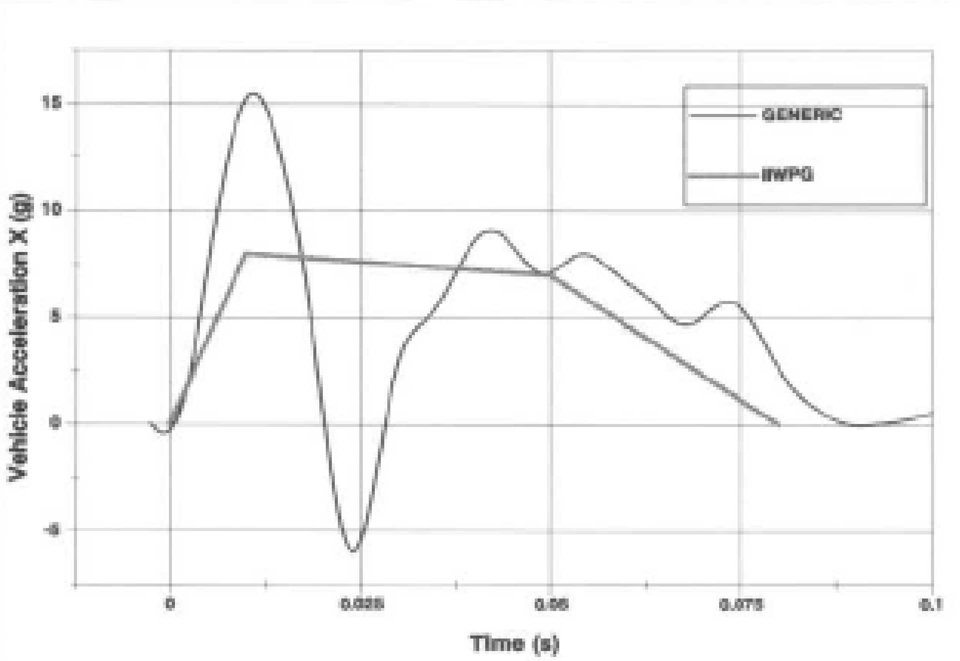
Laboratory Barrier-to-Car Tests

- **E.g. Linder *et al.*, 2003**



Other Pulse Proposals

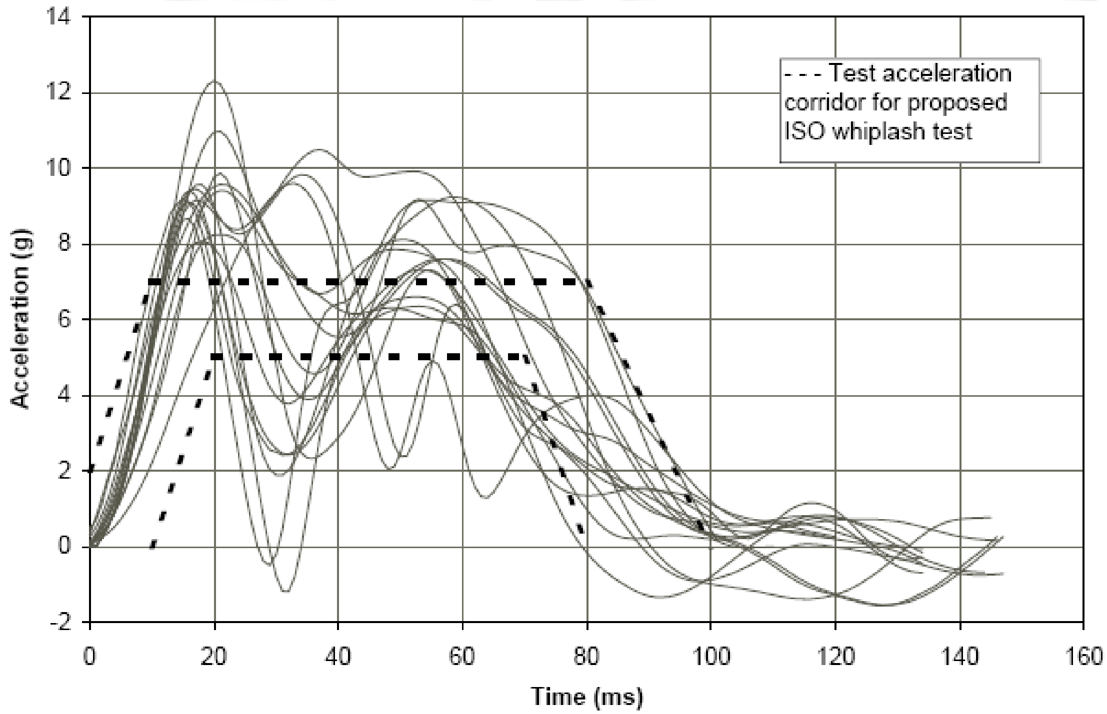
- I.e. early IIWPG pulse



Avery 2001

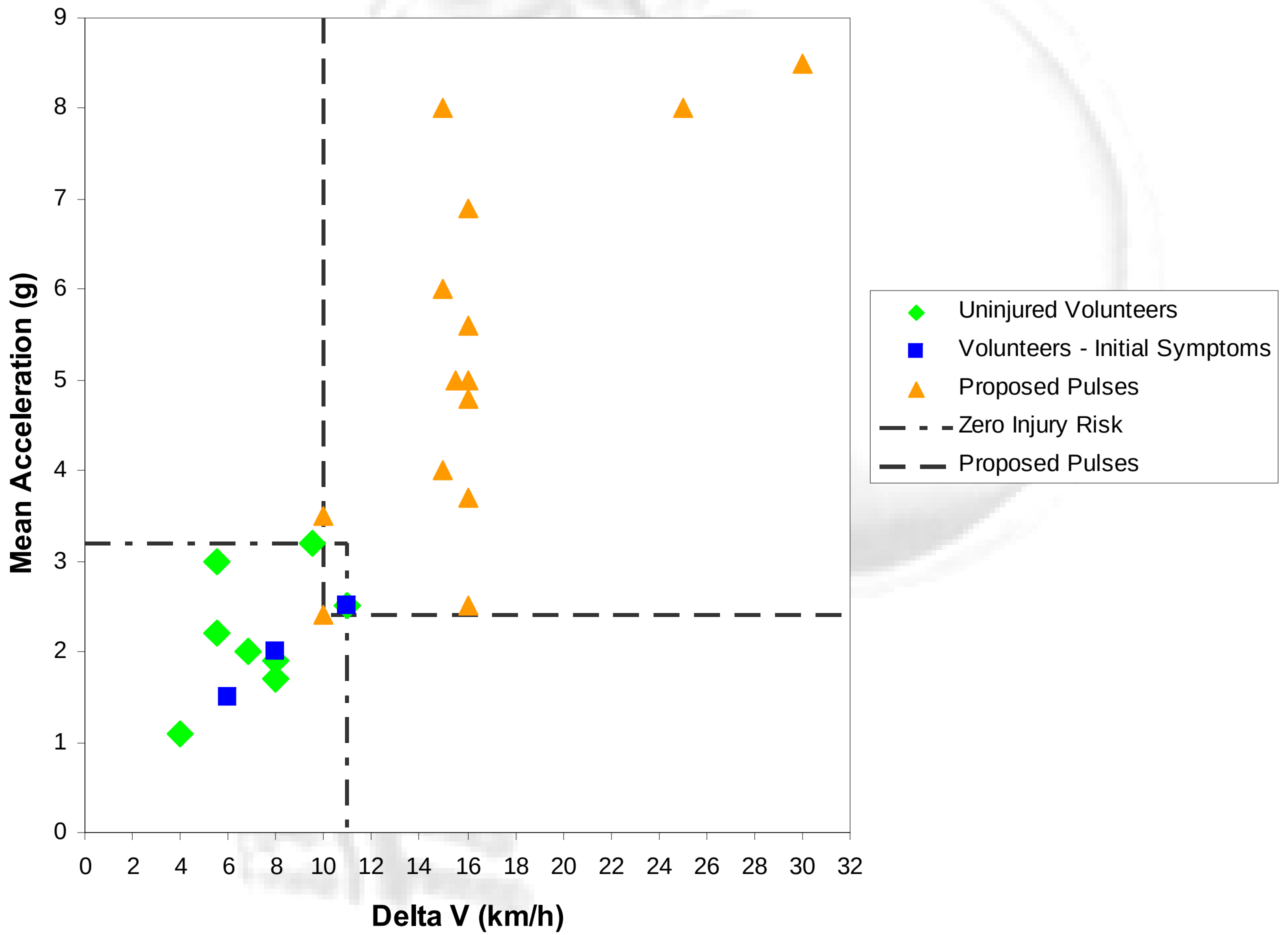
Other Pulse Proposals

- **I.e. early IIWPG pulse**



Zuby *et al.*, 2003

Volunteer Test Data *vs.* Proposed Pulses



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 Δ*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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