GTR Head Restraints
Triggering of active systems in sled test

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04.05.2007
Dynamic Test of GTR / FMVSS 202a

Test conditions in GTR / FMVSS 202a:
• Complete vehicle (without tires, fluids, unsecured components)
• Vehicle fixed rigidly on test sled
• Positioning of seats and dummy (…)
• Acceleration of test platform (corridor, approx. 17 km/h, 9 g, 90 ms)

Missing definitions in GTR / FMVSS 202a:
• Triggering of active head restraints (external, internal, status of ignition, …)
• Measuring method of head – torso angle (sensors, calculation method, …)
Test pulse for dynamic test

Test pulse of GTR / 202a:
- Synthetic puls, sinus form

Crash test and real world pulses:
- High gradient of acceleration at beginning
- Vehicle specific characteristics of acceleration curve
- High frequency signal characteristics

- Rear-end collision with barrier (example, $\Delta v = 17$ km/h)
- Sled pulse corridor of FMVSS 202a ($\Delta v = 17$ km/h)
- Rear-end collision vehicle to vehicle (example, $\Delta v = 20$ km/h)
Criteria for triggering active Systems

Acceleration:

- Acceleration currently only criteria considered by FMVSS 202a / GTR
- High triggering level leads to late deployment / poor safety level
- Low triggering level leads to fast deployment / good safety level but many erroneous system activations

Not considered in GTR:

- Vehicle weight
- Plausibility checks
- Pulse form
- Mis-use

=> Active systems, designed for real world crash, may not be activated in GTR sled test
Criteria for triggering active Systems

Vehicle weight:

- Acceleration level in rear end crash depending on vehicle weight
- Different layout of triggering algorithm necessary
- Triggering with GTR sinus pulse can lead to different / wrong triggering times in sled test compared to real world crash.

Example: Triggering level at 6g

Fast / early deployment of active system in real world crash
Slow / late deployment in GTR sled test (poor safety performance)
Criteria for triggering active Systems

Plausibility checks:

Additional criteria is checked in vehicle sensor system to verify crash situation

- lateral acceleration (is typical for real world crash)
- check of additional sensors (typical time delay in signals, because acceleration is „running“ through vehicle from rear end to front end

Additional criteria is needed to avoid erroneous system activations

These additional criteria are not available on sled (rigidly fixed vehicle has no lateral acceleration and no time delay between different sensor signals)

=> active systems (designed for real world crash) may not be activated in sled test
Criteria for triggering active Systems

Analysis of pulse form:

Vehicle crash pulse has a typical / vehicle specific form / characteristic

- Puls form / characteristic is used for verification of crash situation
- Puls form / characteristic can be used to get faster triggering
  (puls form can be recognized before a certain acceleration level is achieved)

=> Sinus pulse of sled test may lead to late triggering time of active system
Criteria for triggering active Systems

Avoidance of erroneous system activations:

All additional criteria (vehicle weight, plausibility checks, pulse form) are needed to get an assured deployment of the active system and to avoid erroneous activations and activations in mis-use situations like:

- Road holes
- Kerbstone
- Driving over beam
- Door strike
- Gravel trap
- Stone impact
- Rough road
- Parking minicrash
- etc.

All these criteria are not available in a FMVSS 202a / GTR sled test. Design of vehicle sensor system according to sinus sled pulse will lead to wrong triggering times, non-activations and erroneous activations of active head restraints in real world. In consequence this means a decrease of safety level and customer satisfaction.
### Summary of triggering criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Explanation</th>
<th>Can be considered in GTR/202a test</th>
<th>Available in real world accident</th>
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</table>
| **Acceleration** | • High trigger level leads to slow / late triggering and poor safety level of active system  
• Low trigger level leads to fast / early triggering and good safety level, but also to many erroneous system activations | yes | yes |
| **Vehicle weight** | • Lower acceleration trigger level needed for heavy vehicles, higher for light vehicles to get same triggering time  
• Sinus pulse leads to different trigger times in different vehicles | no | yes |
| **Plausibility check** | • Check of simultaneous lateral acceleration (vibration of vehicle body is typical for real world crash)  
• Check of additional sensor signals (typical time delay between different sensors does not exist on sled) | no rigid fixation of vehicle on sled, no deformations | yes |
| **Pulse form** | • Evaluation of pulse characteristics (vehicle specific, steep rise, oscillations) for faster recognition and triggering | no sinus pulse | yes |
| **Mis-use** | Plausibility checks and evaluation of pulse characteristics necessary to prevent mis-use and erroneous activations like: Road hole / kerbstone / door strike / gravel trap / driving over beam / stone impact / rough road / parking minicrash ... | no not possible (missing criteria) | yes |
Summary

For good safety level of active head restraints in real world accident a fast and early triggering is necessary, erroneous activations should be prevented

=> additional triggering criteria are needed (acceleration not sufficient)

These additional criteria are not available in sled test with synthetic test pulse

=> active systems may not be activated in GTR / FMVSS 202a sled test

=> Adaptation of sensor system to GTR / 202a sled test would lead to many erroneous activations of active system in real world (will not be accepted by customer, may lead to extra costs for customer)

Conclusions:

• External triggering of active head restraints in GTR / 202a test is needed
• External triggering is already allowed in FMVSS (see FMVSS 208, S13.1)
• The vehicle specific triggering time can be obtained in a suitable rear-end crash test (to be defined)