Proposal for a deceleration pulse for AECD sled testing

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Full-scale impact tests and sled test

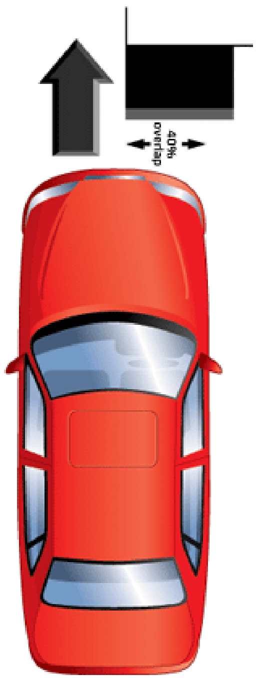
- What is the relationship between the full-scale impact tests, UN R94 and UN R95, and the component-based sled test?
- The full-scale tests provide an assessment of the whole AECS in a front and a side collision:
  1. Taking into account vehicle deformations and vehicle-specific installation; and
  2. Testing the triggering.
- The sled test of the AECD in-vehicle system adds value by:
  1. Providing a vehicle-independent and installation-independent assessment that avoids repeated full-scale tests after re-designs of AECD components; and
  2. Covering real-world collision configurations that are more challenging to AECD than the full-scale tests UN R94 and UN R95, in order to ensure that AECS deliver high societal benefits to those casualties who need it most.

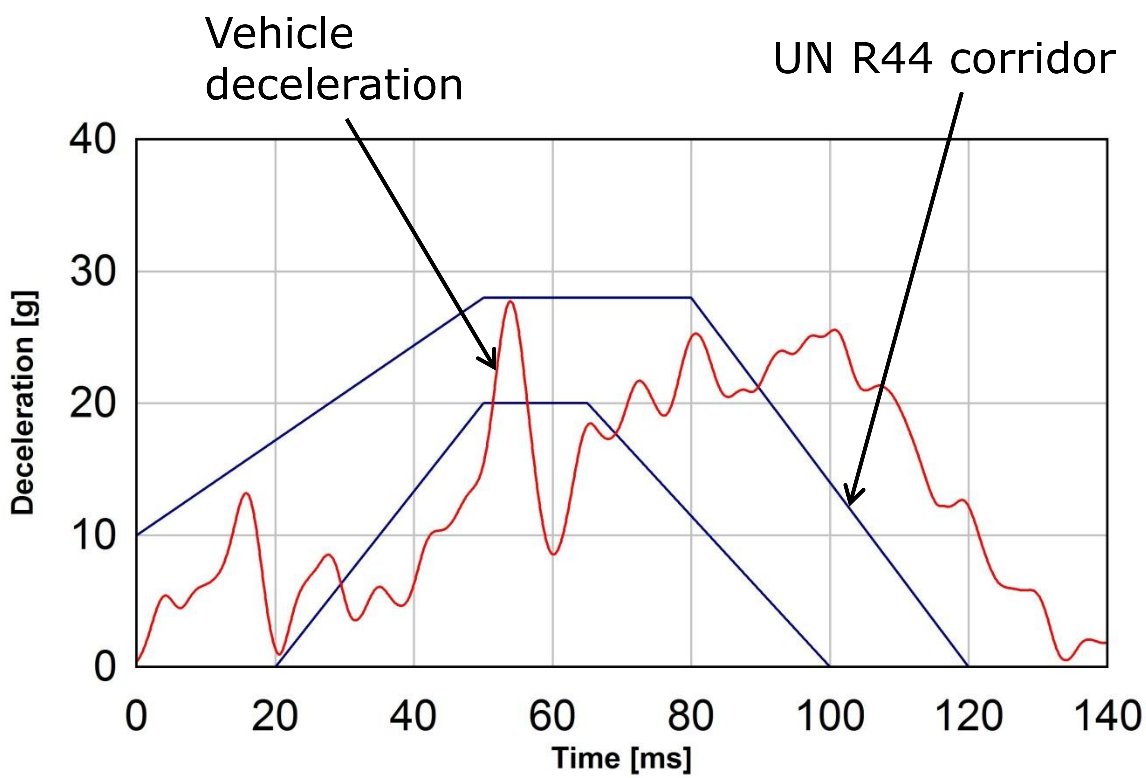
Why is a pulse similar to UN R94 tests not suitable for component-based sled tests?

Decelerations in UN R94 full-scale test

UN R94
56 km/h
40% overlap
Deformable barrier

Deceleration pulse
Small family car (MY 2008)
Peak deceleration: 28*g*
Duration: ca. 130 ms

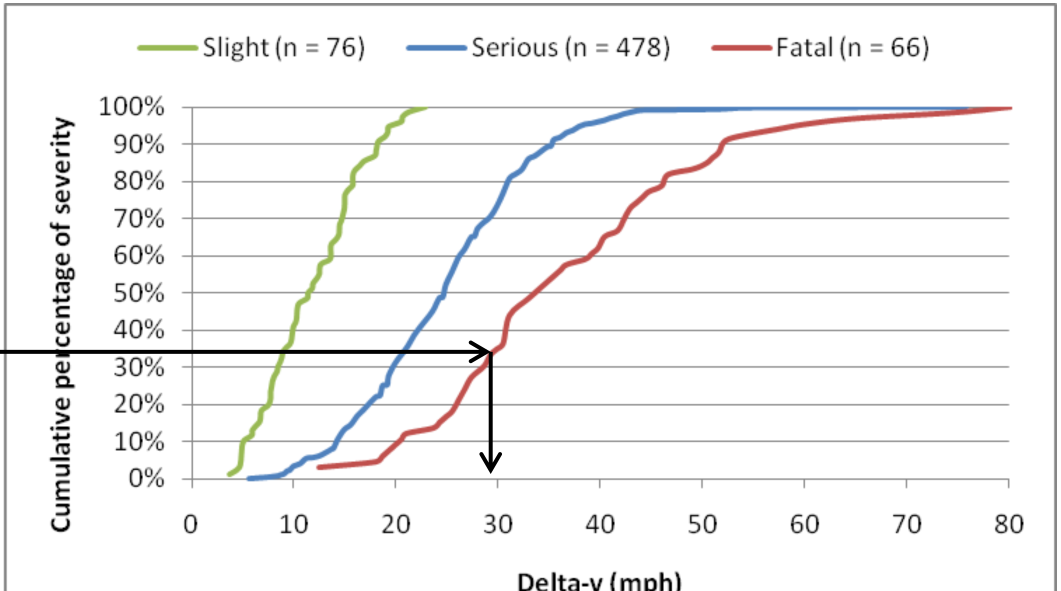




How was the UN R94 test defined?

- What accident severity was considered appropriate?
  What was technically feasible?
- The consensus at the time was to chose a Δv-level (change in velocity) that covered about[1]:
  - 1/3 of all fatals; and
  - 1/2 of those severely injured (MAIS3+)

Cumulative casualty percent curve to establish link between the chosen injury risk and corresponding Δv



UK CCIS/OTS data, years 2000-2009, for illustrative purposes

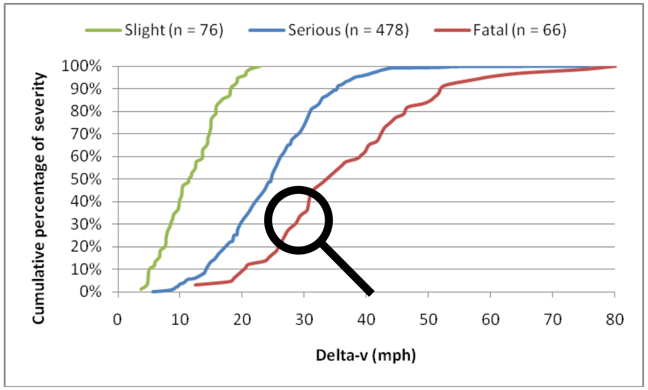
[1] Lowne, RW (1994). EEVC Working Group 11 Report on the Development of a Front Impact Test Procedure. Proceedings of the 14th ESV Conference. Munich, Germany.

How was the UN R94 test defined?

- Casualties at every given Δv-level result from a wide variety of different collision configurations
- Which configuration should be simulated?
  - Purpose of the UN R94 test was an assessment of the **protection of occupants**, which includes structural crashworthiness and compartment strength.
  - Hence, a test configuration was chosen to represent a worst case for occupant protection[1]:
    - Offset test (engaging only one longitudinal member) to encourage vehicle design changes towards a structure that performs well under a wide range of conditions; and
    - Deformable barrier to simulate interactions in car-to-car impact.

[1] Lowne, RW (1994). EEVC Working Group 11 Report on the Development of a Front Impact Test Procedure. Proceedings of the 14th ESV Conference. Munich, Germany.

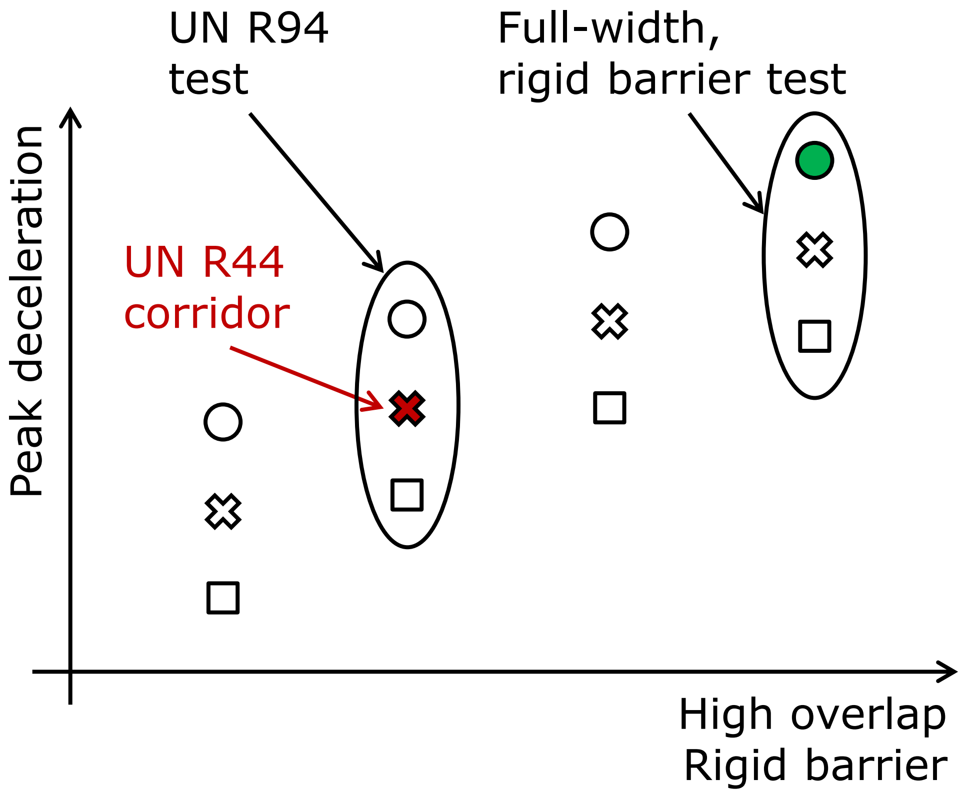
Different peak decelerations at identical Δv



Different cars:

- ○ Small car
- ✗ Medium car
- □ Large car

Different collision configurations:

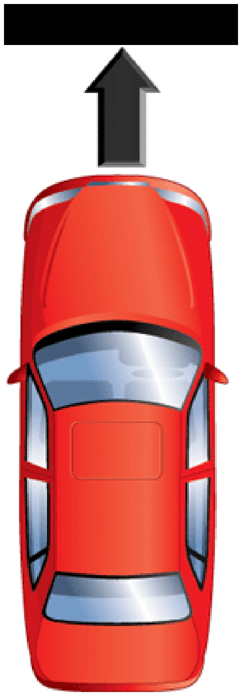


What does this mean for AECD testing?

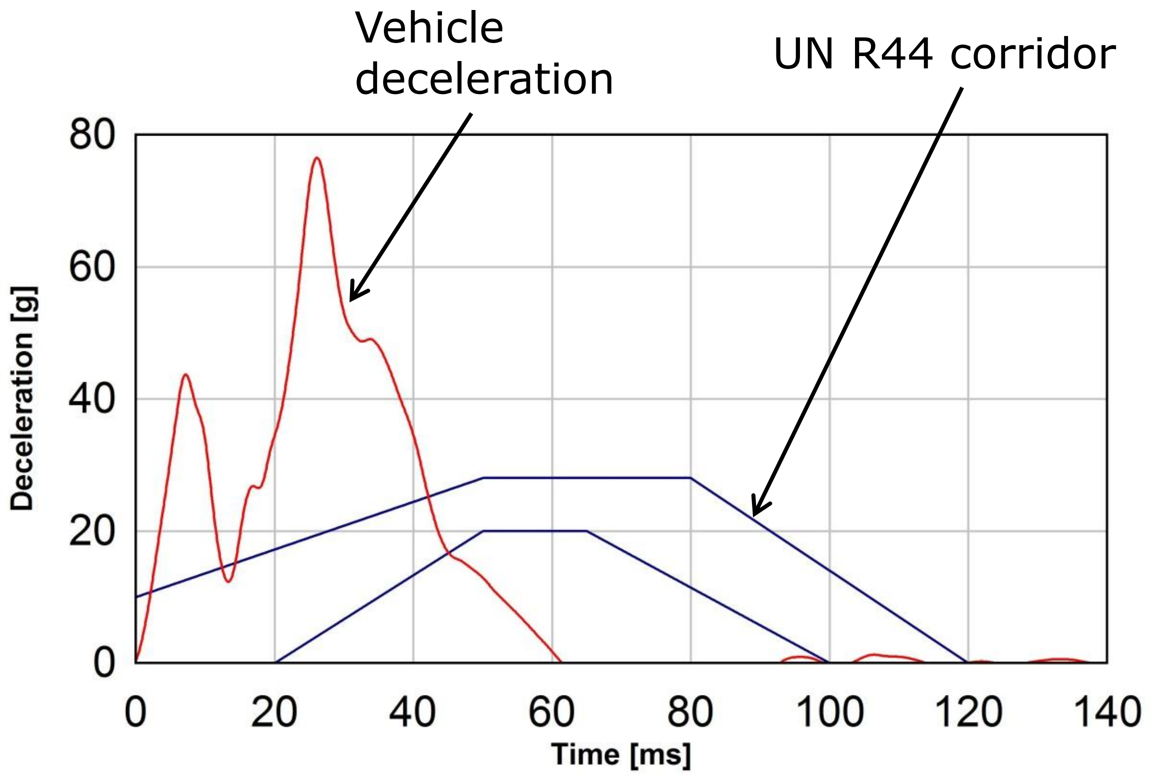
- The UN R94 test configuration is challenging for structural crashworthiness but not the most challenging for restraint systems or AECD survivability:
  - AECD components are mounted directly onto the vehicle structure, i.e. not protected by restraint systems.
  - The most harmful mechanism to these components is likely to be forces experienced due to **high peak deceleration levels**.
- At the same Δv-level, the configuration with the highest peak deceleration levels is: Full-width impact into rigid barrier.
- UN R94 represents a configuration of fairly moderate peak deceleration levels compared with full-width impact into rigid barrier.

Deceleration pulse of a full-width test

Full-width test
56 km/h
100% overlap (full-width)
Rigid barrier

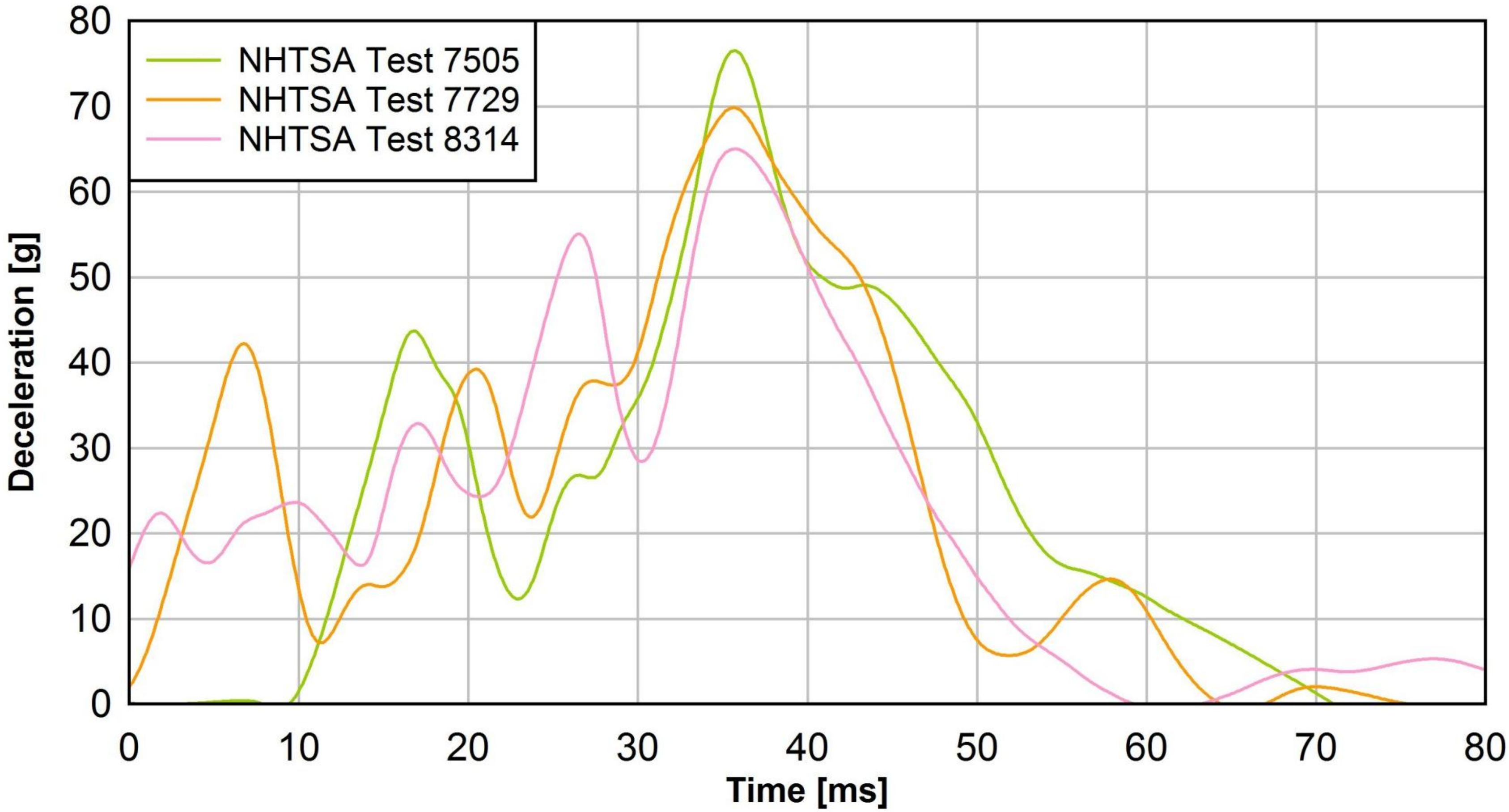


Deceleration pulse
Supermini (MY 2012)
Peak deceleration: 77*g*
Duration: ca. 60 ms

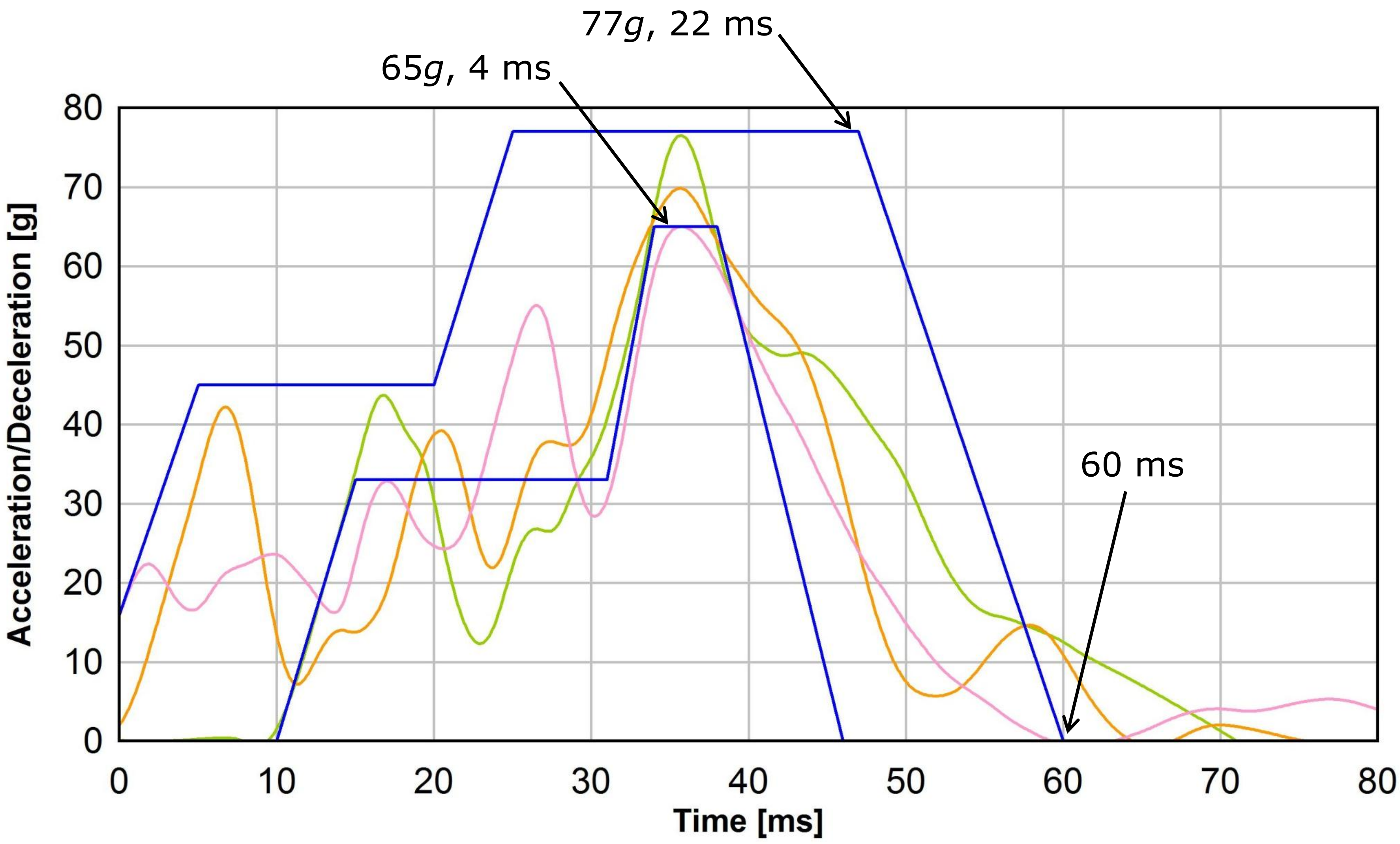


Defining a deceleration corridor

- A corridor can be defined based on a sample of full-scale crash test results of superminis, MYs 2012 and 2013 (56 km/h, rigid barrier, full-width):



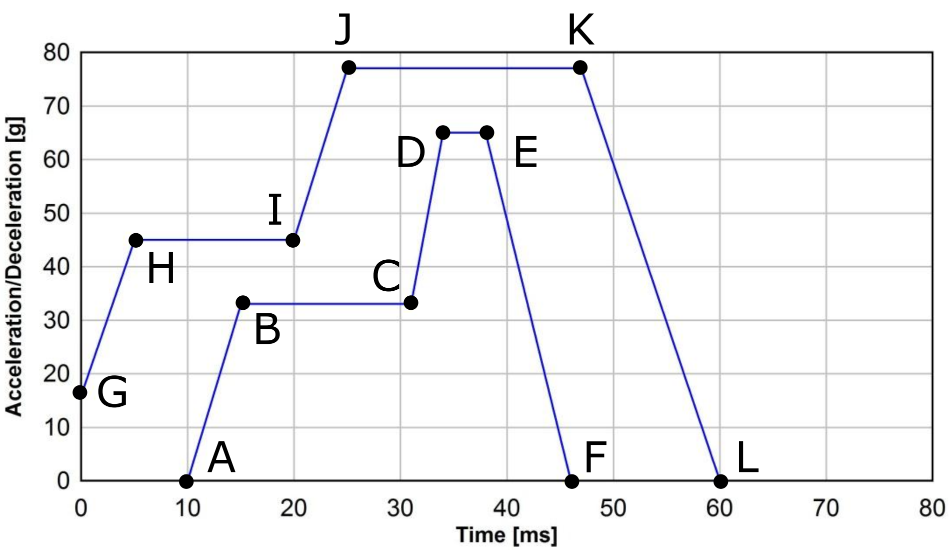
Deceleration corridor based on full-width tests



Deceleration corridor based on full-width tests (detailed description)

Deceleration corridor based on full-width tests

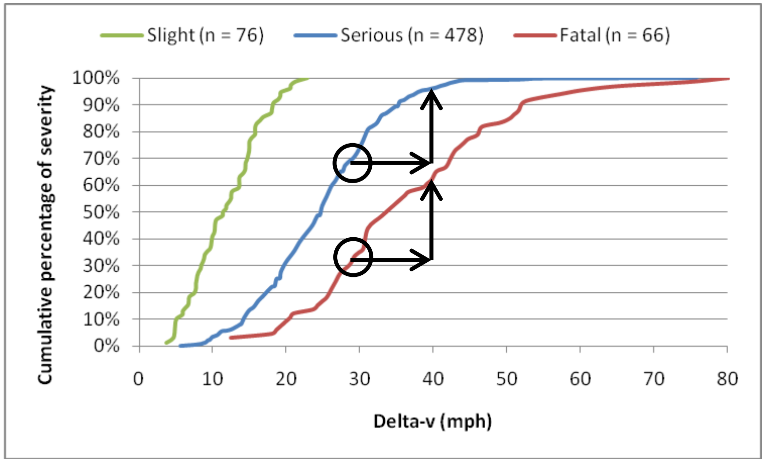
Based on 56 km/h, rigid barrier, full-width impact tests

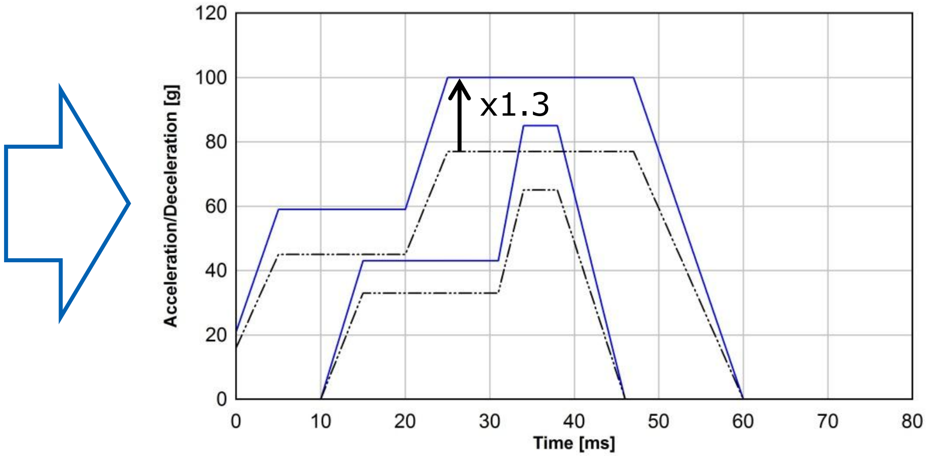


Point	Time (ms)	Deceleration (g)
A	10	0
B	15	33
C	31	33
D	34	65
E	38	65
F	46	0
G	0	16
H	5	45
I	20	45
J	25	77
K	47	77
L	60	0

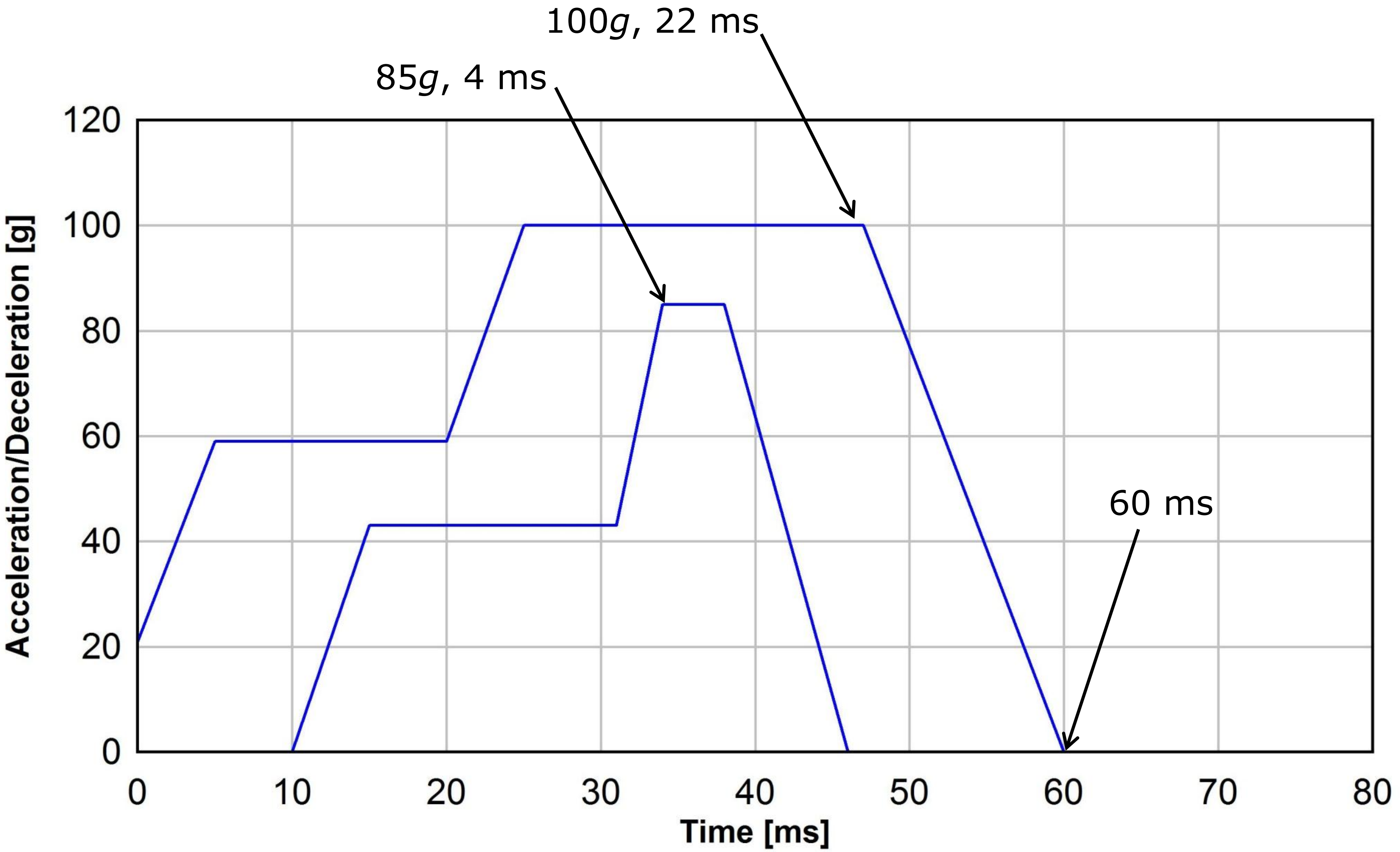
Is this corridor enough to ensure real-world safety?

- This deceleration corridor is to be considered a **minimum approach** because these levels already occur in crash tests at a Δv-level chosen to represent only 1/3 of fatals and 1/2 of severely injured.
- From a safety and product assurance perspective, it seems advisable to exceed these levels, in order to ensure high societal benefits among fatal and serious injuries.
- Applying a **safety factor of 1.3** is proposed to represent cases at a higher severity level and to cover potentially higher peak decelerations at an installation location further towards front of the vehicle.





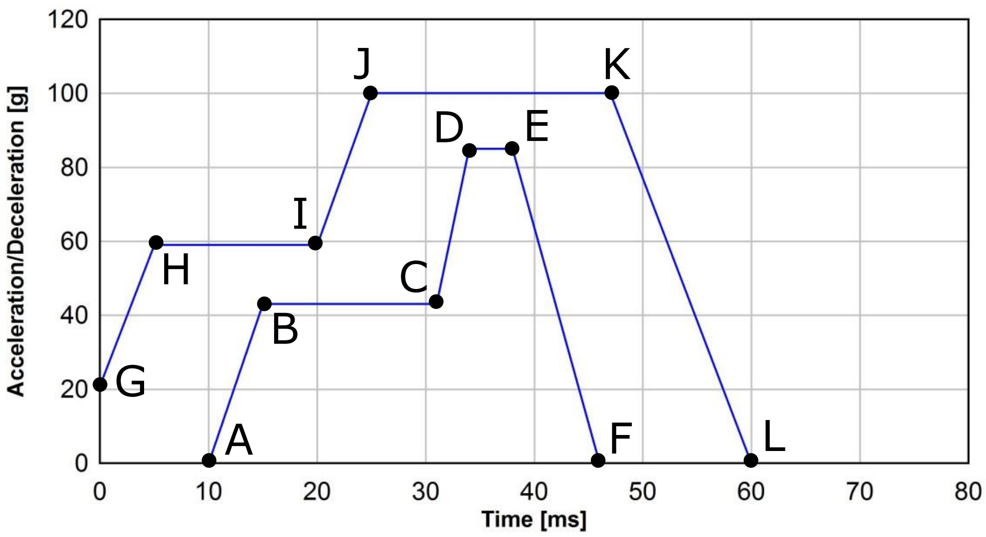
Proposed Deceleration Corridor



Proposed Deceleration Corridor

Proposed Deceleration Corridor

Based on 56 km/h, rigid barrier, full-width impact tests and safety factor 1.3



Point	Time (ms)	Deceleration (g)
A	10	0
B	15	43
C	31	43
D	34	85
E	38	85
F	46	0
G	0	21
H	5	59
I	20	59
J	25	100
K	47	100
L	60	0

Conclusions

- The UN R44 pulse corridor, which is similar to UN R94 decelerations, is not suitable for AECD testing: UN R94 was designed to challenge the structural crashworthiness of vehicles, not to test the resistance of on-board equipment.
- A more challenging real-world configuration (at the same Δv-level) is a full-width, rigid barrier impact.
- To cover a greater proportion of casualties a deceleration pulse corridor was proposed based on crash test data and an additional safety factor:
  - **Peak deceleration: 85-100*g***
  - **Peak duration: ≥4 ms**
  - **Total duration: ≤60 ms**
- The nature of the sled test is vehicle- and installation-independent. This makes a distinction between front/side impacts obsolete because the in-vehicle orientation is not known.
  → **The proposed pulse should be applied in various directions**.

Thank you

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