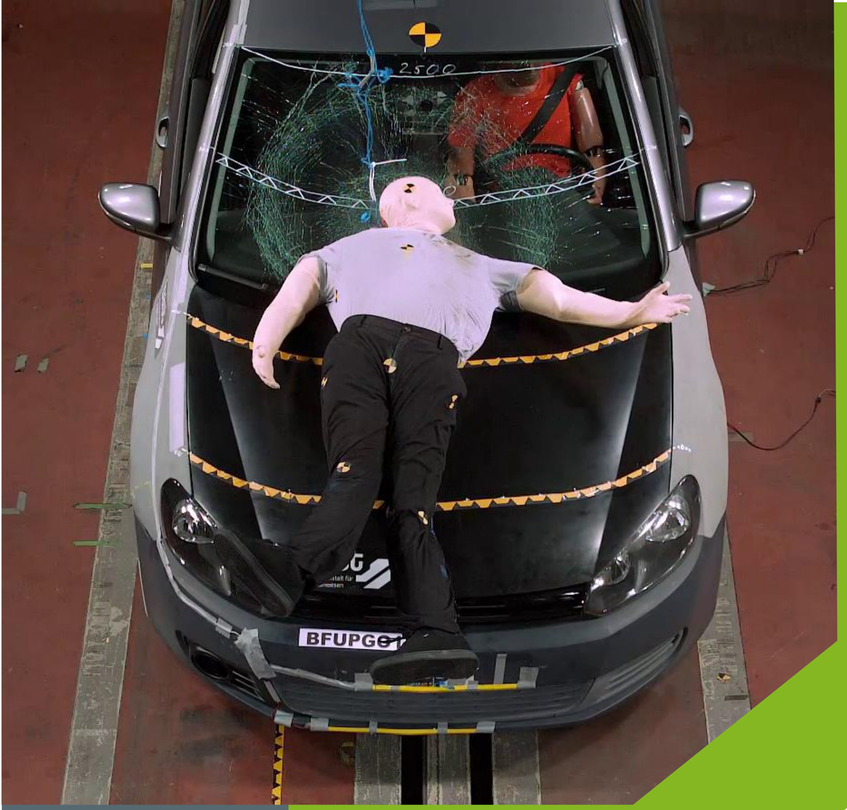


Federal Highway and
Transport Research Institute

Use of a Full-Body Dummy to investigate the Windscreen Fracture Behaviour in Pedestrian Crashes with Passenger Cars

Einsatz eines Ganzkörperdummies zur Untersuchung des Bruchverhaltens von Windschutzscheiben im Pkw-Fußgängeranprall

5. Dummy.Crashtest.Konferenz.

Münster, 2-3 July, 2025

03.07.2025 | Oliver Zander| BASt

Many questions to answer, 20 minutes to go…

bast
Federal Highway and
Transport Research Institute

How is the current situation in legislation wrt passive VRU safety
and what are the issues?

Does the windscreen fracture behavior in impactor tests correspond to reality?

What can a full-body dummy contribute to the investigations?

Are impactor and full-body dummy tests comparable?

What do we learn?

What may be a possible approach?

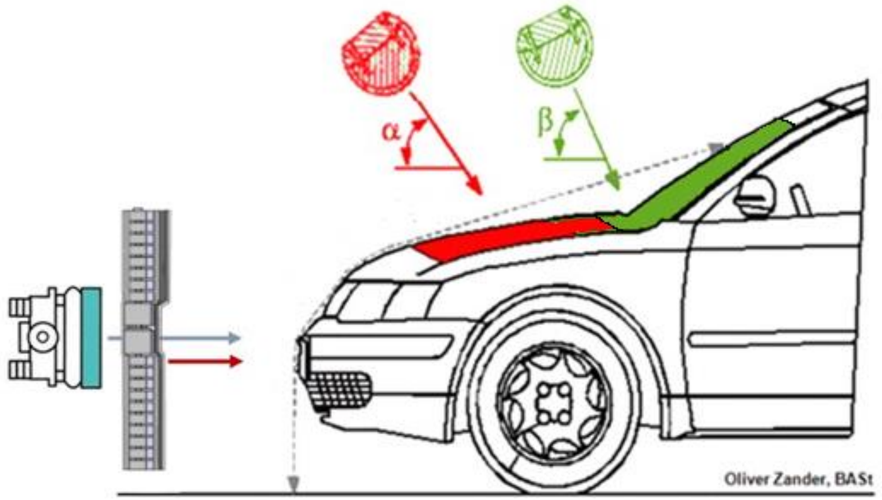
Current situation: legal requirements (UN-R 127)

Federal Highway and Transport Research Institute

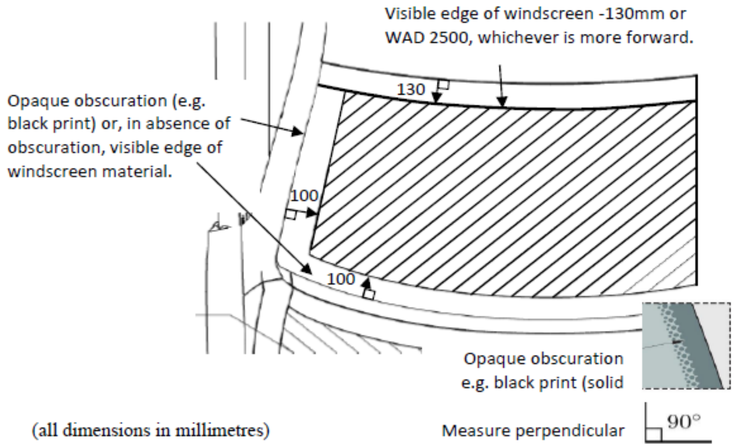
Head:
3,5/4,5 kg, 35 km/h
HPC 1000 (1/2 of child headform area)
(2/3 of entire headform area)
HPC 1700 (1/2 of child headform area)
(1/3 of entire headform area)
Child: 1000-1700 mm, 50°
Adult: 1700-2500 mm, 65°
Cowl area: Monitoring

Lower extremities (FlexPLI):
40 km/h,
340 Nm Tibia (264 mm relaxation zone: 380 Nm),
22mm MCL, 13 mm ACL/PCL
Impact height: Ground level + 75 mm

Upper Leg (for high bumper vehicles):
40 km/h
7,5 kN
510 Nm
Impact alignment: mid of bumper



Since UN-R 127.03: Inclusion of windscreen test area and cowl monitoring area



Focus:
Assessment of glazing,
not the underlying structure!

Current situation: legal requirements (UN-R 127)

Current Wording in UN-R 127.03 (including Suppl. 2) and UN-R127.04 (including Suppl. 1)

Text of the Regulation

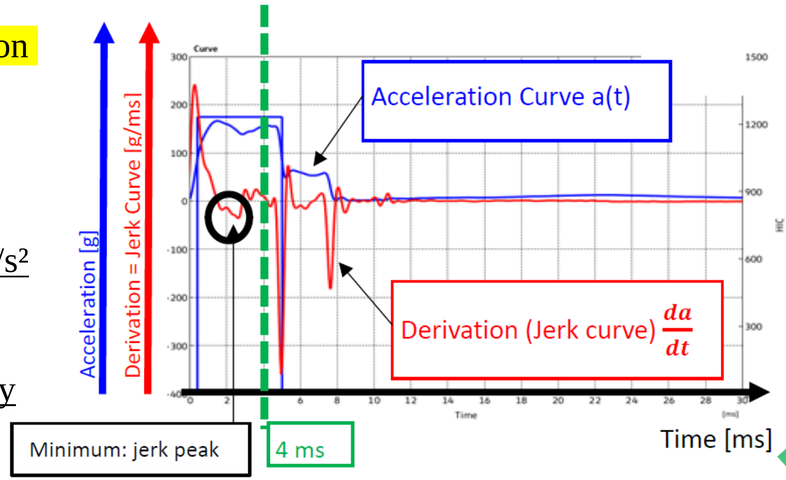
"2.48. "Atypical windscreen fracture behaviour" is where the headform to windscreen impact results in at least one of the following cases:

(a) The absolute value of the minimum value of the derivation of the headform acceleration versus time is less than 180 g/ms within the first 4 ms after the initial contact of the headform to the windscreen, as shown in Figure 16; or

(b) The minimum value of the acceleration below 300 m/s² between the initial peak and 10 milliseconds is reached later than 4 ms in the time/acceleration plot, or glass breaking which expands to whole windshield is not visibly observed."

Figure 16
Jerk criterion graph and formula

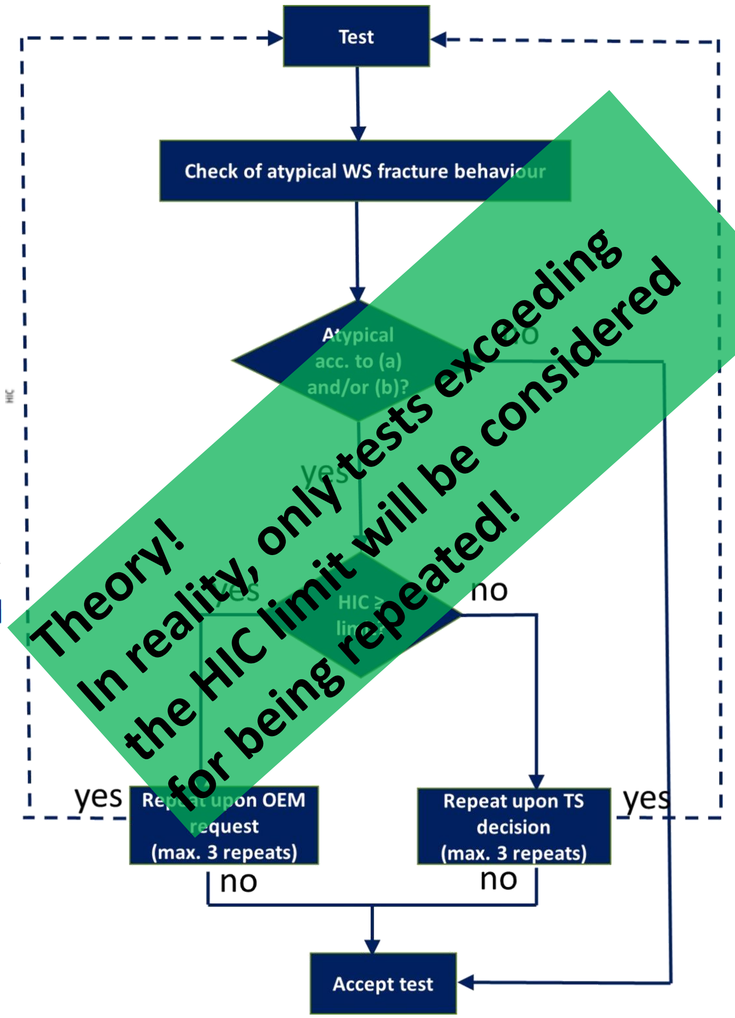
$$\left| \min \left(\frac{da}{dt} \right) \right| < 180 \text{g/ms}, \quad \text{for } 0 < t < 4\text{ms}$$



Annex 5

"4.8. Tests may be repeated in case of atypical windscreen fracture. The repetition of the test is at manufacturer's request where the HIC value exceeds or is equal to the respective limit of the head impact zone. The maximum number of repetitions on a measuring point is 3 (i.e. 4 tests total) in this case. On request of the technical service the tests may be repeated where the HIC value is below the limit of the head impact zone, for instance in case of underlying structures within 100 mm of the measuring point.

Tests with atypical windscreen fracture shall be duly recorded in the test report."



Issues

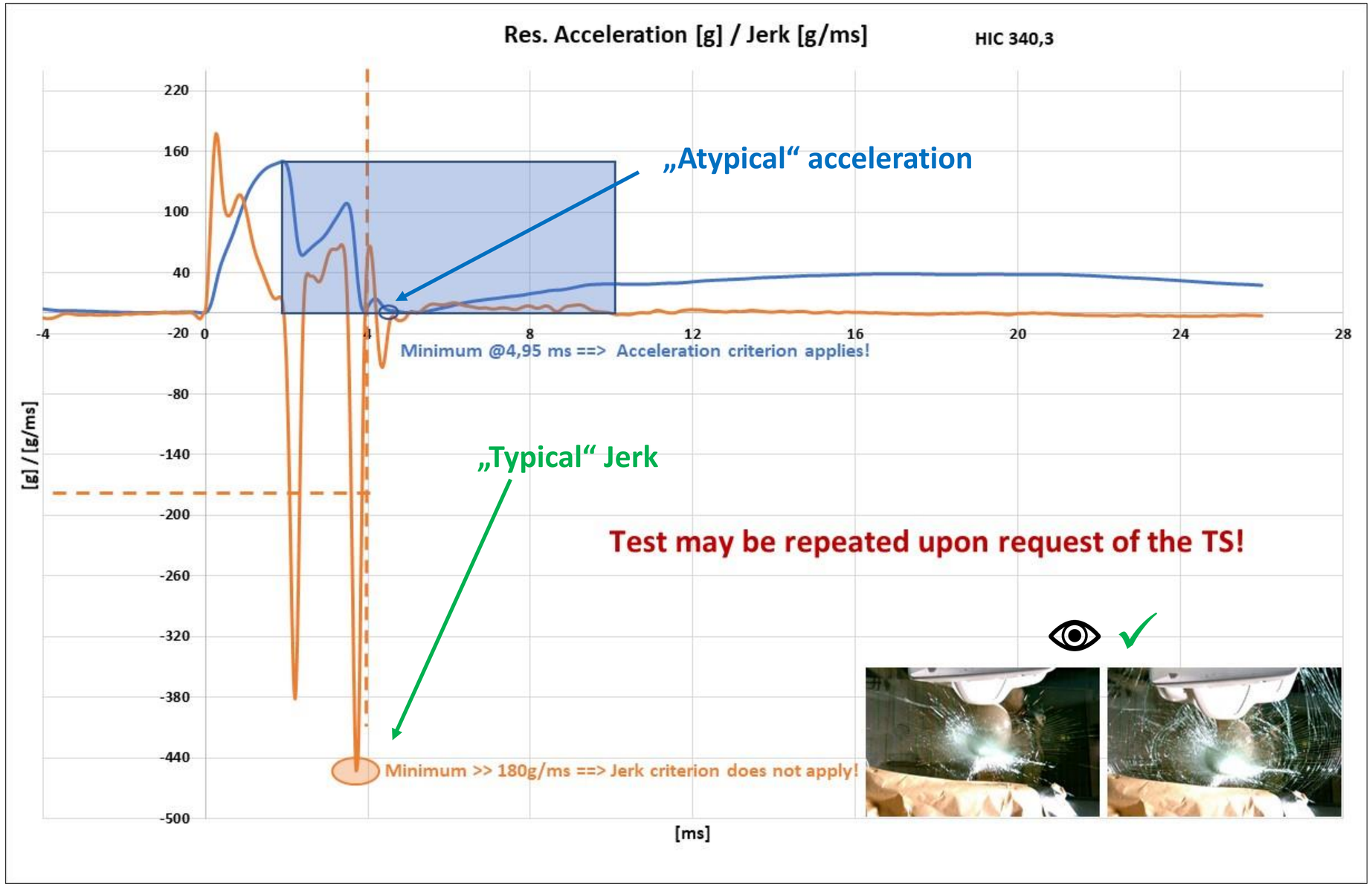
Hernia spider

High res splitter

No fracture

Same car,
same head impactor,
same impact point,
same impact speed
same impact angle!

Issues



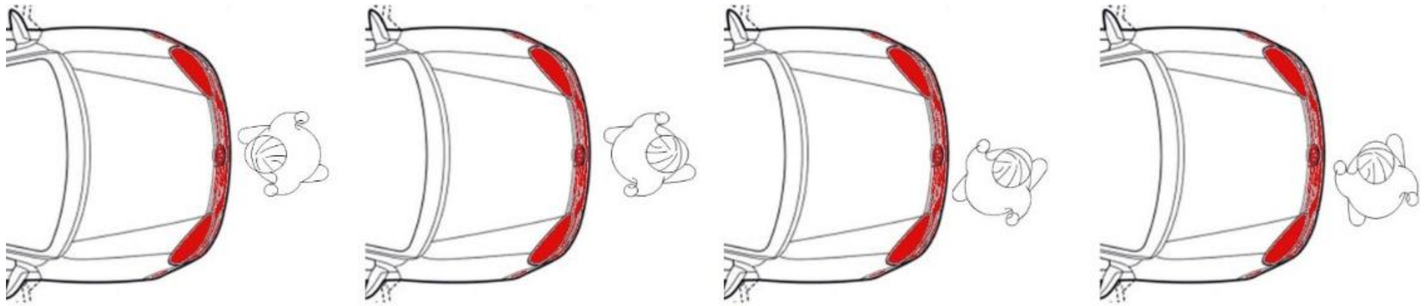
“The minimum value of the acceleration below 300 m/s² between the initial peak and 10 milliseconds is reached later than 4 ms in the time/acceleration plot.”

Reality?

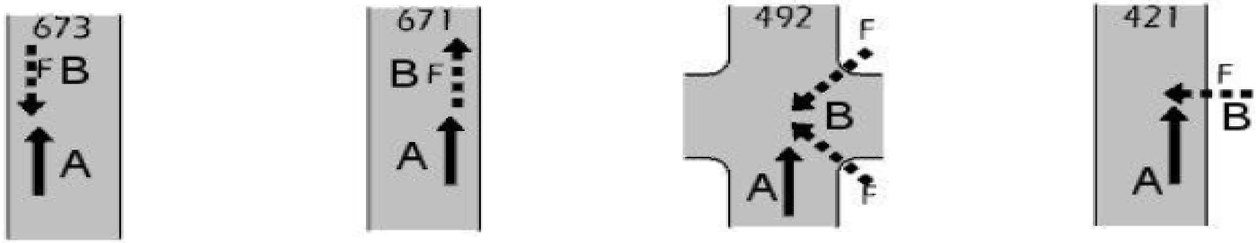
Does the windscreen fracture behavior in impactor tests correspond to reality?

Source: GIDAS

Contribution of a full-body dummy

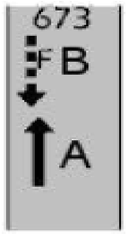


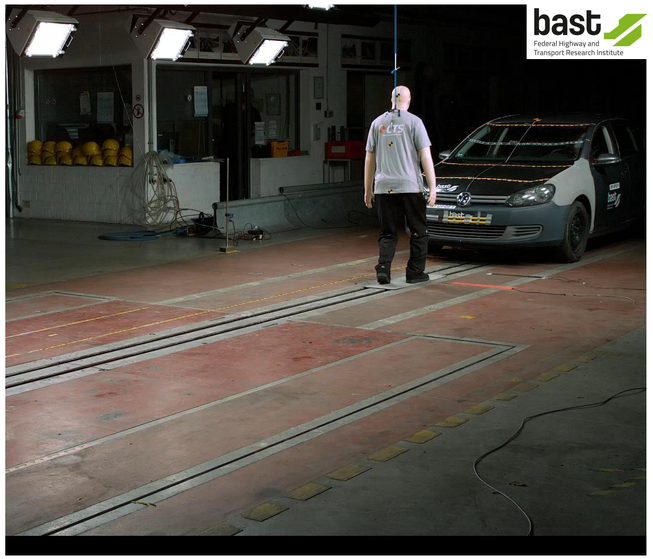
frontal rearward oblique lateral

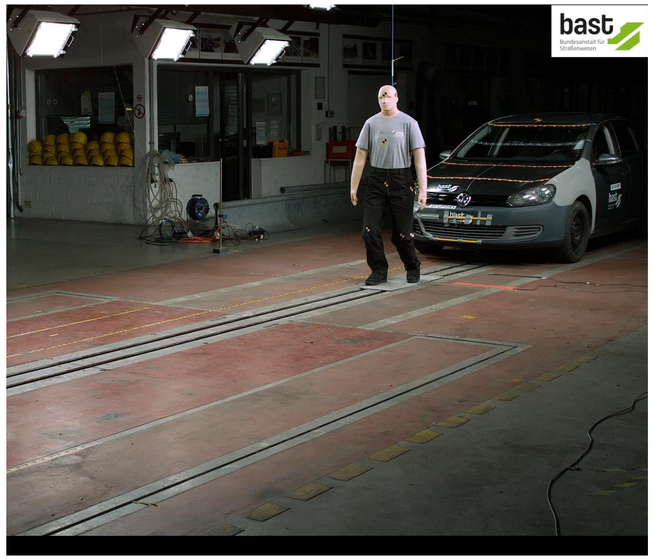


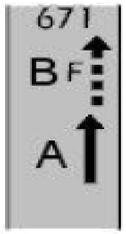
Vehicle speed = 40 km/h
Stationary dummy
Four dummy orientations
First point of contact @ vehicle centerline

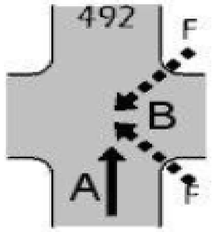
Contribution of a full-body dummy

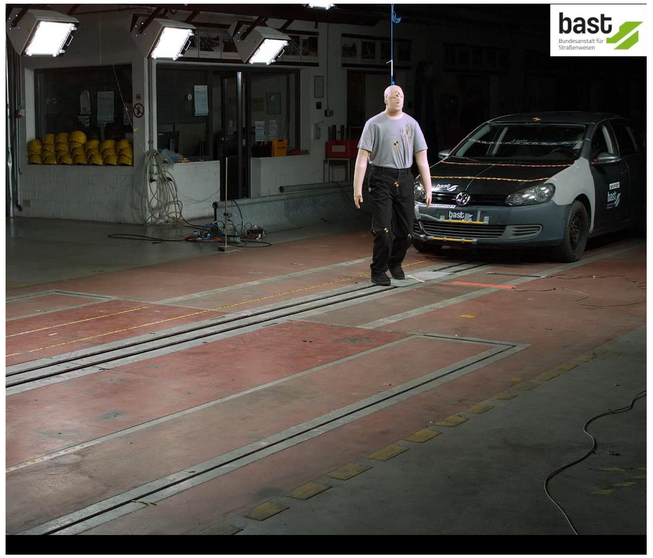


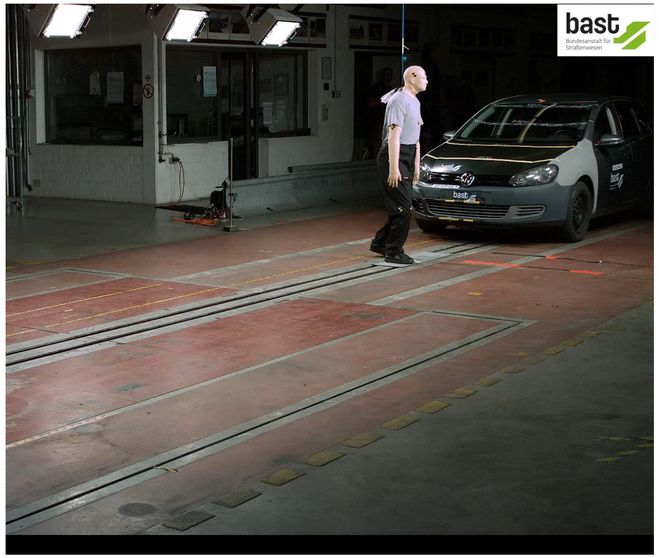


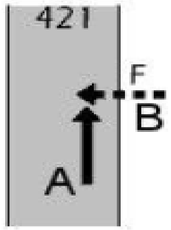




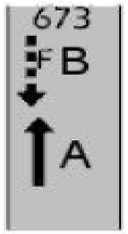


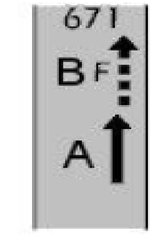


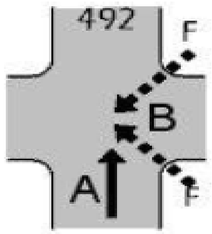


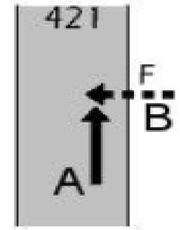


Contribution of a full-body dummy

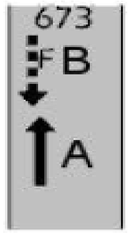




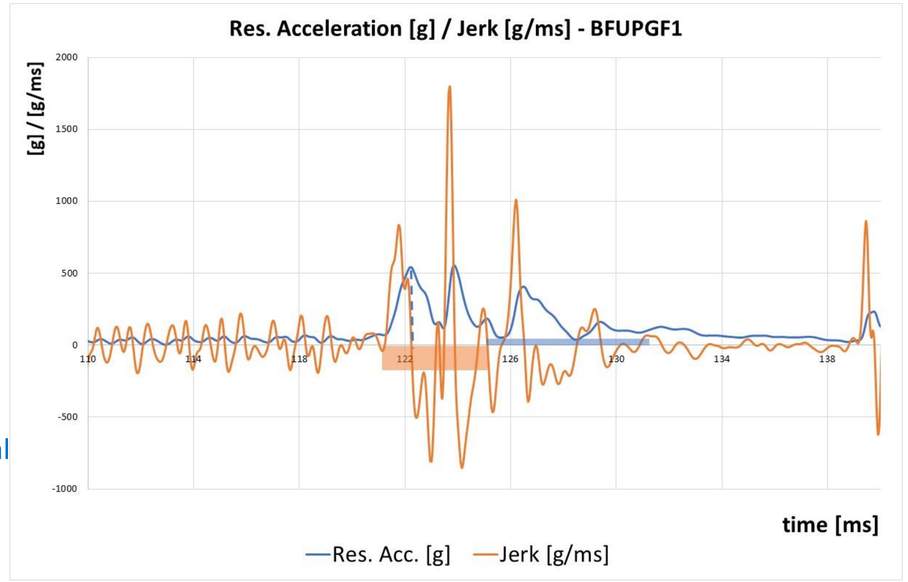


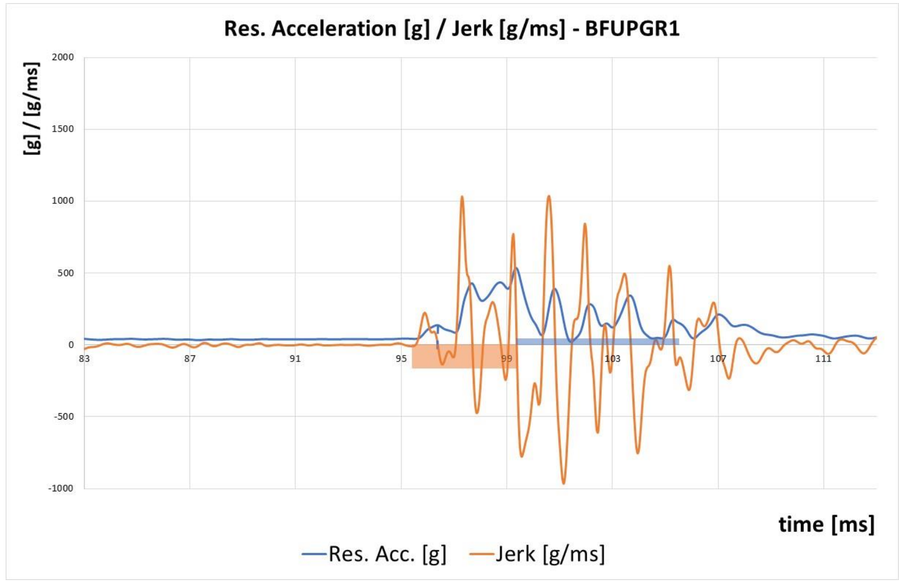


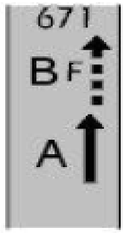
Contribution of a full-body dummy



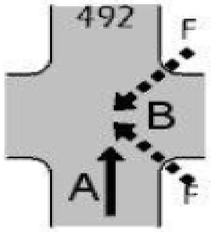
HIC 7776
Acceleration: typical
Jerk: typical



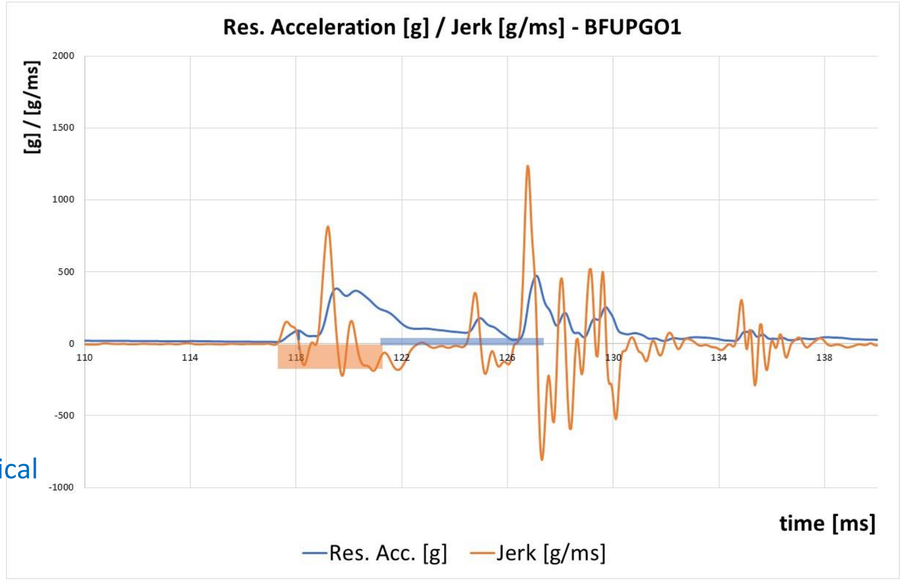


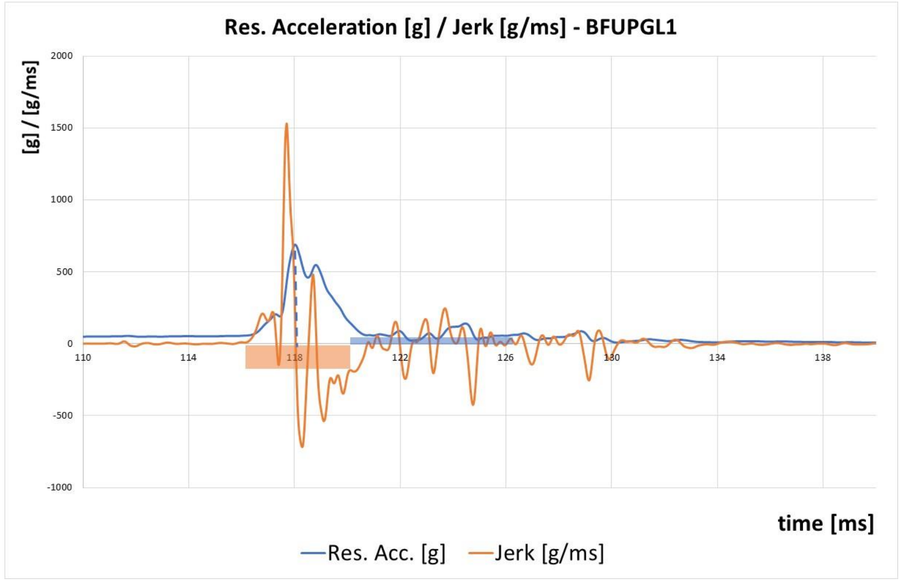


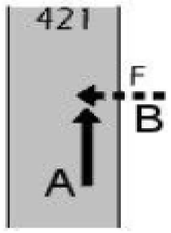
HIC 7784
Acceleration: atypical
Jerk: typical



HIC 4763
Acceleration: atypical
Jerk: typical

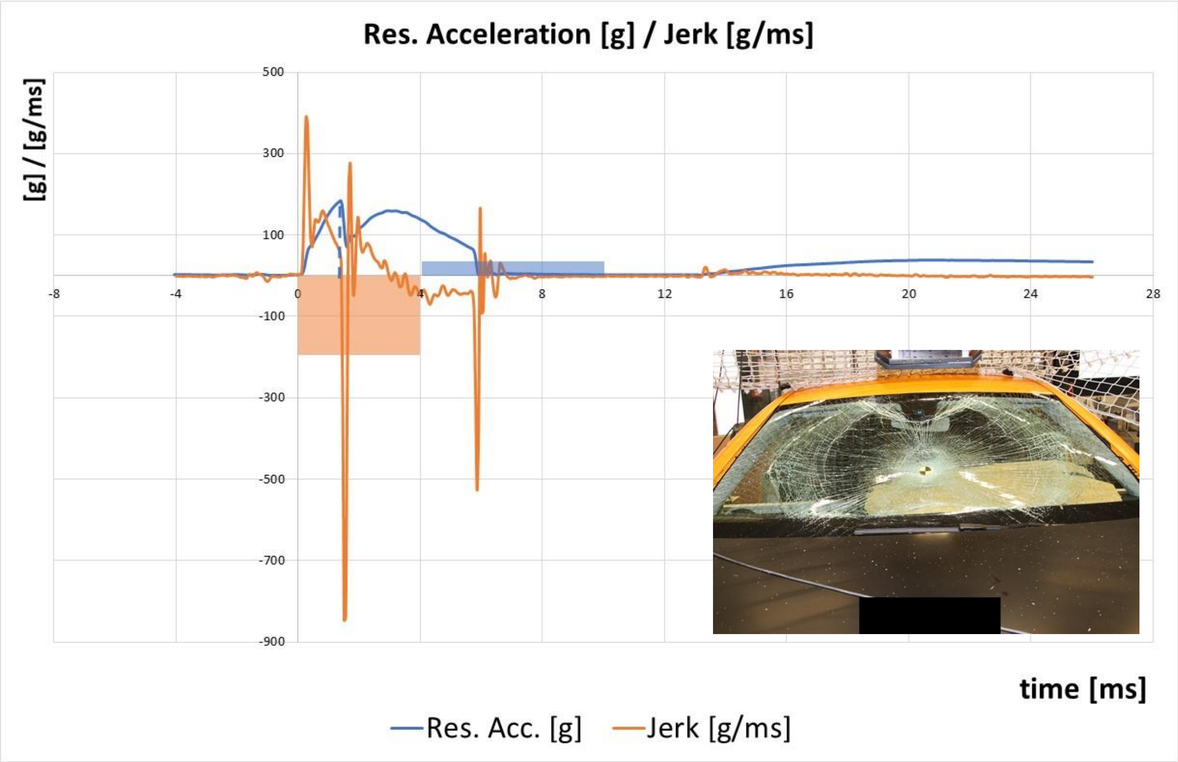


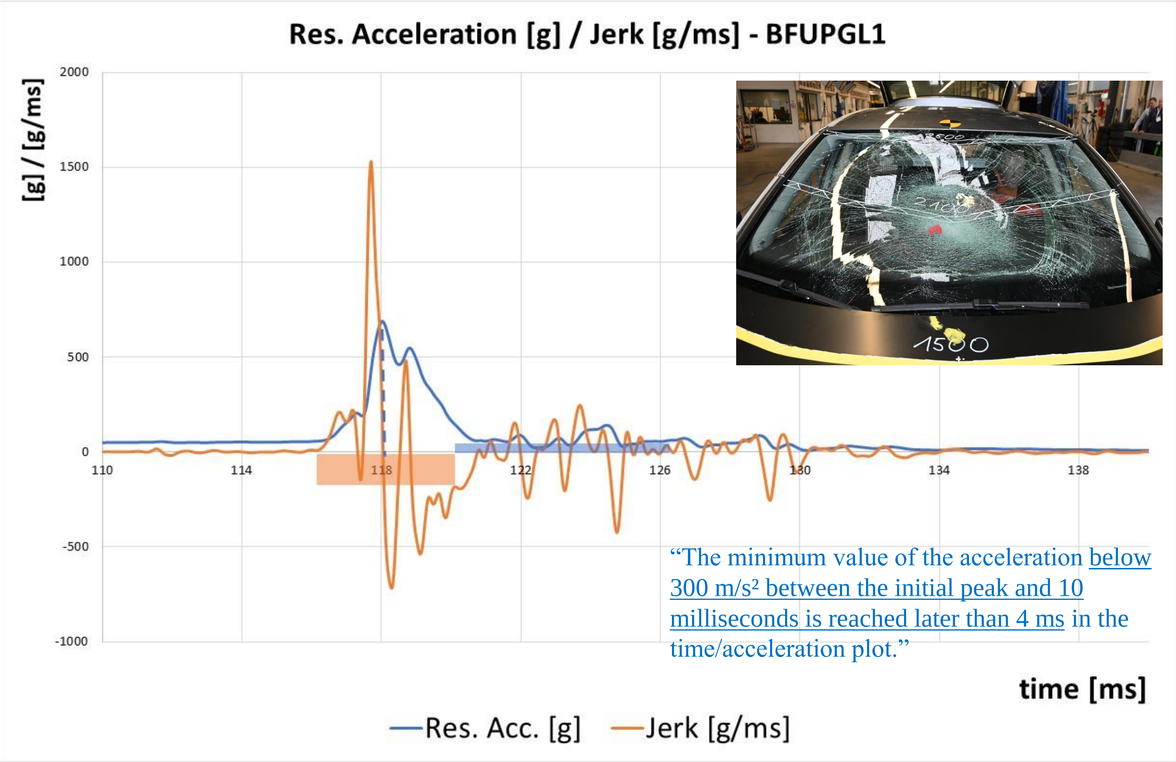




HIC 10232
Acceleration: atypical
Jerk: typical

Comparison: impactor and full-body dummy tests





"The minimum value of the acceleration below 300 m/s² between the initial peak and 10 milliseconds is reached later than 4 ms in the time/acceleration plot."

Test	Head Impactor	Full-scale
Impact speed	11,1 m/s (head impact speed)	11,1 m/s (vehicle speed @ 1st point of contact)
Jerk criterion	typical	typical
Acceleration criterion	atypical	atypical
Max. Head resultant acc	183	688 (@118ms)
HIC	933	10232

Discussion

Federal Highway and Transport Research Institute

Headform tests to the windscreen sometimes result in atypical fracture behaviour of the glazing.

The developed criteria for atypical fracture behavior, allowing a repetition of tests, are often contradictory.

Windscreen fracture patterns in real world accidents are often mimicked in a better way during full-scale vehicle to dummy tests instead of impactor tests.

The visually typical windscreen fracture behaviour seems better reflected by the jerk.

The acceleration criterion seems sometimes misleading.

A deletion of the acceleration criterion from the regulatory text may be considered.

Tests should always be repeated in case of atypical windscreen fracture.

A revision of the test and / or test conditions may be considered in the future.

Possible approach

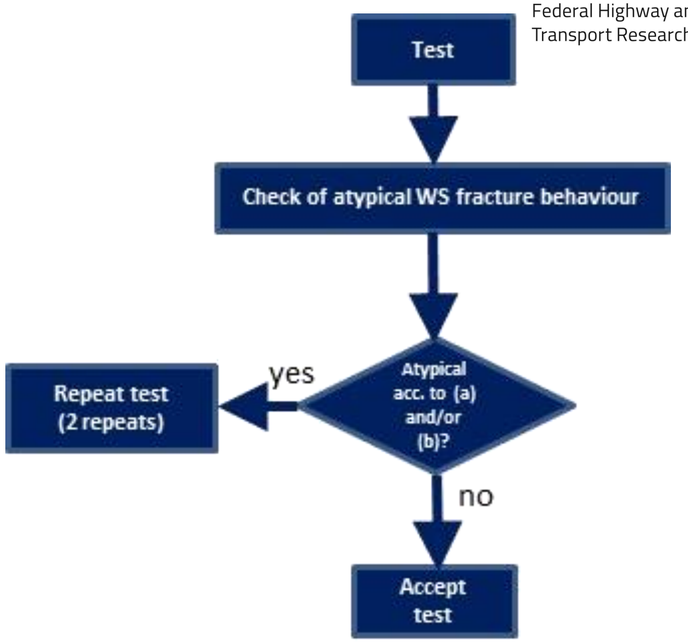
Idea for Supplement to UN-R 127

Text of the Regulation

"2.48. "Atypical windscreen fracture behaviour" is where the headform to windscreen impact results in at least one of the following cases:

(a)The absolute value of the minimum value of the derivation of the resultant headform acceleration versus time is less than 180 g/ms within the first 4 ms after the initial contact of the headform to the windscreen, as shown in Figure 16; or

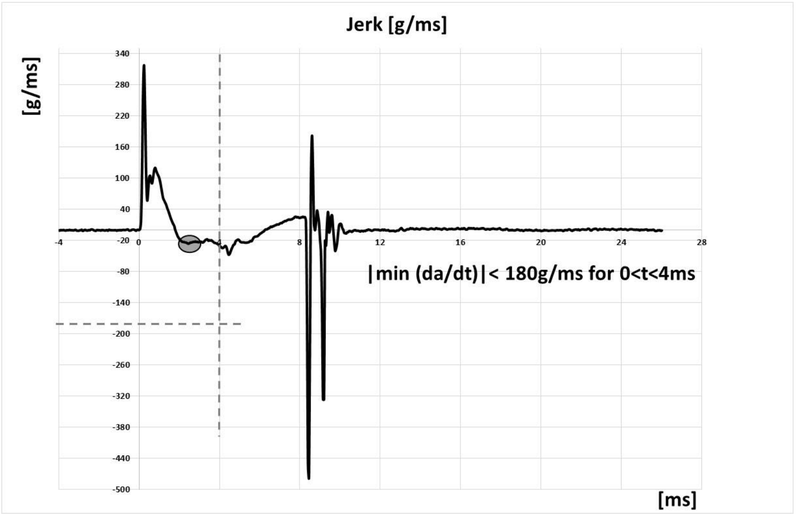
(b) Glass breaking which expands to whole windshield is not visibly observed."



Annex 5

"4.8. Tests shall be repeated twice in case of atypical windscreen fracture and the arithmetic mean value of all three tests shall be taken into account for vehicle assessment.

Tests with atypical windscreen fracture shall be duly recorded in the test report."



Questions answered?

Federal Highway and Transport Research Institute

Headform tests to the windscreen result in sometimes atypical fracture behaviour.

Does the windscreen fracture behavior in impactor tests correspond to reality?
Sometimes, only.

Dummy head impacts to the windscreen seem to be closer to reality in terms of windscreen fracture.

Are impactor and full-body dummy tests comparable? Sometimes.

What do we learn? A lot. ☺

What may be a possible approach? Collect more data.
Delete acceleration criterion.
Revise test procedures, based on further research.

bast
Federal Highway and
Transport Research Institute

Thank you for your attention!

We look forward to the discussions.

zandero@bast.de