



EqOP: Airbag Model Validation

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EqOP TF3 VCT: Concept for Proof of Concept



Concept for proof of concept

0.) Document requirement on VCT procedure which have been defined so far in report form (Decision list)

1.) What is needed to make level 3 possible?

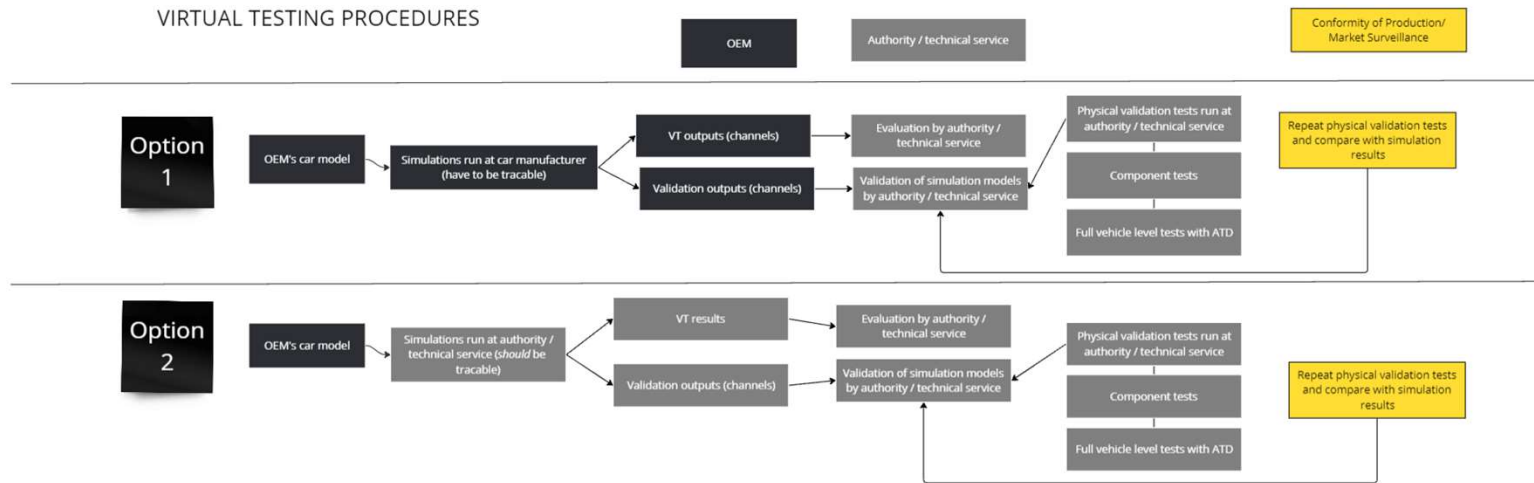
2.) Develop concept for option 1 and 2 and draft a testing procedure + requirements of all involved tools in written form (start with UN R21 text?)

3.) Collect inputs for cost benefit analysis - how much reduction in injury risk can be achieved with the introduction?

4.) Check with all contracting parties feasibility of the introduction of the procedure developed in 2)

5.) Check with industry feasibility of the introduction of the procedure developed in 2)

VIRTUAL TESTING PROCEDURES



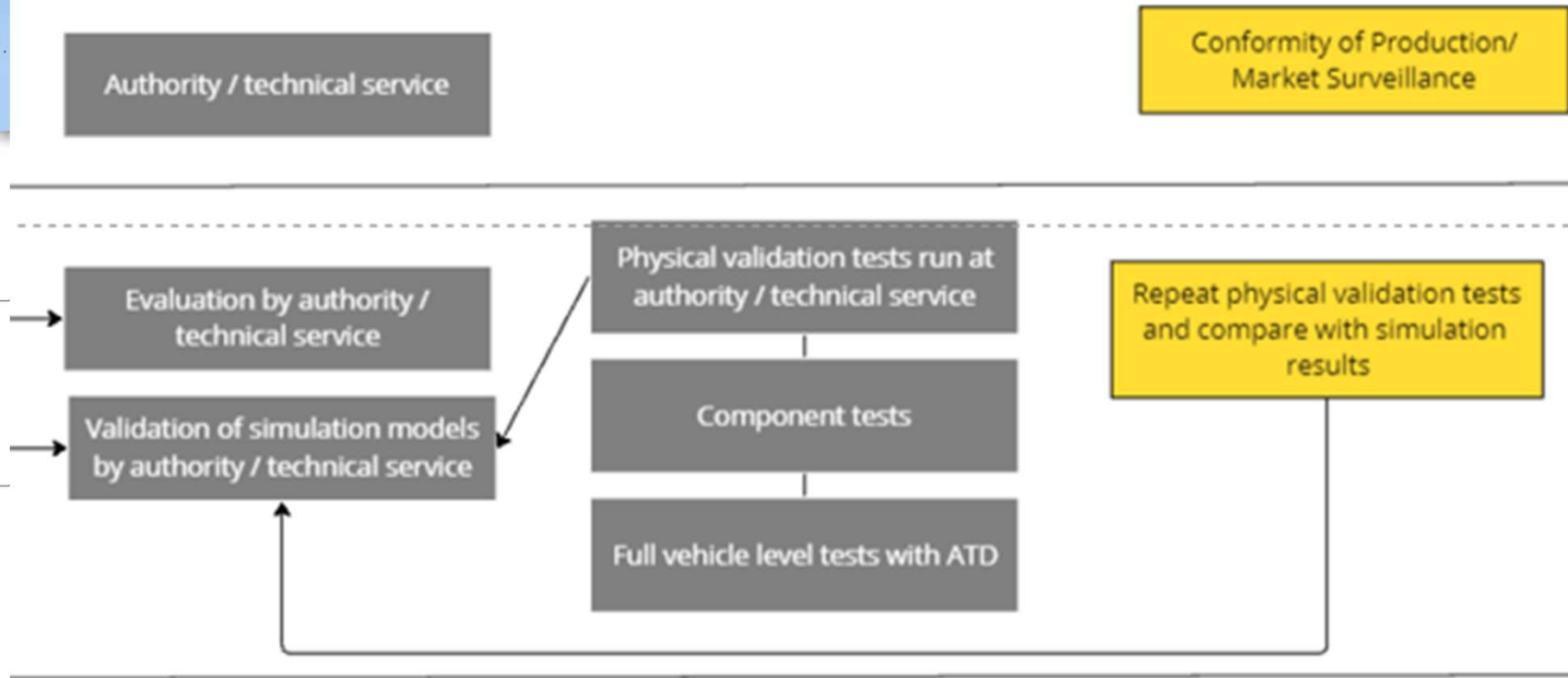
EqOP TF3 VCT: Concept for Proof of Concept



Concept for proof of concept

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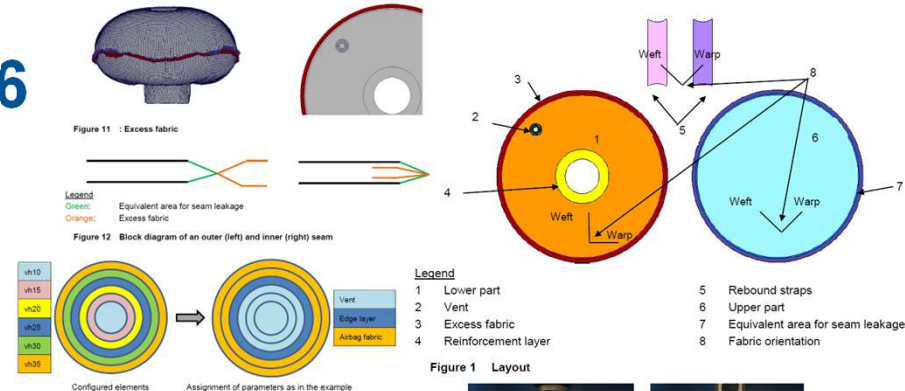
1.



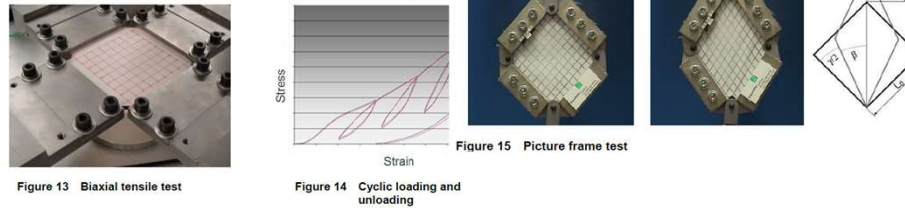
Standard Airbag Validation AK-LV36

LV 36
Issue 2014-09

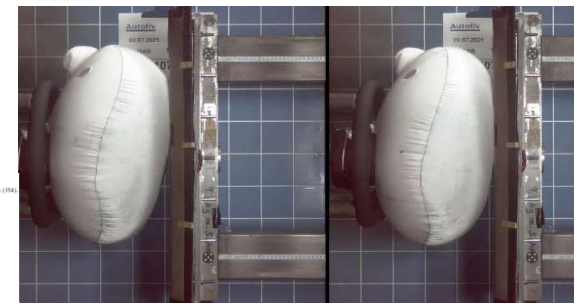
Modeling



Component Testing



Subsystem Testing



Validation (CORA-Rating)

5.4.3 Validation quality
The evaluation for the curve comparison of each configuration with CORA must be at least 90% (115).
The weighting of the individual signals is as follows (115):

Table 4: Specified parameters for CORA

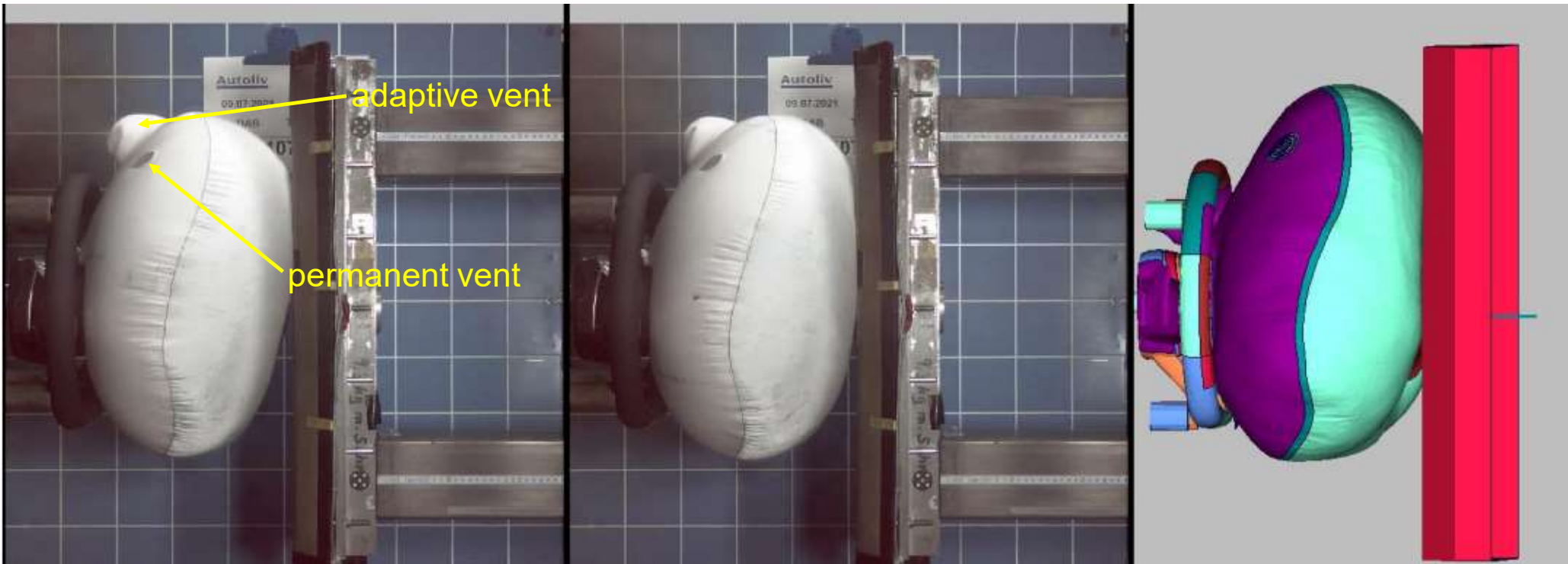
Signal	Weighting	Corridor method	Cross-correlation form/size/phase
Acceleration	0.70	1	0
Velocity	0.00	-	-
Displacement	0.15	0	1
Pressure	0.15	0.5	0.5
			0.33/0.33/0.33

Modeling Guidelines for Airbag Models; Occupant Protection Simulation

Description, Assembly, Validation, and Documentation of Airbag Models

Preface
This Supply Specification version was prepared by representatives of the automobile manufacturers Audi AG, BMW AG, Daimler AG, Porsche AG, and Volkswagen AG in the "Occupant Protection Simulation Methods" Working Group AK 2.5.8.
This LV is stored as an MS Word file in the Audi AG Standards Department.
No claim is made as to its completeness. The automobile manufacturers may demand additional tests to reflect to the present state of art at any time.
Since the individual car manufacturers may make changes if necessary, only their in-house standards that are based on this LV must be used.
Deviations from this LV are listed in the in-house standards on the cover sheet (in justified exceptional cases, deviations can be presented in italics in the text of the standard). If modifications of individual test sections are required in individual cases, these modifications must be agreed upon separately between the appropriate departments of the car manufacturer and of the supplier.
For general development projects of the car manufacturers, test reports will be accepted as long as the tests were performed by an independent institute that is accredited as per DIN EN ISO/IEC 17025. Acceptance of the test reports does not automatically result in a release. Other test reports may be accepted at the discretion of the purchaser.

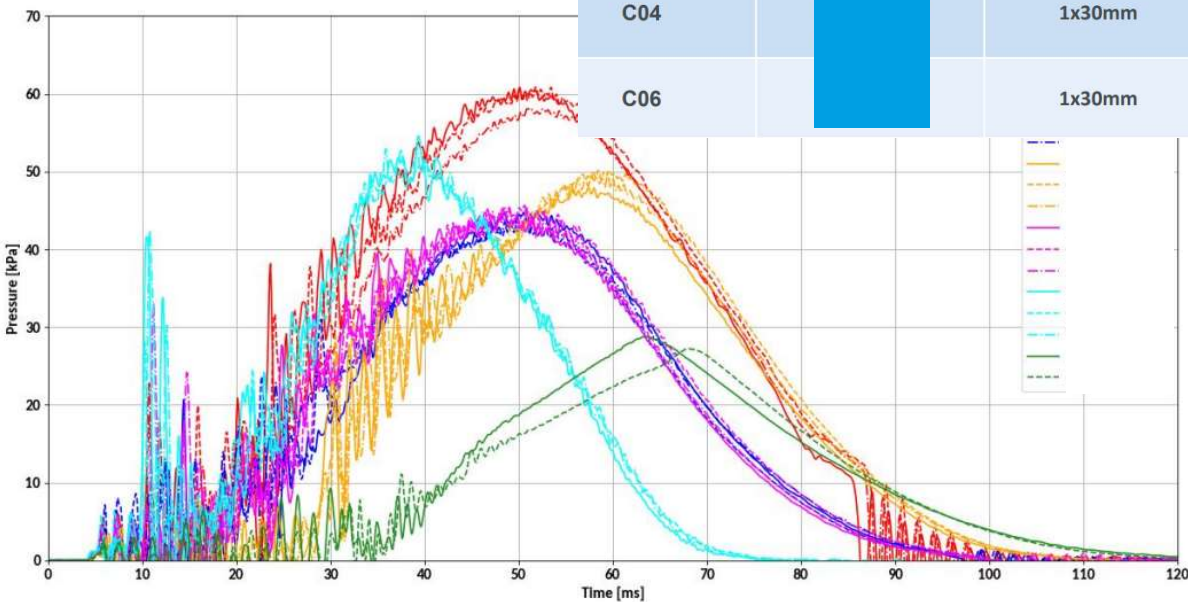
Standard Airbag Validation



- Comparison of airbag deployment

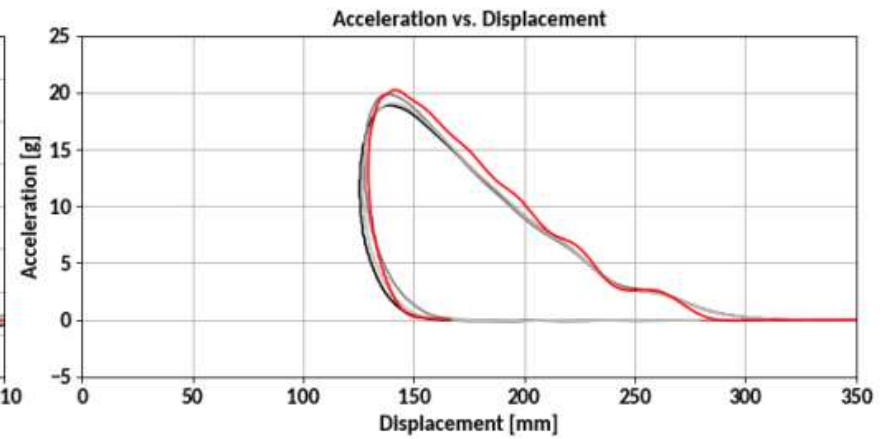
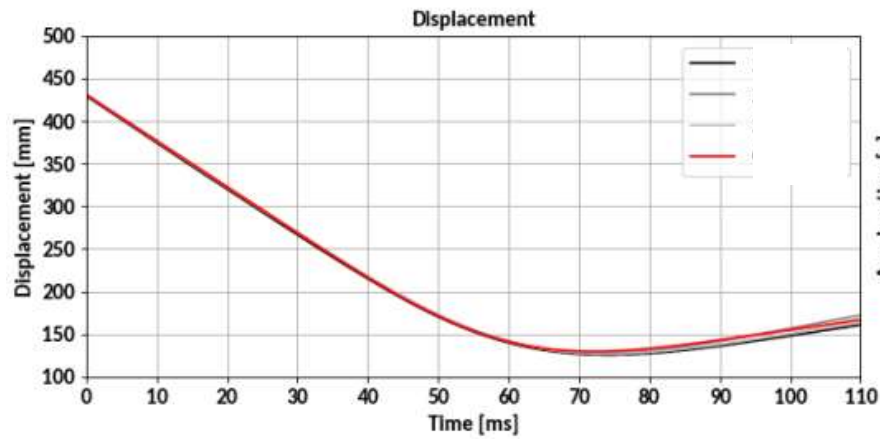
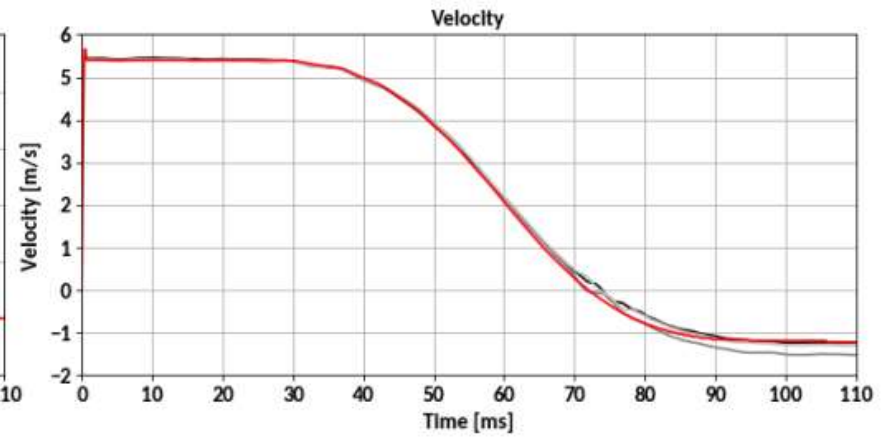
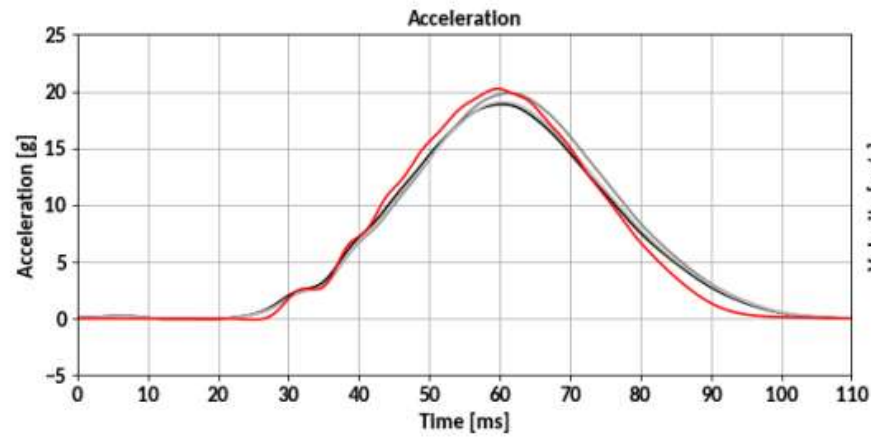
Standard Airbag Validation

Config.	Tests	Vents	Trunk Vent	HI mass [kg]	HI velocity [m/s]	HI distance [mm]
C00		no Vents	TV stitched up	35.0	3.5	302
C01		1x30mm	TV stitched up	35.0	3.5	303
C02		1x30mm	TV stitched up	35.0	5.4	430
C03		1x30mm	TV not activated	35.0	3.5	302
C04		1x30mm	TV activated at 32ms	35.0	5.4	299
C06		1x30mm	TV not activated	35.0	4.5	430



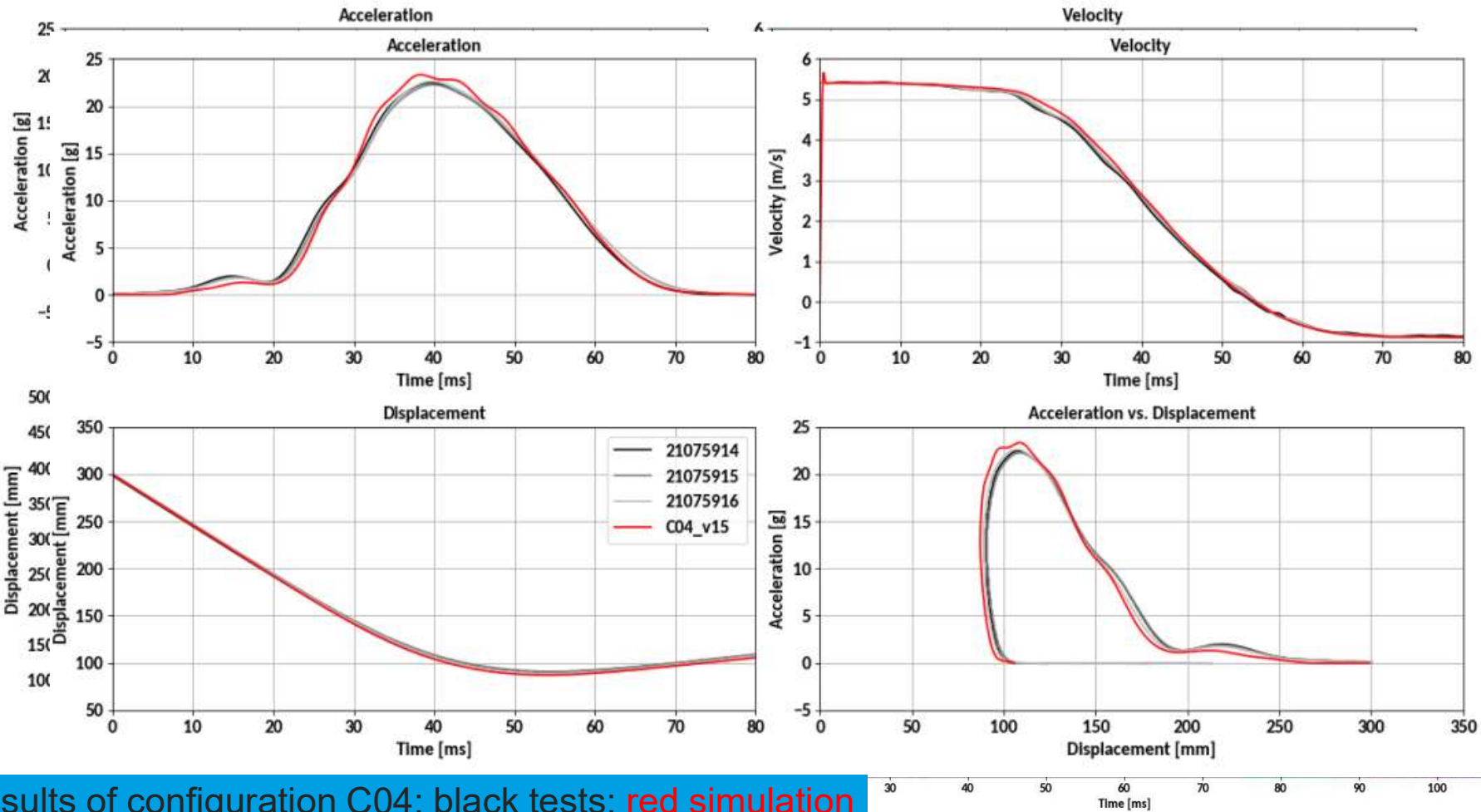
Different pressure levels in linear impactor tests cover whole operational range and hardware features of investigated airbag

Sta



■ Results of configuration C02: black tests; red simulation

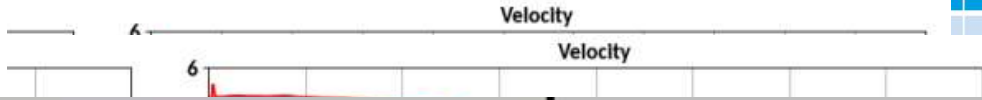
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■ Results of configuration C04: black tests; red simulation

Standard Airbag Validation

Config.	Tests	Vents	Trunk Vent	HI mass [kg]	HI velocity [m/s]	HI distance [mm]
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No.	Experiment	Rating	Weight
1	Konfiguration C00	0.961	0.167
2	Konfiguration C01	0.947	0.167
3	Konfiguration C02	0.884	0.167
4	Konfiguration C03	0.973	0.167
5	Konfiguration C04	0.957	0.167
6	Konfiguration C06	0.825	0.167
Total rating of load case 1:		0.925	1.0

■ Total CORA-rating of ≥ 0.9 (all loadcases) requested by all German OEMs according method of „Arbeitskreis“

Quality of System Model

	FMVSS 208			USNACP	Euro NCAP	ECE	ECE	China NCAP	Korea NCAP
	0° 40km/h 5% Dummy	0° 40km/h 50% Dummy	0° 56km/h 50% Dummy	0° 56km/h 5% Dummy	50% MPDB 50km/h	50km/h RB 5%	50km/h RB 5%	50kph ff 50%	56kph RB00 5%
Overall	Red	Green	Green	Red	Yellow	Yellow	Yellow	Yellow	Yellow
Head acc	Red	Green	Yellow	Red	Yellow	Yellow	Green	Yellow	Yellow
Neck Fx	Red	Yellow	Green	Yellow	Green	Green	Green	Green	Green
Neck Fz	Red	Yellow	Yellow	Yellow	Green	Green	Green	Yellow	Green
Neck Myoc	Red	Yellow	Yellow	Red	Green	Green	Green	Yellow	Yellow
Nij	Red	Red	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Yellow
Chest acc	Yellow	Green	Green	Green	Yellow	Green	Green	Yellow	Green
Chest defl	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow
Chest VC	Yellow	Green	Yellow	Green	Green	Green	Green	Yellow	Green
Pelvis acc	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Pelvis deviation	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Iliac left	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Iliac right	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Red
Femur left	Yellow	Yellow	Green	Red	Red	Yellow	Green	Yellow	Green
Femur right	Yellow	Green	Green	Yellow	Green	Yellow	Yellow	Green	Red
Kneeslider left	Yellow	Yellow	Yellow	Yellow	Red	Green	Green	Yellow	Green
Kneeslider right	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Yellow	Red
Tibia left	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow
Tibia right	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
AB remain depth	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Dummyposition	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Beltforce B3	Yellow	Yellow	Green	Green	Green	Green	Green	Yellow	Green
Beltforce B6	Yellow	Yellow	Yellow	Red	Yellow	Red	Yellow	Green	Yellow
Belt outlet	Yellow	Yellow	Green	Green	Yellow	Green	Green	Yellow	Green

Example for the validity of the simulation model of a customer restraint system compared to car crashes at final state (confidence matrix). The model is not predictive but shows right tendencies and was very helpful for the development of the restraint system.

30% < Δmax
 10% < Δmax ≤ 30%
 Δmax ≤ 10%

Frontal Crash: Examples for other Crash-Relevant Components

Belt system (validated@suppliers)

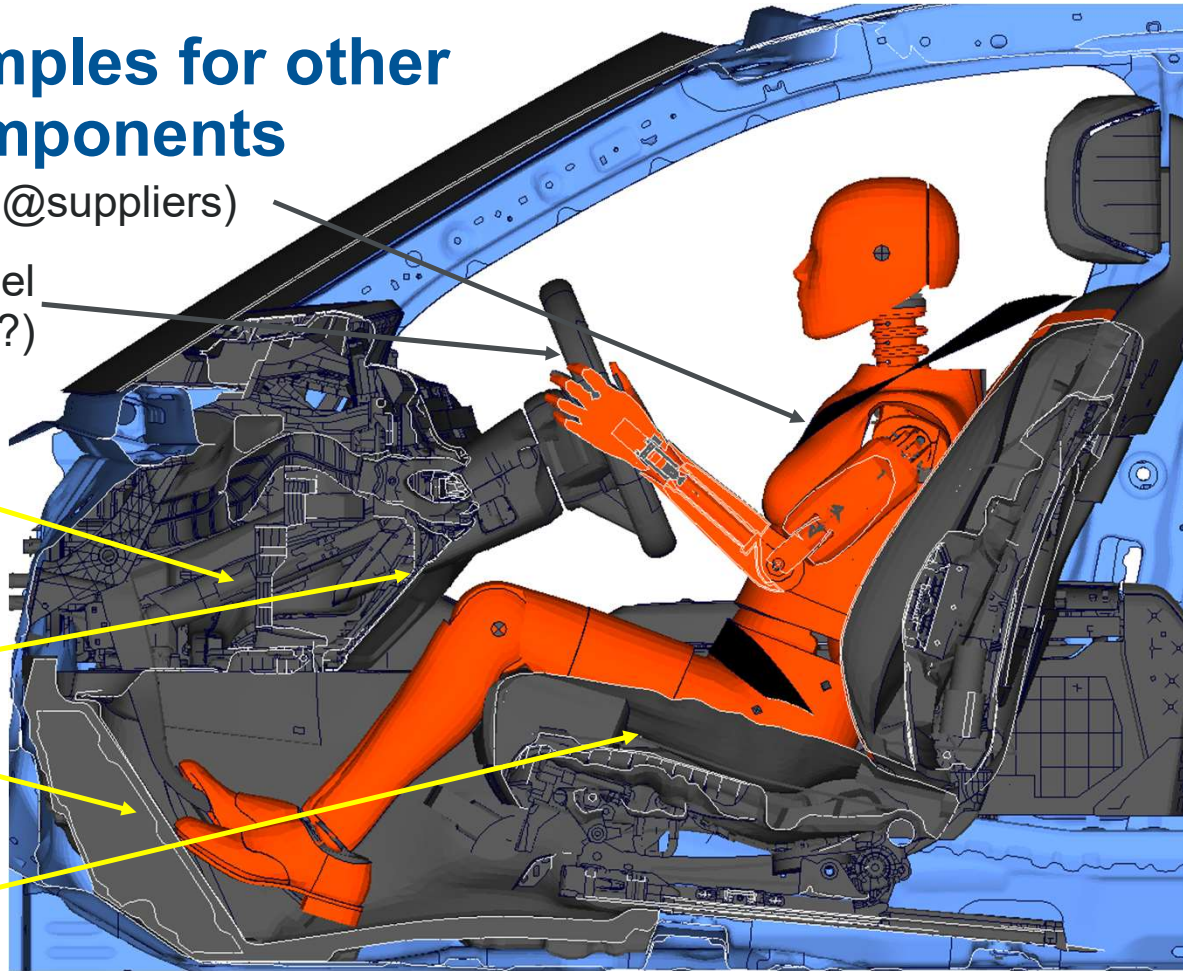
Stiffness of steering wheel (validated@Autoliv only?)

Collapsible steering column (validated@OEM?)

IP stiffness

Stiffness of floor

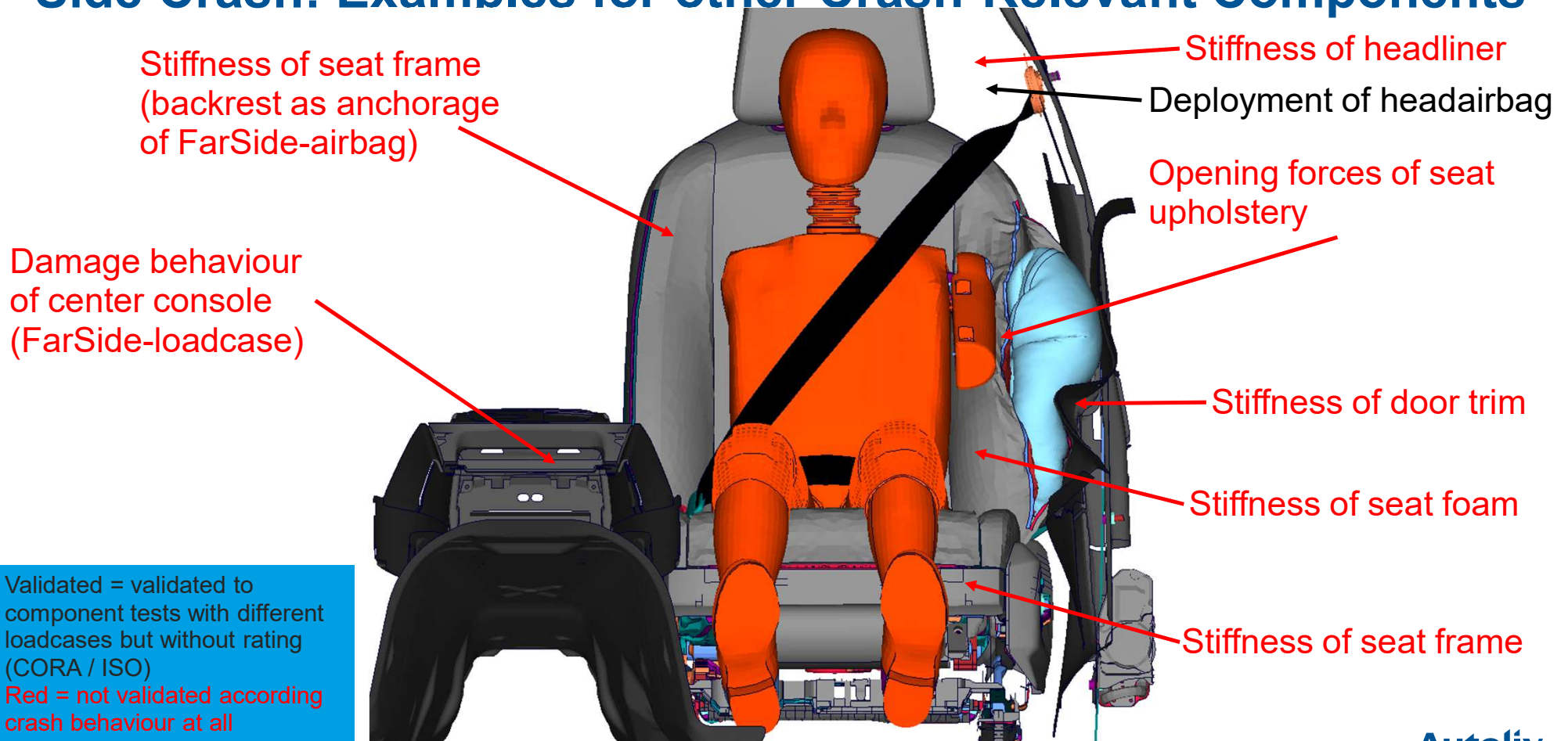
Crash behaviour of seat cushion / seat ramp



Validated = validated to component tests with different loadcases but without rating (CORA / ISO)

Red = not validated according crash behaviour at all

Side Crash: Examples for other Crash-Relevant Components



Discussion

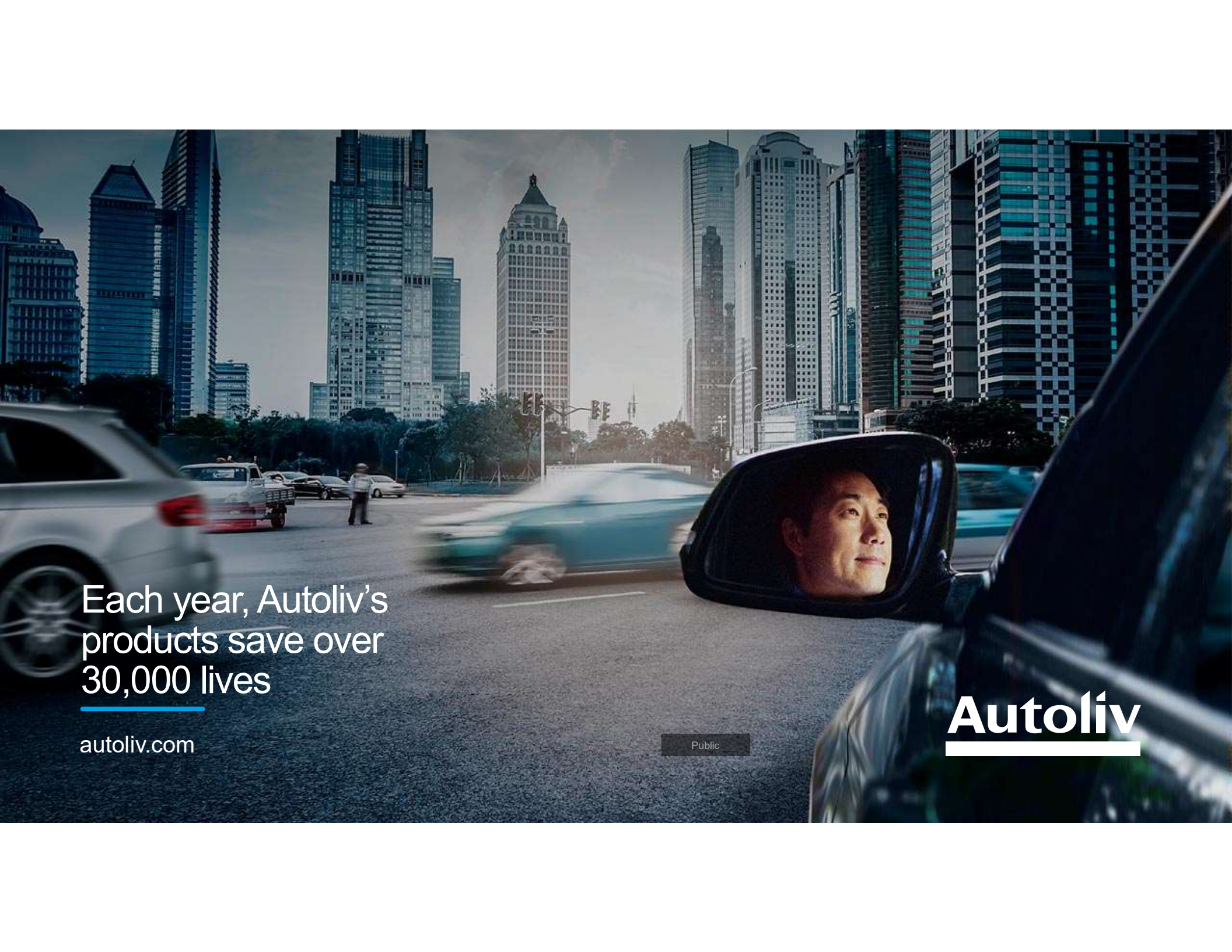
- It seems necessary to do validation on component level if a high level of predictivity (level 3) shall be reached.
- Same effort as for requirements on airbag validation (AK-LV36) should be put in the crash behaviour of all components which highly influence dummy kinematics. Not enough effort has been undertaken in this direction so far. Different load-cases covering loadings of front and side crash should be added in this regard.
- If the existing component regulations would address simulation model requirements, increasing administration and costs are foreseen.
- Predicting sled tests or crash tests covering the whole range of possible working points to be assessed, and with randomized testing of different scenarios, could be another approach. However, here a solution must be found for the following issue:
 - Variation of the results from the hardware dummy is high and therefore ratings must use low limits. This doesn't comply with the requirement to assess predictivity of the model.

Discussion II

- Establish new regulations on component testing or extend already existing ones.

Regulation	Load-case
UN R.E.3.	H-Point Manikin
UN R12	Occupant protection from the steering control system
UN R14	Safety-belt anchorages
UN R16	Safety-belts; sled test with R16-manikin in standard seat and R16 pulse; 50kph
UN R17	Seats; quasi-static tests of seatback and headrest; alternatively dynamic test BioRID50M
UN R21	Interior fittings (interior head impact)
UN R95	Front seat on the struck side; Belted ES250M ; MDB (950kg) 50kph; Perpendicular
UN R135	Front seat on the struck side; WSID50M ; Pole side impact 32kph; angled
UN R94	Belted driver and front pass; HIIS50M and HIIS50M ; Frontal ODB; 40% overlap (driver side of vehicle); 56kph
UN R137	Belted driver and front pass; HIIS50M and HIIS5F ; Full frontal; Perpendicular; 50kph

- Make component testing mandatory in a way that it is needed to proof component validation to technical service but leave it open how this is done in detail.
 - Kind of components to be tested should be fixed by regulation
 - Technical service would need to have sufficient expertise to judge quality of validation method



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