

ATD MODEL QUALIFICATION PROCEDURE FOR VIRTUAL TESTING

HIII F05, M50, M95

ACEA VT PS

Teams

Euro NCAP WG VTC

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4th June 2025

The logo for ACEA, featuring the word "aceia" in a lowercase, dark blue, sans-serif font. The letters 'a', 'c', and 'e' have small blue dots at their top and bottom curves, respectively.

EURONCAP VIRTUAL TESTING PROCEDURE

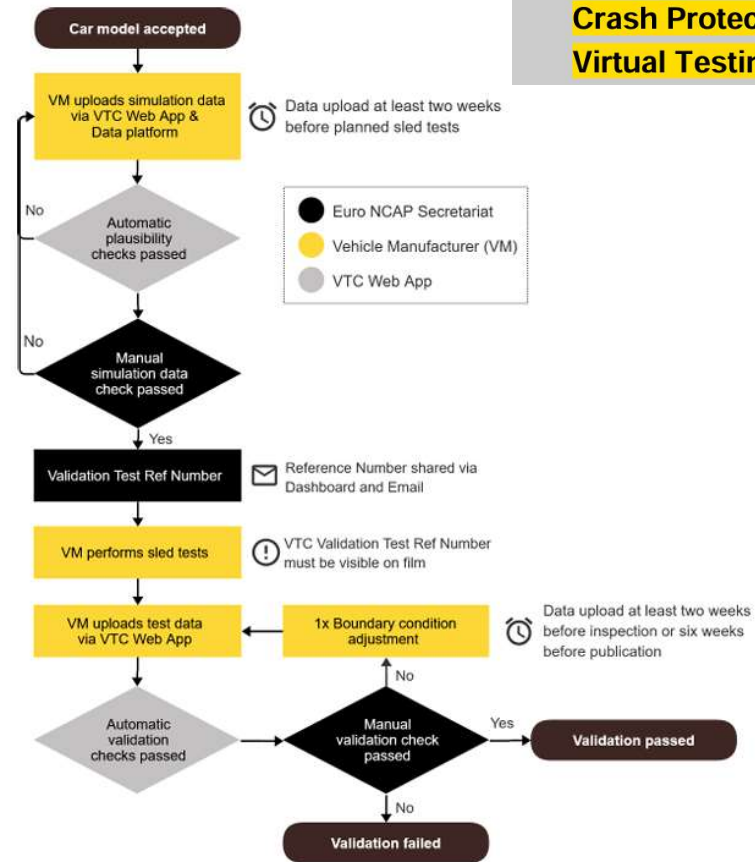


5.1 Qualification of the dummy model

The dummy model(s) used in this procedure must be qualified beforehand to ensure that it behaves consistently when compared to its physical counterparts. The qualification of the dummy models must be performed according to the specifications in Euro NCAP Technical Bulletin CP-XXX.

Documentation on the dummy qualification shall be uploaded together with the simulation results to the VTC server. The VM is responsible for ensuring that all requested dummy outputs are available with

- A qualified finite element (FE) dummy model needs to be used for VT



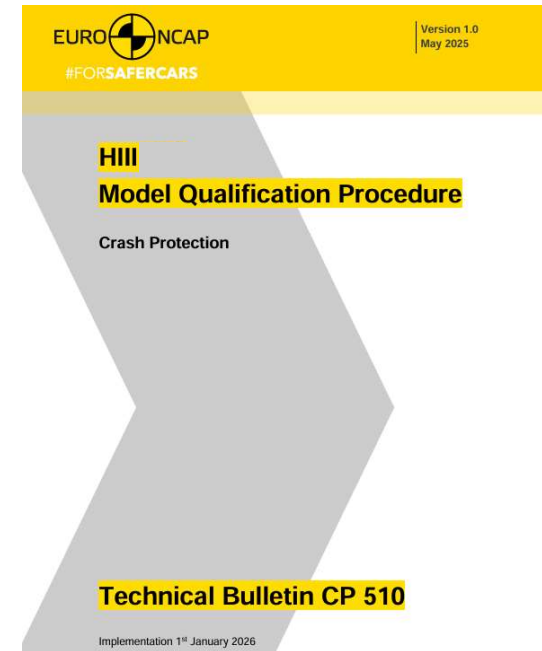
A certification procedure must be established for the dummy models, which are used in VT assessment

DUMMY MODEL QUALIFICATION

- Three level approach for the qualification of the ATD virtual models
 - Normative dummy requirements
 - Component level
 - Full scale tests

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Dummy model (e.g. HIII F05, M50 and M95) validation needs to be assessed at different level

DUMMY MODEL QUALIFICATION STAGE 1 NORMATIVE DUMMY REQ.

- Normative requirements are the same as for the hardware ATD regarding: mass properties, dimensions, range of motion, instrumentation, dummy dynamic qualification procedures
- The normative requirements for HF, H3 and HM do not cover all body regions equally (e.g. lower leg)
- The current certification requirements generally assesses the performance in term of values achieved. A time window is sometime prescribed.

Body Region	Test method	Loading	HF	H3	HM
			Certif. HW Guideline	Certif. HW Guideline	Certif. HW Guideline
Head	Head Drop	Impact Forehead	SAE J2862	SAE J2856	SAE J2860
	Head Drop	Impact Forehead	SAE J2862	SAE J2856	SAE J2860
Upper Neck	Pendulum Impact	Flexion - bending	SAE J2862	SAE J2856	SAE J2860
	Pendulum Impact	Extension - bending	SAE J2862	SAE J2856	SAE J2860
	Pendulum Impact	Flexion - bending	SAE J2862	SAE J2856	SAE J2860
	Pendulum Impact	Extension - bending	SAE J2862	SAE J2856	SAE J2860
	Pendulum Impact	Extension - bending	SAE J2862	SAE J2856	SAE J2860
Thorax	Thorax Impact	Impact sternum	SAE J2862	SAE J2856	SAE J2860
	Thorax Impact	Impact Sternum - Low Speed	SAE J2878	SAE J2779	
	Thorax Impact	Impact sternum	SAE J2862	SAE J2856	SAE J2860
	Thorax Impact	Impact Sternum - Low Speed	SAE J2878	SAE J2779	
KTH	Thigh Impact	Knee - axial Impact	SAE J2862	SAE J2856	SAE J2860
	Knee Slider Impact Knee Slider Impact	Straight legt - Knee Impact - perpendicular Straight legt - Knee Impact - per - LS	SAE J2862	SAE J2856 SAE J2876	SAE J2860
Foot & ankle	Pendulum Impact	Impact on upper foot		UN-R94-04.S2	
	Pendulum Impact	Impact on heel		UN-R94-04.S2	
	Pendulum Impact	Impact on heel with shoe on		UN-R94-04.S2	
	Pendulum Impact	Impact on upper foot		UN-R94-04.S2	
	Pendulum Impact	Impact on heel		UN-R94-04.S2	
	Pendulum Impact	Impact on heel with shoe on		UN-R94-04.S2	

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- The current certification requirements generally assesses the performance in term of values achieved. A time window is sometime prescribed.
- NCAPs assessment parameters (e.g HIC) are in some cases not covered by dummy certification

Body Region	EuroNCAP current assessment Parameter	Test method	Loading	Limits	HF	H3	HM		
					Certif. HW	Certif. HW	Certif. HW		
					Guideline	Limits	Guideline	Limits	Guideline
Head	HIC15	Head Drop	Impact Forehead	500-700	SAE J2862	500-700	SAE J2856	tbd	SAE J2860
	a3ms (g)	Head Drop	Impact Forehead	72-80	SAE J2862	72-80	SAE J2856	tbd	SAE J2860
Upper Neck	Shear (kN)	Pendulum Impact	Flexion - bending	1,2-1,95	SAE J2862	1,9-3,1	SAE J2856	tbd	SAE J2860
		Pendulum Impact	Extension - bending		SAE J2862		SAE J2856		SAE J2860
	Tension (kN)	Pendulum Impact	Flexion - bending	1,7-2,62	SAE J2862	2,7-3,3	SAE J2856	tbd	SAE J2860
		Pendulum Impact	Extension - bending		SAE J2862		SAE J2856		SAE J2860
Extension Moment (Nm)	Pendulum Impact	Extension - bending	36-49	SAE J2862	42-57	SAE J2856	tbd	SAE J2860	
Thorax	Deflection (mm)	Thorax Impact	Impact sternum	18-34	SAE J2862	22-42	SAE J2856	tbd	SAE J2860
		Thorax Impact	Impact Sternum - Low Speed		SAE J2878		SAE J2779		
	VC	Thorax Impact	Impact sternum	0,5-1,00	SAE J2862	0,5-1,00	SAE J2856	tbd	SAE J2860
		Thorax Impact	Impact Sternum - Low Speed		SAE J2878		SAE J2779		
KTH	Femur compr. (kN)	Thigh Impact	Knee - axial Impact	2,6-6,2	SAE J2862	3,8-9,07@0 7,56@10	SAE J2856	3,8 kN (Knee Mapping)	SAE J2860
	Knee Displacement (mm)	Knee Slider Impact	Straight legt - Knee Impact - perpendicular	Currently not assessed	SAE J2862	6-15	SAE J2856	<6 mm (Knee Mapping)	SAE J2860
Foot & ankle	Tibia index	Pendulum Impact	Impact on upper foot	Currently not assessed		0,4 - 1,30	UN-R94-04.S2	tbd	
		Pendulum Impact	Impact on heel				UN-R94-04.S2		
		Pendulum Impact	Impact on heel with shoe on				UN-R94-04.S2		
	Tibia compr. (kN)	Pendulum Impact	Impact on upper foot	Currently not assessed		2,0-8,0	UN-R94-04.S2	tbd	
		Pendulum Impact	Impact on heel				UN-R94-04.S2		
		Pendulum Impact	Impact on heel with shoe on				UN-R94-04.S2		

Legend Dummy Hardware Certification tests
Certification test is missing
Certification requirements exists but differ or cannot be verified wrt EuroNCAP assessment parameter
Certification requirement can be used

DUMMY MODEL QUALIFICATION STAGE 2 COMPONENT LEVEL TEST

- A subset of certification tests was used to derive guidelines for Stage 2 validation of the dummy models
- Data were provided to PDB from EuroNCAP and OEMs dummy labs

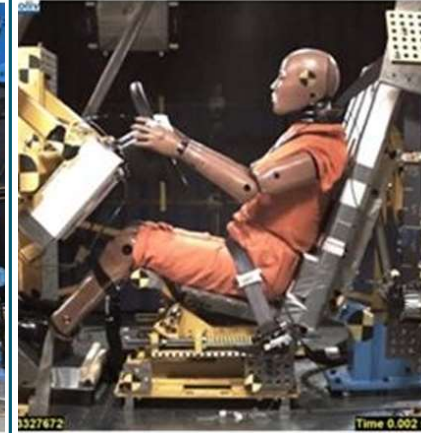
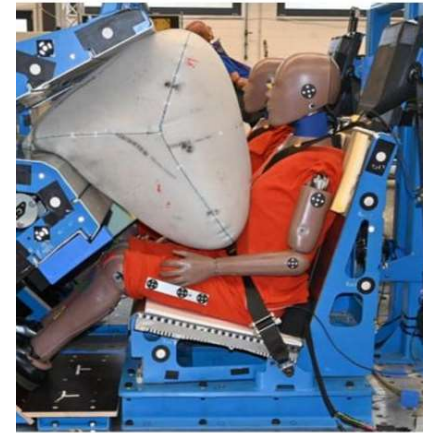
Test	Hybrid III 5%		Hybrid III 50%		Hybrid III 95%	
	# dummies	# labs	# dummies	# labs	# dummies	# labs
Neck extension	8	6	9	6	12 (13)	12 (13)
Neck flexion	6 (8)	5 (6)	9 (10)	6 (7)	12 (13)	7 (8)
Thoracic impact high speed					11 (13)	8
Thoracic impact low speed	5 (7)	3 (5)	8 (9)	5 (6)		
Upper leg impact (left/right)	8 / 7	6 / 5	10 / 8	7 / 5	12 (13) / 11	8 / 6

Legend Dummy Hardware Certification tests
Certification test is missing
Certification requirements exists but differ or cannot be verified wrt EuroNCAP assessment parameter
Certification requirement can be used

Body Region	EuroNCAP current assessment Parameter	Test method	Loading	Limits	HF	H3	HM		
					Certif. HW	Certif. HW	Certif. HW		
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Upper Neck	Shear (kN)	Pendulum Impact	Flexion - bending	1,2-1,95	SAE J2862	1,9-3,1	SAE J2856	tbd	SAE J2860
			Extension - bending		SAE J2862		SAE J2856		SAE J2860
	Tension (kN)	Pendulum Impact	Flexion - bending	1,7-2,62	SAE J2862	2,7-3,3	SAE J2856	tbd	SAE J2860
			Extension - bending		SAE J2862		SAE J2856		SAE J2860
Thorax	Extension Moment (Nm)	Pendulum Impact	Extension - bending	38-49	SAE J2862	42-57	SAE J2856	tbd	SAE J2860
	Deflection (mm)	Thorax Impact	Impact sternum	18-34	SAE J2862	22-42	SAE J2856	tbd	SAE J2860
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Foot & ankle	Tibia index	Pendulum Impact	Impact on upper foot	Currently not assessed		0,4 - 1,30	UN-R94-04.S2	tbd	
			Impact on heel				UN-R94-04.S2		
			Impact on heel with shoe on				UN-R94-04.S2		
	Tibia compr. (kN)	Pendulum Impact	Impact on upper foot	Currently not assessed		2,0-8,0	UN-R94-04.S2	tbd	
			Impact on heel				UN-R94-04.S2		
	Pendulum Impact	Impact on heel with shoe on				UN-R94-04.S2			

DUMMY MODEL QUALIFICATION STAGE 3 FULL SCALE TEST

- Test which resemble the use cases of the dummy models
- They were not planned as twin sled tests projects >> different testing and boundary condition



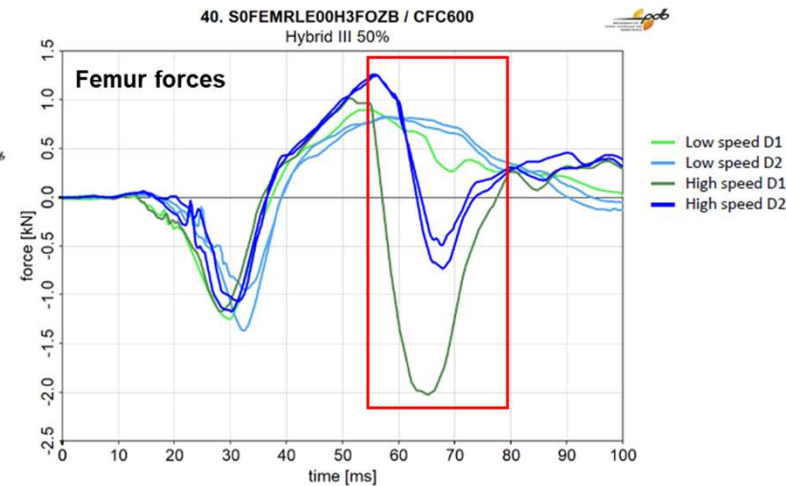
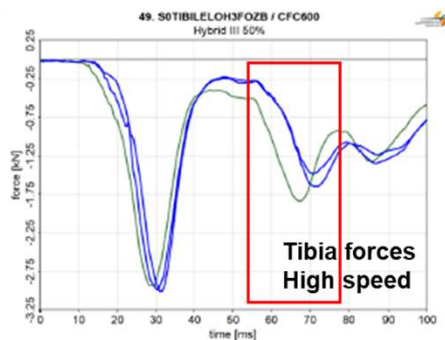
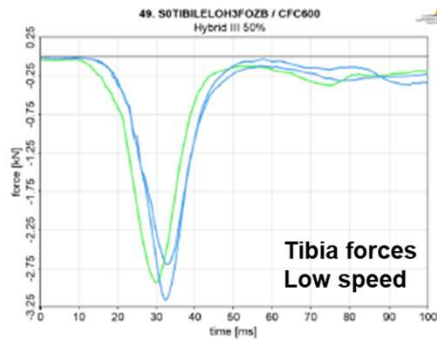
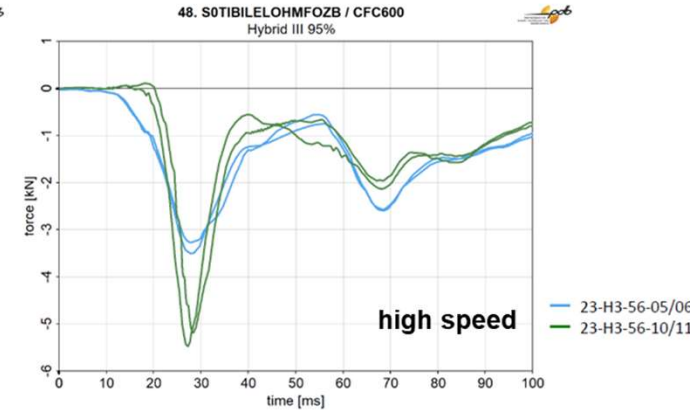
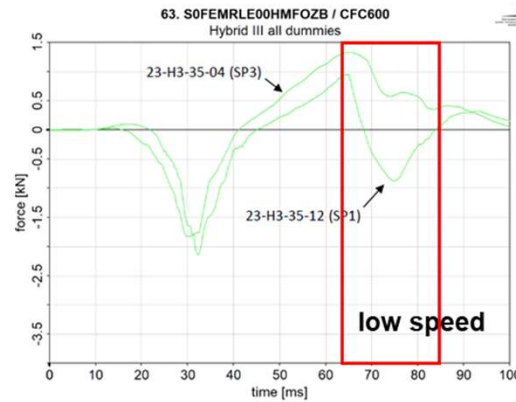
	<u>BASt</u>	<u>Autoliv</u>
Reproducibility	Yes (differ. dummies per perc.)	No (1 dummy per perc.)
Repeatability	Yes	Yes
Positioning data		
Available	Yes	Yes
<u>Analysed and plausible</u>	Yes	Yes
Test videos		
Available	Yes	Yes
<u>Analysed</u>	Yes	Yes
Analysis of test data		
Completed	Yes	Yes
<u>CAD-Modelle</u>		
PAMCRASH/VPS	Yes	Q3 2025
LS-DYNA	Yes	Yes
Load level		
Distinguishes between low-/high-speed	Significant	Small difference
Absolute values	Low to middle	Middle to high

DUMMY MODEL QUALIFICATION LOWER EXTREMITIES ISSUES



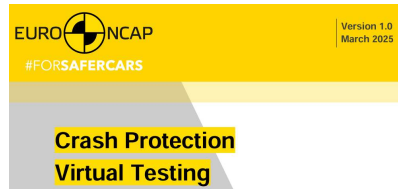
HM BAST/PDB test
H3 BAST/PDB test

Femur forces



A large scatter in the femur contact behaviour between dummies >> no clear target for dummy qualification

DUMMY MODEL QUALIFICATION CHALLENGES FOR THE CHECKING VALIDATION SLED MODEL



5.4 Acceptance Criteria

5.4.1 ISO score

For those sensors in the tables below, the calculated Sensor Score must exceed 0.5 to fulfil the ISO score validation criteria.

Currently, the scores for all other sensors are only monitored and have no consequence on the acceptance of the data and the scoring.

Frontal Impact	Sensor location	Type	Axes
Head & Neck	Head CoG	Accelerations	x,y,z
		Deflection	x
Chest & Abdomen	Chest	Accelerations	x,y,z
		Deflection	x
Knee, femur and pelvis	Pelvis	Accelerations	x,y,z
		Deflection	x
Vehicle	B-pillar	Accelerations	x
	Shoulder Belt (B3)	Force	1D
	Lap Belt (B6)	Force	1D

Table 20: ISO score requirements for stage 3 certification. L/R refers to Left/Right

Dummy			PDB/BAST	Chalmers	
Dummy	Acceleration	Head	≥ 0.65	≥ 0.65	
		Chest	≥ 0.50 for low speed ≥ 0.60 for high speed	≥ 0.50 for low speed ≥ 0.60 for high speed	
		Pelvis	≥ 0.60	≥ 0.60	
	Angular rates	Head	≥ 0.50	≥ 0.50	
		Chest	≥ 0.65 (only HM)	-	
		Pelvis	≥ 0.50	Monitoring	
	Forces	Upper neck	≥ 0.50	≥ 0.50	
		Thoracic spine	≥ 0.50 (only HF)	-	
		Lumbar spine	≥ 0.50 (only HF, H3)	≥ 0.50	
		Iliac spine L/R*	≥ 0.50 (only HF)	≥ 0.50 (only HF)	
		Femur L/R*,1	≥ 0.50	≥ 0.50 (only HF, H3); HM monitoring	
		Upper & Lower Tibia+,1	≥ 0.50	≥ 0.50	
		Moments	Upper neck	≥ 0.50	≥ 0.50
	Miscellaneous	Displacement	Chest compression	≥ 0.65	≥ 0.65
			Force	Seatbelt	≥ 0.70 (B1, B3, B6)
		Pullout	Seatbelt	≥ 0.60	≥ 0.60
		Pressure	Airbag	-	≥ 0.70
		Displacement	Steering column	-	≥ 0.65 only high speed

*average ISO limit between left and right ISO scores
 + average ISO limit of the left and right lower and upper tibia ISO scores
 1 only Z-component, other relevant components (e.g. Tibia force in x-direction) to be delivered as monitoring

Validation requirements for the sled model reflects the issues faced in the qualification of the HIII models

DUMMY MODEL QUALIFICATION

WHAT IS NEEDED TO USE HIII DUMMIES FOR VALIDATION IN HOMOLOGATION

- In general:
 - Extend Stage 1 certification to harmonize the certification level between dummy percentiles
 - E.g. lower extremities HF and HM dummy
 - Extend Stage 2 certification requirements
 - Define Stage 3 certification requirements depending on the loading configuration
 - Only full frontal loading → mostly fore-aft ATD kinematics
 - Even with flat and very stiff footrest (PDB/BAST tests) or fixed ankles (Autoliv) → Limited Tibia Index Assessment, only forces but not moments
 - Harmonization of the sled models (e.g friction values used in PDB/Bast vs Autoliv sleds)
- Above mentioned aspects depend on
 - Which criteria or kinematik behaviour needs to be assessed
 - Dummy suitability
 - Loading conditions

EuroNCAP Technical Bulletin CP510 is a first step towards standardization requirements of HIII model, but there is room for improvement

DUMMY MODEL QUALIFICATION

WHAT WOULD BE NEEDED FOR HOMOLOGATION

- A Team
 - ACEA, CLEPA, EuroNCAP, TU Graz for providing feedback and coordination
 - ATD and Humanetics for providing simulation data
 - Autoliv and BAST for providing sled data results
 - EuroNCAP and OEM dummy labs for providing dummy (hardware) certification results
 - PDB to perform the signals analysis and ISO score calculation
 - Software houses (Ansys-Dynamore, Keysight-ESI) for developing and harmonizing the model of the sled tests

THANKS TO EVERYONE!



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