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EUROPEAN NEW CAR
ASSESSMENT PROGRAMME

Technical Bulletin

THOR Specification and Certification

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Preface

In 2020 the European New Car Assessment Programme (Euro NCAP) updated its offset frontal impact test procedure. These updates are centred on the adoption of the Thor anthropometric test device and a new barrier face for the mobile progressive deformable barrier (MPDB).

This Technical Bulletin details the specification of the THOR dummy specification and certification corridors.

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EUROPEAN NEW CAR ASSESSMENT PROGRAMME (Euro NCAP)

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1. THOR Specification

1.1 The THOR dummy to be used in the MPDB test shall conform to standard build level B (SBL-B) following the THOR-50M drawing package August 2018 as published by NHTSA[i]. However, the following modifications shall be made.

1.2 The dummy shall be equipped with an onboard data acquisition system for both certification and Euro NCAP testing.

1.3 Minor deviations of the shoulder assembly from the NHSTA published drawings are acceptable, provided that these are approved according to the most up to date version of TB029.

1.4 Spine

1.4.1 The THOR dummy shall be equipped with a four-position spine box set to the 'slouched' posture which is equivalent to +9°.

1.4.2 The spine box offers only four posture adjustments, -9° erect posture, 0° neutral posture, +9° slouched posture and +12° super slouched posture.

1.4.3 Alternative spine box designs may only be used where data has been provided to show equivalence between the NHSTA spine assembly and modified spine assembly.

1.5 Lower Legs

1.5.1 The THOR dummy shall be equipped with Hybrid III 50th percentile lower legs, including Mil Spec shoes, HIII knee slider sensor and roller ball-bearing knees shall be fitted. The interface between the THOR 50% upper legs and the Hybrid III lower legs will be at the HIII ball bearing knee slider/ THOR knee.

2. THOR Certification

2.1 The THOR dummy shall be certified in accordance with procedures specified in THOR 50th Percentile Male (THOR-50M) Qualification Procedures Manual, September 2018[ii], limited to the following dummy segments and tests. (Other tests specified are not applicable and replaced by items 2.5, 2.6 and 3.1).

2.1.1 Head Impact Test
2.1.2 Neck Tests, all 6 six conditions
2.1.3 Upper Thorax Impact at 4.3m/s
2.1.4 Left and Right Lower Thorax Impact
2.1.5 Abdomen Impact
2.1.6 Left and Right Upper Leg Impact

2.2 Test impact conditions (test fixture, impactor mass, velocity, geometry, etc.) as specified shall apply.

2.3 Thorax and abdomen displacement sensors and their data processing shall comply with as specified in ISO TS21002[iii].

2.4 Certification corridors as specified in Table 1 through Table 9 shall apply. Note: neck pendulum deceleration pulse corridors changed per NHTSA 2018 qualification manual due to implementation of a more accurate method to determine time zero. This leads to a minor time shift, hence the small shift in pendulum pulse definitions with respect to the previous versions of TB026.

2.5 The knee sliders shall be certified to SAE J2876 after every THREE impact tests and as specified in SAE J2856 after every NINE impact tests. See Technical Bulletin TB006 for more details.

2.6 The HIII lower legs shall be certified in accordance with procedures specified in Annex 10 of ECE Regulation No. 94.

Table 1 Neck Flexion Certification corridors

Parameter	Units	Lower Limit	Upper Limit	Width
Pendulum velocity	m/s	4.95	5.05	1%
Pendulum velocity @ 8ms after T0	m/s	1.57	1.92	10%
Pendulum velocity @ 16ms after T0	m/s	3.13	3.82	10%
Pendulum velocity @ 24ms after T0	m/s	4.42	5.41	10%
Peak upper neck My	Nm	27.3	31.5	7%
Upper neck Fz most positive value prior to 40ms	N	835	961	7%
Peak head angular velocity (relative to earth)	deg/s	-1993	-1732	7%
Peak head rotation (relative to pendulum)	deg	-65.3	-56.7	7%

Table 2 Neck Extension certification corridors

Parameter	Units	Lower Limit	Upper Limit	Width
Pendulum velocity	m/s	4.95	5.05	1%
Pendulum velocity @ 10ms after T0	m/s	1.74	2.12	10%
Pendulum velocity @ 20ms after T0	m/s	3.30	4.04	10%
Pendulum velocity @ 30ms after T0	ms/	4.53	5.54	10%
Peak upper neck My	Nm	-24.9	-20.4	10%
Peak upper neck Fz	N	-3103	-2539	10%
Peak head angular velocity (relative to earth)	deg/s	1855	2267	10%
Peak head rotation (relative to pendulum)	deg	57.1	69.8	10%

Table 3 Neck Lateral Left and Right certification corridors

Parameter	Units	Lower Limit	Upper Limit	Width
Pendulum velocity	m/s	3.35	3.45	1.5%
Pendulum velocity @ 4ms after T0	m/s	1.06	1.30	10%
Pendulum velocity @ 8ms after T0	m/s	2.09	2.55	10%
Pendulum velocity @ 12ms after T0	m/s	3.16	3.86	10%
Upper Neck Mx first peak after 40ms*	Nm	44.8	51.5	7%
First peak head angular velocity* (relative to earth)	deg/s	1256	1445	7%
Peak head rotation relative to pendulum*	deg	38.0	43.8	7%

*specifications are presented as absolute values to accommodate both left & right impacts

Table 4 Neck Torsion Left and Right certification corridors

Parameter	Units	Lower Limit	Upper Limit	Width
Pendulum velocity	m/s	4.95	5.05	1%
Pendulum velocity @ 10ms after T0	m/s	1.71	2.09	10%
Pendulum velocity @ 15ms after T0	m/s	2.57	3.14	10%
Pendulum velocity @ 20ms after T0	m/s	3.46	4.23	10%
Pendulum velocity @ 25ms after T0	m/s	4.27	5.22	10%
Peak upper neck Mz*	Nm	37.9	43.6	7%
Peak upper neck angular velocity* (relative to earth)	deg/s	1358	1563	7%
Peak neck fixture rotation* (relative to pendulum)	deg	43.0	49.5	7%

*specifications are presented as absolute values to accommodate both left & right impacts

Table 5 Head Impact certification corridors

Parameter	Units	Lower limit	Upper Limit	Width
Pendulum velocity	m/s	1.95	2.05	2%
Peak probe force	N	4890	5976	10%
Peak head CG resultant acceleration	g	104.9	120.7	7%

Table 6 Upper Thorax 4.3m/s

Parameter	Units	Lower limit	Upper Limit	Width
Pendulum velocity	m/s	4.25	4.35	1.2%
Peak probe force	N	2642	3039	7%
Peak upper left resultant deflection	mm	47.5	54.7	7%
Peak upper right resultant deflection	mm	47.5	54.7	7%
Ratio of left z- and x-deflection at time of peak resultant deflection	-	0.62	0.75	4%*
Ratio of right z- and x-deflection at time of peak resultant deflection	-	0.62	0.75	4%*

* Relative to mean of resultant deflection corridor

Table 7 Left and Right Lower Thorax certification corridors

Parameter	Units	Lower limit	Upper Limit	Width
Pendulum velocity	m/s	4.25	4.35	1.2%
Peak Probe Force	N	3372	3880	7%
Peak left and right lower X-axis rib deflection	mm	-52.4	-45.6	7%

Table 8 Lower Abdomen certification corridors

Parameter	Units	Lower limit	Upper Limit	Width
Pendulum velocity	m/s	3.25	3.35	1.5%
Peak probe force	N	2572	3143	10%
Lower left abdomen X-axis deflection @ peak force	mm	-83.8	-72.8	7%
Lower right abdomen X-axis deflection @ peak force	mm	-83.8	-72.8	7%
Difference between L&R X-axis deflections @ peak force	mm	-	8	n.a.

Table 9 Left and Right Upper Leg certification corridors

Parameter	Units	Lower limit	Upper Limit	Width
Pendulum velocity	m/s	2.55	2.65	2%
Peak Probe Force	N	4221	5158	10%
Peak Femur Force Fz	N	-3314	-2712	10%
Peak Resultant Acetabulum Force	N	1478	1806	10%
Left Acetabulum Fx @ peak resultant acetabulum force	N	0	-	n.a.
Right Acetabulum Fx @ peak resultant acetabulum force	N	-	0	n.a.

3. Inspections

3.1 PADI

3.1.1 Refer to the NHTSA Procedure for Assembly, Disassembly, and Inspection (PADI)[ii] August 2018 for detailed instructions on THOR-50M. Section 18 provides a tester's checklist as starting point.

3.2 Chest and abdomen displacement sensors

3.2.1 Ensure that chest and abdomen displacement sensors (IR-TRACCs, etc..) are offset corrected in the data acquisition system according ISO TS21002 and are within expected range in its zero-position.

3.3 Face foam

3.3.1 The face foam shall be inspected during regular certification of the dummy (after every three tests) or when the head lower performance was exceeded.

3.3.2 During the course of testing, normal wear on the foam has been observed by THOR users. This wear may be in the form of small tears or abrasions on the rear surface (Figure 1). Surface wear and small tears on the foam are normal and do not adversely affect the performance of the head assembly.

3.3.3 The head assembly consists of a specially designed Confor facial foam (p/n 472-1401) sandwiched between the skull assembly and the head skin (Figure 2). The foam can be inspected by removing the skull cap on the rear of the head (remove four screws). Then pull the dummy skin forward around the skull. The foam sits inside the head skin and can be taken out once the skin is removed from the head.

3.3.4 The foam shall be replaced if multiple large cracks are present on the rear face of the foam, see Figure 3-left.

3.3.5 Assembly of face foam, head skin and skull cap is in reverse order.

3.3.6 No foam certification test is specified at this point, but one may be implemented at a later date.

Figure 1 Small tears in rear surface of the foam

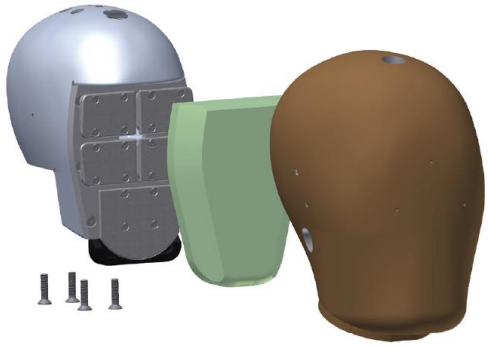

Figure 2 Head Assembly exploded view

Figure 3 Face foam seen from the back, new condition (left), replace if multiple large cracks appear (right)

[i] https://www.nhtsa.gov/filebrowser/download/178861 THOR-50M Drawing Package August 2018

[ii] https://www.regulations.gov/docket?D=NHTSA-2019-0106 THOR-50M Qualification Procedures Manual September 2018, and Procedure for Assembly, Disassembly, and Inspection (PADI).

[iii] ISO TS21002, "Road vehicles – Multidimensional measurement and coordinate system definition" 2021.