EURO NCAP

#FORSAFERCARS

Version 2.0
March 2025

# THOR 50th Specification and Certification

## Crash Protection

# Technical Bulletin CP 106

Implementation 1st January 2026

# PREFACE

During the test preparation, vehicle manufacturers are encouraged to liaise with the laboratory and to check that they are satisfied with the way cars are set up for testing. Where a manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Manufacturers are forbidden from making changes to any parameter that will influence the test, such as dummy positioning, vehicle setting, laboratory environment etc.

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of Euro NCAP. Where a disagreement exists between the laboratory and manufacturer, the Euro NCAP secretariat should be informed immediately to pass final judgment. Where the laboratory staff suspect that a manufacturer has interfered with any of the set up, the manufacturer's representative should be warned that they are not allowed to do so themselves. They should also be informed that if another incident occurs, they will be asked to leave the test site.

Where there is a recurrence of the problem, the manufacturer’s representative will be told to leave the test site and the Secretary General should be immediately informed. Any such incident may be reported by the Secretary General to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

# CONTENTS

# 1 THOR 50TH SPECIFICATION

## 1.1 General

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 April 2023 as published by NHTSA.

https://www.regulations.gov/document/NHTSA-2019-0106-0013 - THOR-50M with alternate shoulders Drawing Revisions-Jan 2023. The shoulders described in drawing 472-3800 shall be used.

## 1.2 Certification

With the exception of the upper thorax, the THOR dummy shall be certified in accordance with procedures specified in THOR 50$^{th}$ Percentile (THOR-50) Qualification Procedures Manual. https://www.regulations.gov/document/NHTSA-2019-0106-0010

Euro NCAP defines a different test to qualify the upper thorax, this procedure is under development and will be is detailed in this document by summer 2025.

No manufacturer shall have access to any pre-test information regarding any of the test equipment to be used by Euro NCAP or be permitted to influence its selection in any way.

The THOR shall be re-certified after every FOUR impact tests.

If an injury criterion reaches or exceeds its normally accepted limit (eg HIC of 700) then that part shall be re-certified.

If any part of a dummy is broken in a test, the part shall be replaced with a fully certified component.

A copy of the dummy certification certificate will be provided as part of the full report for a test.

Certification is limited to the following dummy segments and tests.

Additional tests specified are not applicable and replaced by items detailed in Sections 1.2.4, 1.2.5 and 1.10.

Head Impact Test
Neck Tests, all 6 six conditions
Upper Thorax Impact at 4.3m/s
Left and Right Lower Thorax Impact
Abdomen Impact
Left and Right Upper Leg Impact

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

1.2.2 Thorax and abdomen displacement sensors and their data processing shall comply with as specified in ISO TS21002, Road vehicles – Multidimensional measurement and coordinate system definition 2021.

1.2.3 Certification corridors as specified in Table 1 to Table 11 shall apply.

1.2.4 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.

1.2.5 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 | 27.9 | 32.2 | 7% |
| Upper neck Fz most positive value prior to 40ms | N | 822 | 946 | 7% |
| Peak head angular velocity (relative to earth) | deg/s | -2045 | -1777 | 7% |
| Peak head rotation (relative to pendulum) | deg | -67.2 | -58.4 | 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 | -25.3 | -20.7 | 10% |
| Peak upper neck Fz | N | -3210 | -2626 | 10% |
| Peak head angular velocity (relative to earth) | deg/s | 1855 | 2267 | 10% |
| Peak head rotation (relative to pendulum) | deg | 58.5 | 71.5 | 10% |

Table 3 Neck lateral left 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 peak after 40ms | Nm | 44.8 | 51.5 | 7% |
| First peak head angular velocity (relative to earth) | deg/s | -1445 | -1256 | 7% |
| Peak head rotation relative to pendulum | deg | -43.2 | -37.6 | 7% |

Table 4 Neck lateral 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 peak after 40ms | Nm | -51.5 | -44.8 | 7% |
| First peak head angular velocity (relative to earth) | deg/s | 1256 | 1445 | 7% |
| Peak head rotation relative to pendulum | deg | 37.6 | 43.2 | 7% |

Table 5 Neck torsion left 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 | -1529 | -1329 | 7% |
| Peak neck fixture rotation (relative to pendulum) | deg | -50.3 | -43.7 | 7% |

Table 6 Neck torsion 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 | -43.6 | -37.9 | 7% |
| Peak upper neck angular velocity (relative to earth) | deg/s | 1329 | 1529 | 7% |
| Peak neck fixture rotation (relative to pendulum) | deg | 43.7 | 50.3 | 7% |

Table 7 Head impact certification corridors

| Parameter | Units | Lower limit | Upper limit | Width |
|---|---|---|---|---|
| Pendulum velocity | m/s | 1.95 | 2.05 | 2% |
| Peak probe force | N | 5022 | 6138 | 10% |
| Peak head CG resultant acceleration | g | 105.3 | 121.2 | 7% |

Table 8 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 | 3108 | 3576 | 7% |
| Peak upper left resultant deflection | mm | 40.7 | 46.9 | 7% |
| Peak upper right resultant deflection | mm | 40.7 | 46.9 | 7% |
| Ratio of left z- and x-deflection at time of peak resultant deflection | - | 0.21 | - | 4%* |
| Ratio of right z- and x-deflection at time of peak resultant deflection | - | 0.21 | - | 4%* |

* Relative to mean of resultant deflection corridor

Table 9 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 | 3330 | 3832 | 7% |
| Peak left and right lower X-axis rib deflection | mm | -52.6 | -45.8 | 7% |

Table 10 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 | 2626 | 3210 | 10% |
| Lower left abdomen X-axis deflection @ peak force | mm | -85.9 | -74.7 | 7% |
| Lower right abdomen X-axis deflection @ peak force | mm | -85.9 | -74.7 | 7% |
| Difference between L&R X-axis deflections @ peak force | mm | - | 8.0 | n.a. |

Table 11 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 | 7500 | 9166 | 10% |
| Peak Femur Force Fz | N | -5412 | -4428 | 10% |
| Peak Resultant Acetabulum Force | N | 2464 | 3012 | 10% |
| Left Acetabulum Fx @ peak resultant acetabulum force | N | 0 | - | n.a. |
| Right Acetabulum Fx @ peak resultant acetabulum force | N | - | 0 | n.a. |

## 1.3 Dummy instrumentation

All instrumentation used in the dummy shall be:

Calibrated before the test programme.

Re-calibrated after one year, regardless of the number of tests for which it has been used.

Re-calibrated if it reaches its CAC during any test.

Listed in the test report along with calibration dates

Mounted according to procedures laid out in SAE J211.

In accordance with the performance specifications detailed in SAE J2570.

The CAC for each transducer shall be chosen to cover the Minimum Amplitude listed in the table. In order to retain sensitivity, CACs which are orders of magnitude greater than the Minimum Amplitude may not be used.

The THOR dummy shall be instrumented to record the channels listed below, additional channels may be recorded. Only in-dummy data acquisition systems are to be used.

The test laboratory must check that acetabulum sensor orientation and post processing is in accordance with the specification detailed in CP 005.

| Location | Parameter | | Minimum amplitude | Channel count |
|---|---|---|---|---|
| Head | Acceleration, $A_x$ $A_y$ $A_z$ | | 250g | 3 |
| | Angular rate sensor | | 4000deg/sec | 3 |
| | Tilt sensor, X Y | | NA | 2 |
| Skull spring | Force | | 5kN | 2 |
| Upper Neck | Force | $F_x$ $F_y$ | 9kN | 2 |
| | | $F_z$ | 14kN | 1 |
| | Moment, $M_x$ $M_y$ $M_z$ | | 290Nm | 3 |
| Neck | Tilt sensor, X Y | | NA | 2 |
| T1 | Acceleration, $A_x$ $A_y$ $A_z$ | | 200g | 3 |
| T4 | Acceleration, $A_x$ $A_y$ $A_z$ | | 200g | 3 |
| Clavicle (L & R) | Force | | 10kN | 8 |
| Thorax | Compression, DC0 | | 100mm | 4 |
| | Angle, Y Z | | 50deg | 8 |
| | Tilt Sensor, X Y | | NA | 2 |
| Thoracic temperature | Temperature | | 30°C | 1 |
| Mid Sternum | Acceleration, $A_x$ | | 200g | 1 |
| Abdomen | Compression, DC0 | | 100mm | 2 |
| | Angle, Y Z | | 50deg | 4 |
| | Acceleration, $A_x$ | | 200g | 1 |
| T12 | Acceleration, $A_x$ $A_y$ $A_z$ | | 200g | 3 |
| | Force, $F_x$ $F_y$ $F_z$ | | 5kN | 3 |
| | Moment, $M_x$ $M_y$ | | 300Nm | 2 |
| | Tilt Sensor, X Y | | NA | 2 |
| Pelvis | Acceleration, $A_x$ $A_y$ $A_z$ | | 200g | 3 |
| | Tilt sensor, X Y | | NA | 2 |
| ASIS (L & R) | Force, $F_x$, | | 9kN | 2 |
| | Moment, $M_y$ | | 220Nm | 2 |
| Acetabulum (L & R) | Force, $F_x$ $F_y$ $F_z$ | | 5kN | 6 |
| Femurs (L & R) | Force, $F_x$ $F_y$ $F_z$ | | 20kN | 6 |
| | Moment, $M_x$ $M_y$ $M_z$ | | 400Nm | 6 |

| | | | |
|---|---|---|---|
| Knees (L & R) | Displacement, $D_{knee}$ | 19mm | 2 |
| Upper Tibia (L & R) | Force, $F_x$ $F_z$ | 12kN | 4 |
| | Moment, $M_x$ $M_y$ | 400Nm | 4 |
| Lower Tibia (L & R) | Force, $F_x$ $F_z$ | 12kN | 4 |
| | Moment, $M_x$ $M_y$ | 400Nm | 4 |

The onboard temperature sensor shall be attached in accordance with ISO TR 27957, and the temperature sensor shall meet the requirements of ISO 6784.

## 1.4 Additions and modifications

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

Spine

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

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

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.

THOR neck shields shall not be used for the driver.

The standard THOR shoulder pad shall be used unless, before testing, the OEM identifies an issue of the shoulder belt slipping towards the neck. In which case, the THOR dummy shall be equipped with the modified shoulder pad adopted under Technical Bulletin G 003.

Lower Legs

The THOR dummy shall be equipped with:

Hybrid III 50th percentile lower legs

HIII knee slider sensor and roller ball-bearing knees

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.

## 1.5 Dummy clothing and footwear

THOR shall be clothed with formfitting cotton stretch pants which must not cover the dummy's knees. The torso shall be clothed with the jacket only.

Care must be taken when fitting the THOR dummy jacket to ensure that the jacket is fitted correctly around the shoulder pad.

The feet of the THOR shall be fitted with rubber soled shoes equivalent to those specified in UN Regulation No. 94.

## 1.6 Dummy joints

Stabilise the dummy temperature by soaking in the required temperature range for at least 1 hour. An updated joint setting procedure is currently under development. Until that is adopted, the following procedure shall be used.

Set the torque on the shoulder screws to obtain a 1-2g holding force of the arm on its pivot.

For adjustable joints in the legs, the tensioning screw or bolt which acts on the constant friction surfaces shall be adjusted to obtain a 1-2g holding force.

The dummy joint stiffnesses shall be set as close as possible to the time of the test and not more than 24 hours before the test.

Maintain the dummy temperature within the permissible temperature range between the time of setting the limbs and up to a maximum of 10 minutes before the time of the test.

## 1.7 Dummy positioning measurements

The following measurements are to be recorded prior to the test after the positioning procedures have been carried out, see Figure 1.

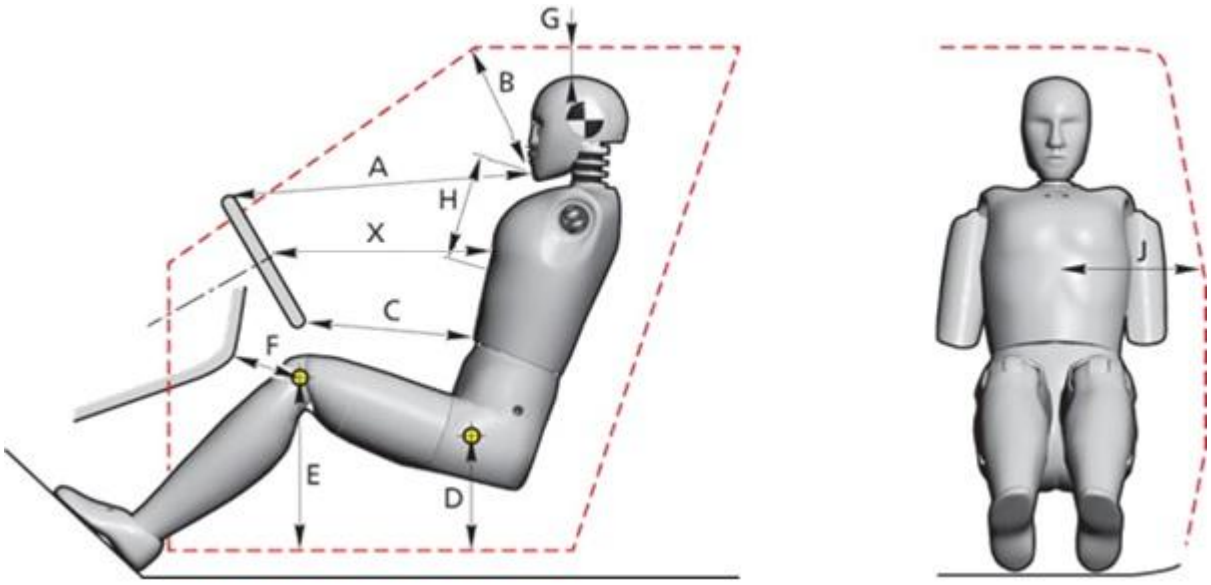



Figure 1 Dummy measurements

| Driver measurements | Description |
|---|---|
| **A** | Chin to top of rim |

| Driver measurements | Description |
|---|---|
| **B** | Chin to top edge of glass |
| **C** | Stomach to rim |
| **D** | H-point to top of sill |
| **E** | Knee bolt to top edge of sill |
| **F** | Knee bolt to top edge of bolster |
| **G** | Head to roof surface |
| **H** | Chin to webbing (vertically) |
| **J** | Belt webbing to door (horizontally) |
| **X** | Wheel centre to chest (horizontally) |
| θ | Neck Angle |
| | H-Point Co-ordinates (to vehicle reference) |
| α | Seat back angle as defined by torso angle of SAE manikin |
| **β** | Head angle |
| γ | T1 neck |
| ε | Pelvic angle (x and y) |

| Passenger measurements | Description |
|---|---|
| **A** | Chin to top of rim or front passenger's seatback |
| **B** | Chin to top edge of glass |
| **C** | Stomach to facia or front passenger's seatback |
| **D** | H-point to top of sill |
| **E** | Knee bolt to top edge of sill |
| **F** | Knee bolt to top edge of bolster or front passenger's seatback |
| **G** | Head to roof surface |
| **H** | Chin to webbing (vertically) |
| **J** | Belt webbing to door (horizontally) |
| **X** | 200mm below chin to closet part of facia or front passenger's seatback (horizontally) |
| θ | Neck Angle |

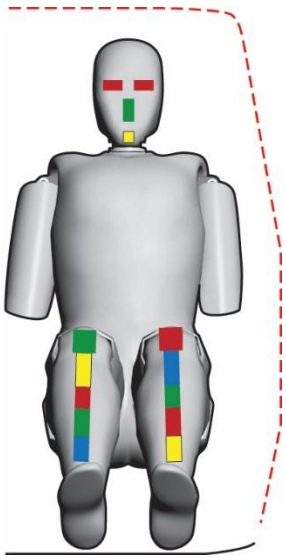
| | |
|---|---|
| | H-Point Co-ordinates (to vehicle) |
| α | Seat back angle as defined by torso angle of SAE manikin |
| ε | Pelvic angle |

## 1.8 Dummy painting and marking

The adult dummies shall have masking tape placed on the areas to be painted using the sizes detailed below. The tape shall be completely covered with the following coloured paints. The paint shall be applied close to the time of the test to ensure that the paint will still be wet on impact. Child dummy painting is detailed in the Euro NCAP COP testing protocol.

Driver & passenger

| | |
|---|---|
| Eyebrows (left and right) | Red |
| Nose | Green |
| Chin | Yellow |
| Left Knee | Red |
| Right Knee | Green |
| Left Tibia (top to bottom) | Blue, Green, Red, Yellow |
| Right Tibia (top to bottom) | Yellow, Red, Green, Blue |



Paint area sizes:

| | |
|---|---|
| Eyebrow | 25 x 100mm, single strip with lower edge at the same height as headskin moulding hole on side of head. |
| Nose | 25 x 40mm strip, vertically down nose centre line beneath eyebrow. |
| Chin | 25 x 25mm square, centre line of chin. |

| | |
|---|---|
| Knee (L/R) | 45 x 45mm square, knee centre line with bottom edge level with top of tibia flesh. |
| Tibia (L/R) | 25mm x 50mm, 4 adjacent areas down leg centre line with top edge level with top of tibia flesh. |

## 1.9 Dummy temperature

The THOR dummy shall have a stabilised temperature in the range of 19°C to 22°C.

A stabilised temperature shall be obtained by soaking the dummy in temperatures that are within the range specified above for at least 1 hour prior to the test. The temperature shall be recorded at intervals not exceeding 10 minutes and not exceeding 5 minutes before test. All readings shall be supplied as part of the standard output of the test.

After switching on the in-dummy data acquisition, the air inside the dummy and the sensors may warm up whereas the dummy itself is still at a lower temperature. Such sudden temperature rises do not reflect the actual dummy temperature and may be ignored as long as they do not exceed a duration of 20 minutes

## 1.10 Post test inspection

All dummies shall be visually inspected immediately after the test.

Any lacerations of the skin or breakages must be noted in the test details, a dummy may have to be re-certified in this case.

Any screws that have become loose or detached shall be re-tightened to the required torque or replaced as necessary.

Refer to the NHTSA Procedure for Assembly, Disassembly, and Inspection (PADI) August 2023 for detailed instructions on THOR-50M. Section 18 provides a tester's checklist as starting point. https://www.regulations.gov/document/NHTSA-2019-0106-0017

**Face foam**

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

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 2). Surface wear and small tears on the foam are normal and do not adversely affect the performance of the head assembly.

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 3). 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.

The foam shall be replaced if multiple large cracks are present on the rear face of the foam, see Figure 4-left.

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

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

Figure 2 Small tears in rear surface of the foam

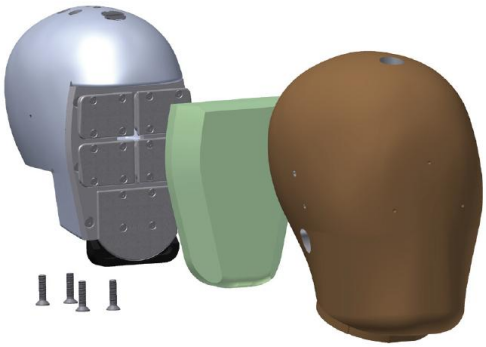


Figure 3 Head Assembly exploded view

Figure 4 Face foam seen from the back, new condition (left), replace if multiple large cracks appear (right)