

Q6 (Advanced 6 year old child) User Manual





For information on Humanetics products, please visit our web site at www.humaneticsatd.com or contact:

Humanetics Innovative Solutions
47460 Galleon Drive
Plymouth, MI 48170, USA
Telephone: 734-451-7878
Fax: 734-451-9549

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1. Introduction

In the late 1970s and early 1980s, TNO and others developed the P-dummies, a series of child dummies that covers almost the complete child population up to 12 years. The P-series dummies are still test tools for the European regulation ECE-R44 and are also adopted by many other standards.

In 1993, the International Child Dummy Working Group started the development of a new series of child dummies as a successor to the P-series. This new series was called the Q-series. Part of the development and evaluation of the Q-dummies took place within European Research programs like CREST¹, CHILD², CASPER³ and EPOCh⁴ all aiming at improving child safety in cars. As of December 2011, the series is available in five age groups, representing a Newborn, 1 year, 1½ year, 3 year, 6 year and 10 year old child.

Nowadays members of this Q family are applied in UNECE Regulation R129, which became effective per January 2013. Also, various consumer rating programs world-wide apply Q dummies.

Humanetics reserves the right to make improvements or implement changes to the dummy, the certification or the user manual if this is deemed necessary. We will of course inform our customers of any changes or modifications should they occur.



Figure 1. Q0 – Q6 dummies: from left to right Q1.5, Q3, Q0, Q6 and Q1

¹ CREST. “Child Restraint System for Cars”, EC-contract number C-RTD SMT4-CT95-2019.

² CHILD. “Child Injury Led Design”, EC-contract number G3RD-CT-2002-0079

³ CASPER. “Child Advanced Safety Project for European Roads”, EC Grant Agreement 218564.

⁴ EPOCh. “Enabling Protection for Older Children”, EC Grant Agreement 218744

2. General Description and Features

2.1 *Design History*

The development of the Q-series, directed by the International Child Dummy Working Group, resulted in a Q3 dummy in 1998, followed by the addition of the Q6 dummy in 1999, and the Q1 in 2000.

Based on customer feedback and test results, Humanetics have received comments on the dummies' performance and durability. This has resulted in an update program that was started in 2004. This update was aimed at a number of issues with the Q dummies in the shoulder, and head/neck area. During this period, the Q0 and Q1.5 were added to the family, based on Q-series anthropometry and biofidelity data.

The European Enhanced Vehicle-safety Committee performed an extensive evaluation program of the Q-series in 2004. A full report on a possible recommendation for use of the dummies in ECE R44 tests is expected in 2005. Results of the first evaluations have been published at the 19th Enhanced Safety of Vehicles conference in 2005⁵. In 2006, the New Programme for the Assessment of Child-restraint Systems (NPACS) adopted the Q dummies for their test protocols.

2.2 *Applications*

The Q6 dummy is suitable for frontal as well as side impact CRS evaluations, to be used for both homologation, consumer rating and research purposes. Applications include:

- Child Restraint Systems (CRS) type approval testing. This includes the UNECE Regulation R129 in which the Q6 dummies will be applied from July 2017 on to assess non-integral Child Restraint Systems (CRS). The Regulation R129 is being introduced in phases including front and side assessment of CRS.

⁵ Assessing New Child Dummies and Criteria for Child Occupant Protection in Frontal Impact, Kate de Jager et. Al, Enhanced Safety of Vehicles conference 2005. Paper no. 05-0157.

- Consumer rating tests. The dummy has been designed to withstand impact with closing velocities up to an average Euro NCAP level. Since January, the Q6 is being used in the Euro NCAP protocols together with the Q10 dummy. Other NCAP organizations like A-NCAP will follow at a later point in time.
- The European Test Consortium (ETC) for Child Restrain Seats uses the Q series for their frontal and side impact consumer test procedures for CRS performance rating⁶.
- Out-of-position tests (OOP), including airbag interaction.

2.3 Features

- The Q-dummies have improved biofidelity over the P-series. Biomechanical information from children and scaled adult biomechanical response curves has been used to define the dummy response. The anthropometry of the dummy is based on CANDAT⁷ data.
- The dummies can be equipped with accelerometers, angular velocity sensors, load cells and displacement sensors. This allows evaluation of the injury risk under various circumstances.
- Special attention has been paid to the handling characteristics of the dummy, ensuring the dummy can be assembled and disassembled quickly, and installing the dummy in the test configuration is simple and repeatable.
- The influence of transducers upon the kinematics of the dummy is minimized, and protection of transducers and cables is integrated in the dummy design.

⁶ New Program for the Assessment of Child Restraint Systems (NPACS), V. Sandner et., Enhanced Safety of Vehicles conference 2009.

⁷ Anthropometric of Children for Dummy Design, D. Twisk et. Al., ECOSA Product Safety Conference. Amsterdam. 1993.

Head

The head is largely made from synthetics. The head cavity is large enough to allow use of several instruments, including linear accelerometers and angular velocity sensors.

Neck

The neck is flexible and allows shear and bending in all directions. The segmented design allows a realistic rotational behavior. The neck is equipped with low stretch neck-cord in order to prevent excessive elongation. The neck-cord is also designed to act as a safety cord in case of rubber failure. A six channel load cell can be mounted at the neck-head and neck-torso interface.

Thorax

The thorax of the child is represented by a single rib cage. The deformation can be measured with an IR-TRACC (Infra-Red Telescoping Rod for Assessment of Chest Compression) sensor. The shoulders are connected with a flexible joint to the thorax, allowing deformation forward. Accelerometers can be mounted on the spine to measure linear accelerations.

Abdomen

The abdomen is foam covered with skin. Biomechanical data from children has been used to determine the required stiffness.

Lumbar Spine

The lumbar spine is a flexible rubber column, with a steel cable, which allows shear and bending in all directions. A six channel load cell can be mounted between the lumbar spine and the pelvis.

Pelvis

The Q-dummy pelvis has removable hip joints. An accelerometer array can be mounted in the pelvis. Special hip joints are available that allow the dummy to be positioned in a standing posture.

Legs

The knee joints can be locked in any position. This feature can be used to facilitate positioning the dummy in a standing position. Note that the dummy does not have the ability to stand without support. It must be placed against some object, such as the dashboard.

2.4 Instrumentation Options

The complete list of instrumentation options includes 36 channels:

Head	Ax, Ay, Az linear acceleration.
Head	Wx, Wy, Wz angular velocity.
Upper Neck	Fx, Fy, Fz forces and Mx, My, Mz moments.
Lower Neck	Fx, Fy, Fz forces and Mx, My, Mz moments.
Thoracic Spine	Ax, Ay, Az linear acceleration.
Thorax	'rib cage' Dx or Dy deflection.
Thorax	'rib cage' Ax and Ay linear acceleration (upper and lower side)
Abdomen	Pressure
Lower Lumbar Spine	Fx, Fy, Fz forces and Mx, My, Mz moments.
Pelvic	Ax, Ay, Az linear acceleration.

2.5 Main Dimensions

The main dimensions of the Q6–dummy are provided below.

Table 1. Main dimensions

Description *	Q6 Dimension [mm]	Tolerance ± [mm]
Seating height (head tilted forward)	601	9
Shoulder height (sitting)	362	7
Stature	1143	9
Chest depth * *	141	5
Shoulder width (maximum)	305	7
Hip width	223	7
Back of buttocks to front knee	366	5
Back of buttocks to popliteus, sitting	299	5

*) Measurements are valid for the dummy without suit.

**) Chest depth is measured at the center line of the fixation hole for the displacement transducer.

2.6 Mass Distribution

The table below shows the masses of the various components of the dummy. The masses given include accelerometer mounts, the IR-TRACC and all screws and fasteners.

Table 2. Mass distribution

Component	Q6 Mass [kg]	Tolerance ± [kg]
Head + Neck (incl. acc. mount)	3.94	0.10
Torso (incl. acc. mounts & IR-TRACC)	9.07	0.40
Legs (left & right)	6.90	0.10
Arms (left & right)	2.49	0.10
Suit	0.55	0.10
Total	22.95	0.80

2.7 Standard Dummy

The standard Q-dummy is delivered with the following items:

- One piece of clothing (a yellow suit);
- Structural replacements in the location of the load cells;
- One set of mounting blocks for use with uni-axial accelerometers.

3. Instrumentation

3.1 General

The dummy accepts both accelerometers and load cells as standard instrumentation. Angular velocity sensors (DTS-ARS and Applied Technologies Associates type ARS-01 or ARS-06 (flanged version)) can be fitted to the head, which requires an alternative head accelerometer mount. The dummy can be equipped with uni-axial accelerometers for all locations. Tri-axial accelerometers can be used on the pelvis and thorax location. The standard dummy will be delivered including mounting blocks for uni-axial accelerometers.

The load cells or their structural replacements are a part of the dummy structure; the structural replacements have to be used in absence of the actual transducer. A 6-channel load cell (Humanetics model IF-217 or IF-218) can be placed in the upper neck, lower neck and lumbar spine location.

Tilt sensor mounts are also available for head, thorax and pelvis to suit 2 axis sensor type IES1402. Part Numbers are 033-1110 head, 033-4110 thorax, and 033-7110 pelvis.

3.2 Transducers

The Q6 dummy can be fitted to measure any or all of the following parameters (see also notes below):

Head

Standard – 3 uni-axial accelerometers in head (A_x , A_y , A_z)

Optional – 3 angular velocity sensors:

Applied Technologies Associates type ARS-01 or ARS-06 (flanged version) or DTS-ARS.

Neck

Standard – Upper neck 6 channel load cell, 3 forces, 3 moments (F_x , F_y , F_z , M_x , M_y , M_z). Humanetics Model IF-217 (350 Ohm) or IF-218 (120 Ohm).

- Lower neck 6 channel load cell, 3 forces, 3 moments (Fx, Fy, Fz, Mx, My, Mz). Humanetics Model IF-217 (350 Ohm) or IF-218 (120 Ohm).

Thorax

Standard – 3 uni-axial accelerometers (or tri-axial accelerometer) in upper spine (Ax, Ay, Az).

- 1 IR-TRACC sensor to measure chest deformation, frontal or lateral (Dx or Dy) (Humanetics model IF-362).

Optional – Additional accelerometers may be installed with double sided tape on flat spots at the rib cage and the thoracic spine (Ax, Ay) (see notes below).

Lumbar Spine

Standard – 6 channel load cell at lumbar spine/ pelvis interface (Fx, Fy, Fz, Mx, My, Mz). Humanetics Model IF-217 (350 Ohm) or IF-218 (120 Ohm).

Abdomen

Optional – Twin pressure sensor

Pelvis

Standard – 3 uni-axial accelerometers (or tri-axial accelerometer) on pelvis skeletal structure (Ax, Ay, Az).

Optional – Asis Load cell left and right (Fx, My) Prototype

Notes:

1. IR-TRACC sensor may be mounted in two ways, either to measure frontal or lateral deformations. The IR-TRACC sensor cannot record the true deformation in oblique impacts. It is recommended not to use the IR-TRACC in tests with expected high oblique rib deformations; this can cause damage to the IR-TRACC sensor, as it has limited range of motion in directions perpendicular to its sensitive deflection direction.

2. Information on the installation of the instrumentation can be found in the assembly/disassembly section of this manual.

3. The Upper Neck Load Cell does not require any correction for measurement of the moment around the OC joint. The (theoretical) OC joint coincides with the neutral axis of the moment measurement of the (Humanetics) load cell.

4. Additional accelerometers may be mounted in the dummy for additional/redundant information. There are no fixed points for attaching these accelerometers. Instead, double-sided tape may be used to attach the accelerometer to the desired location. Two accelerometers may be used to measure deformation velocity and the deformation itself. The procedure is as follows:

Install the accelerometers in the dummy. The sensitive axes of the transducers should be aligned as good as possible. Furthermore, the accelerometers should be installed in locations that are expected to retain their alignment during the deformation phase. Make sure that the accelerometers are not located on positions that may contact other parts of the dummy as a result of deformation. To process and combine the data, first filter both signals at CFC1000 according to SAE J211. Subtract the signals and integrate the result. This results in the deformation velocity. Numerical integration of the calculated velocity signal gives the deformation itself.

Note that this method gives an approximation of the actual deformation. The accuracy is limited due to the fact that the accelerometers do not remain properly aligned during the test and the numerical integrations that include the small measurement errors of the accelerometers cumulative in the velocity and displacement result. The longer the time interval is the larger the cumulative error can be. Experience with the Q3 dummy shows that usage of the acceleration integration method results in an under-estimation of the deformation. At 4.3 m/s initial impact velocity the error is approximately 10%. At 6.7 m/s it is approximately 20%.

5. ASIS load-cells for the Q6 dummy are currently under development. Prototypes are available and evaluation testing is ongoing.

3.3 Accelerometer Mounts

Humanetics support three brands/models of accelerometers or equivalents

- Endevco 7264 and 7267A series
- Entran EGAS Series and EGE3-73 Tri-axial.
- Kyowa ASM Series
- MSC 126M/CM Uni-axial accelerometers

Note: *The tri-axial accelerometers Endevco 7267A and Entran EGE3-073 cannot be fitted to the head. The head will only accept uni-axial accelerometers.*

Note: *Thorax and Pelvis locations will ONLY accept tri-axial transducers with a side-entry cable.*

The uni-axial accelerometers and mounts that can be used for the Q6 dummy are listed Table 3. The mounts and their orientation are depicted in figure 2 to 5. Tri-axial accelerometers and mounts are listed in Table 4.

Table 3. Uni-axial accelerometers and mounts for thorax and pelvis

Accelerometer Type	Location		
	Head Mount (only uni-axial accels)	Thorax	Pelvis
ENTRAN EGAS-FS-50	I.AD	I.AO	I.AO
KYOWA ASM-200BA	I.AM	I.AN	I.AN
ENDEVCO 7264-2000 7264C-2000	I.AM	I.AN	I.AN
ENDEVCO 7264A-2000 7264B-2000	I.AD	I.AO	I.AO
MSC 126M/CM	I.AM	I.AN	I.AN

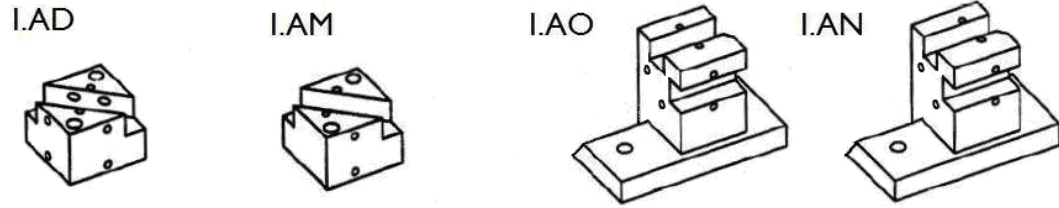


Figure 2. Accelerometer mounts for Q6

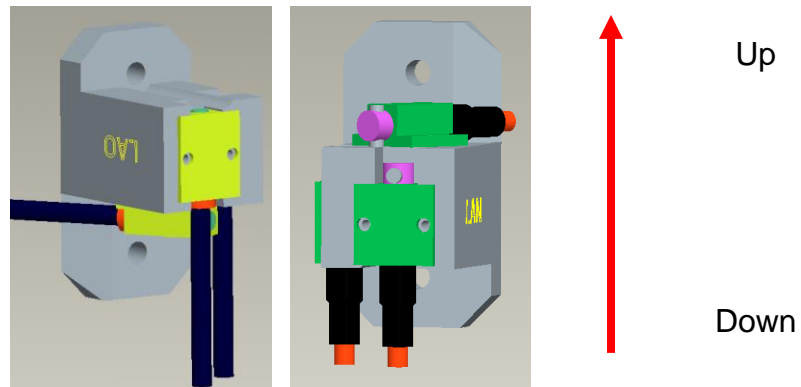


Figure 3. Thorax uni-axial acceleration mounts I.AO (left) and I.AN (right)

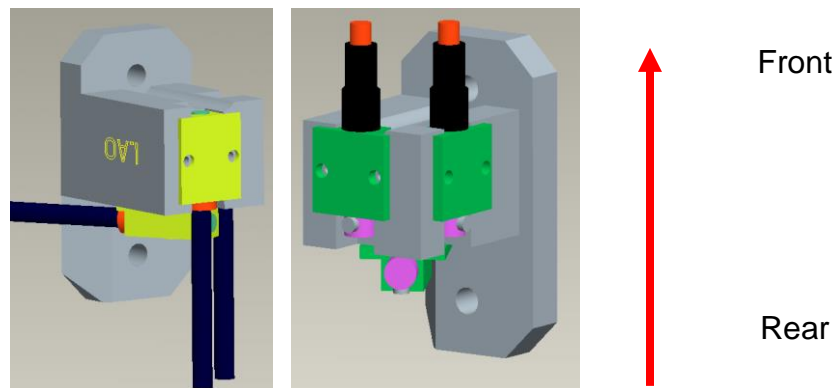


Figure 4. Pelvis uni-axial acceleration mounts I.AO (left) and I.AN (right)

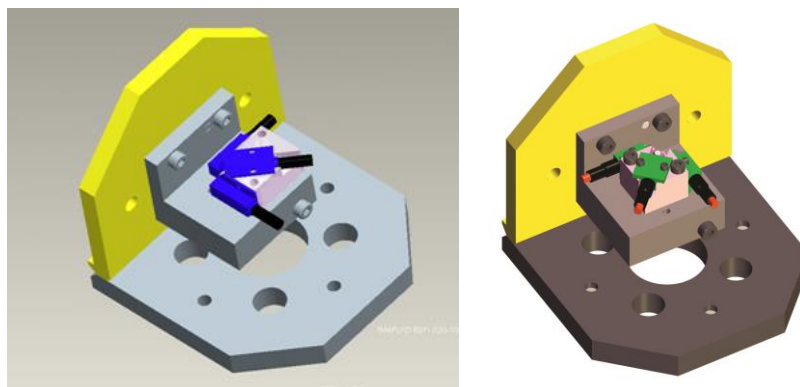


Figure 5. Head uni-axial acceleration mounts I.AD (left) and I.AM (right)

Table 4. Tri-axial accelerometers and mounts for head

Accelerometer Type	Location		
	Head Mount (only uni-axial accels)	Thorax	Pelvis
ENDEVCO 7267A-1500 Tri-axial	Not possible	Use Endevco Mount base	Use Endevco Mount base

3.4 Angular Velocity Sensor Mounting

The application of angular velocity sensors is possible in the head. There are two options:

- I. ATA ARS-01 or ARS-06 (flanged version) (see Figure 6) with special mount block 020-1014.

The mount block 020-1014 consists of a base and three ATA ARS sensor blanks of similar weight and size. Any of these ARS sensor blanks can be replaced with an ATA ARS-01 or ARS-06 (flanged version) sensor. The 020-2014 mounting block will accept the same mount block as the standard accelerometer mounting for the head (I.AD or I.AM, see Figure 2). Note that the arrangement of the accelerometers on the block should be different as the block is mounted in to of 020-1013A and on the bottom of 020-1014, as shown Figure 5. The ATA ARS sensor blanks should not be removed if there are no sensors to replace them.



Figure 6. ATA ARS-01 (left) and ARS-06 (flanged version) (right)

2. DTS ARS-12K with special combine accelerometer/ARS mount (DTS drawing TRIAX-M2D-1168) on the standard bracket 020-1013A. The sensor and the mount are shown in Figure 3.

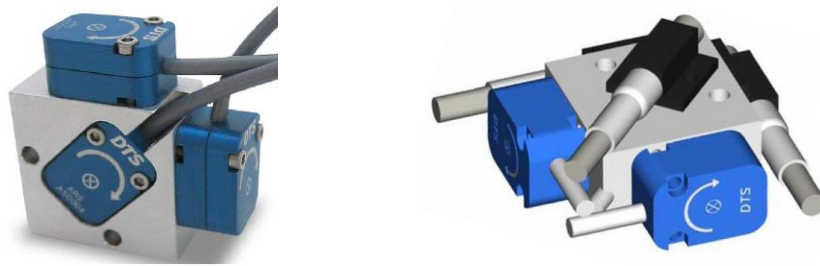


Figure 7. DTS ARS's on the special mount (DTS drawing TRIAX-M2D-1168)

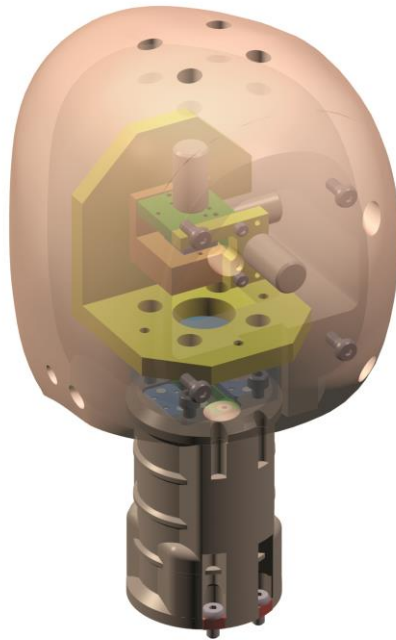


Figure 8. Q6 Head instrumentation

Note: Both accelerometer bracket arrangements 020-1013A (standard) and 020-1014 (optional for ATA-ARS version) are shown in overlay.

3.5 Abdomen Pressure Twin Sensor (ATPS)

Purpose

To measure loadings on the abdomen e.g. from CRS with shields or belt loading under submarining. Injury criteria has been set under UNECE regulation R129. See footnote 8 below.

Description

The sensors are polyurethane bladders closed with an aluminium cap and filled with fluid. See figure 9. The pressure generated in the bladder is measured via a sensor in the cap. The sensor design was developed by IFSTARR and is sold by Transpolis SAS. The bladders come in three sizes 30, 40 and 50 mm diameter. The 40 mm diameter is used on Q6.

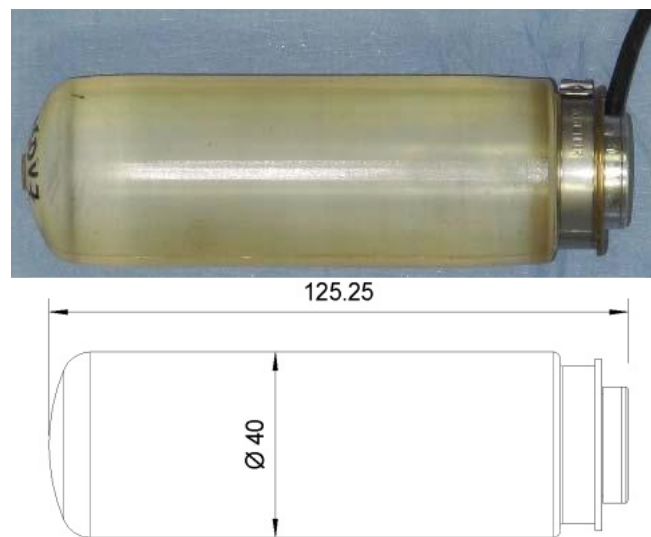


Figure 9. 40 mm ATPS sensor

The ATPS are mounted inside a special abdomen assembly part number 033-5005. This part has two blind holes for the sensors parallel to the lumbar spine. The ATPS are inserted aluminium cap down and the sensor cables come out through small holes at the base on the blind holes. The bladders are put into Lycra sleeves to reduce friction and held in place with Velcro at the bottom of the hole. The abdomen assembly is delivered with foam plugs to facilitate

⁸ ECE/TRANS/WP.29/GRSP/59/Add., Report of the Working Party on Passive Safety on its fifty-ninth session, Addendum 1. Geneva, 9-13 May 2016.

standard certification of the abdomen as in section 8.4. The Lycra sleeves are not used with the foam plugs.

The ATPS have a higher density than the removed standard foam so there is an increase to the abdomen of around 90 grams.



Figure 10. CAD Picture of Q6 Abdomen showing ATPS sleeves assembled without sensors and with foam plugs for certification

For information on biofidelity, sensitivity, performance, repeatability, reproducibility and injury criteria development refer to EEVC document number 661 (to be submitted summer 2016). The assembly and component part numbers for the abdomens that can engage the APTS sensors are summarized in Table 5.

Table 5. Assembly and component part numbers for abdomens that can engage APTS sensors

Description	Part Number	Qty. in Assembly
Abdomen Assembly, ATPS, Tested & Certified	033-5005	
Abdomen ATPS, Q1	033-5010	1
Sensor Sleeve, Fabric	033-5006	2
Sensor Replacement, Foam	033-5007	2

3.6 Cable Routing and Protection

The Q6 dummy transducers have been designed and selected for use with small cross-section cables. These cables do not need much space and ensure minimum interference with the kinematics of the dummy.

In the design of the Q6 dummy, paths for the transducer cables have been defined. The general guideline is that all cables should be routed towards the thoracic spine of the dummy. Cables should run from the top to the base of the thoracic spine. At the lumbar spine/thorax interface, the cables go either towards the left or the right side. The abdomen has been formed to allow the routing of the cables in such a way that they lie recessed between the rib cage and the pelvis skin.

A cable cover is mounted on the back of the thoracic spine. This cover will protect the cables and provide a fixed contour of the back of the dummy.

4. Assembly – Disassembly

4.1 *General Overview*

The Q-dummy consists of the following main components:

- Head
- Neck
- Thorax
- Lumbar spine
- Abdomen
- Pelvis
- Arms
- Legs

The dummy is dressed in a tight-fitting suit. This suit is an integral part of the dummy and should be worn during all tests.

A full description of the instrumentation capabilities is given in section 3.

The tools needed for assembly and disassembly of the Q6 dummy are:

- Screwdrivers.
- Metric hex keys.

4.2 Head

Construction

The head assembly consists of the following parts (see also Figure 11):

Table 6. Head assembly parts

Description	Part No.	Qty. in Assembly
Head Assembly	033-1100	1
Head front assembly.	033-1020	1
Head rear assembly.	033-1002	1
Screw BHCS M5 x 12	5000565	4
Upper neck load cell structural replacement	020-2007	1
Screw FHCS M5 x 10	5000084	4
Accelerometer mounting base (standard)	020-1013A	1
Accelerometer mounting base	020-1013	1
Screw SHCS M3 x 40	5000649	1
Screw SHCS M3 x 10	5000119	2

The head consists of two parts: the front assembly (skull and skin) and a rear assembly (skull cap). The rear assembly may be removed by unscrewing the four M5 x 12 button head cap screws located at the rear of the head. The head skin and skull are molded together and cannot be separated. Inside the head is a large cavity which may be used to mount various types of instrumentation. The standard arrangement is to have the head mounting block bolted in the head which will accept 3 uni-axial accelerometers to measure the linear head accelerations. Optionally a bracket for combined accelerometer-angular rate sensor application (020-1014) can be used.

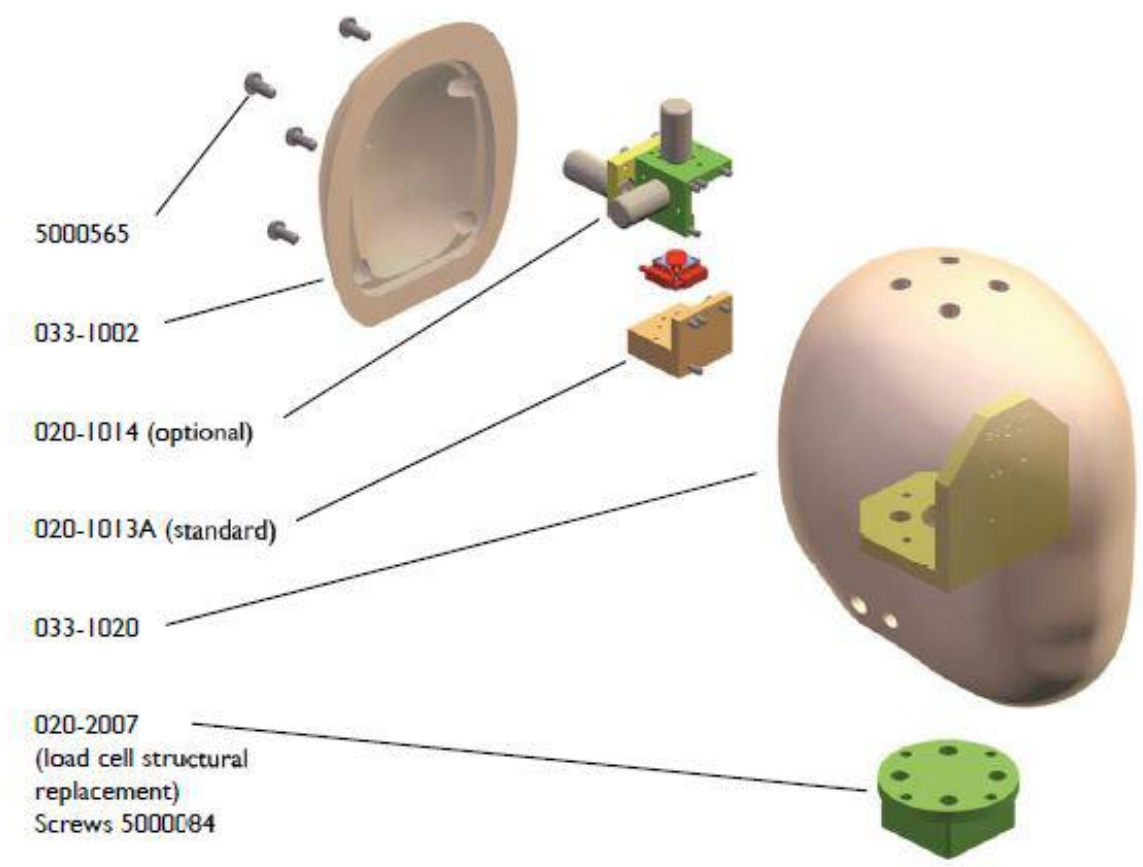


Figure 11. Q6 Head assembly (standard and optional instrumentation brackets shown)

Assembly and Disassembly

Disassembly

The head is attached to the neck through the load cell or the structural replacement. To disassemble the head, first detach the load cell or its structural replacement from the neck.

1. First remove the head rear assembly by unscrewing the four button head cap screws at the back of the head.
2. The accelerometer array can be removed in order to provide access to the screws in the upper neck load cell (or the load cell replacement).
3. With the accelerometer array removed, the M5 SHCS screws that attach the load cell to the neck can be reached through the top of the head.
4. Remove the head and upper neck load cell or structural replacement from the neck.
5. Turn the head upside down, and remove the FHCS screws at the base of the head.

Assembly

The head can be assembled to the dummy by reversing the order of the disassembly.

Instrumentation

Standard Instrumentation

1. To install the accelerometers, first remove the head rear assembly by unscrewing the four M5 x 12 button head screws.
2. Remove the head accelerometer mounting base (020-1013A), from the head cavity, by unscrewing the three cap head screws.
3. The uni-axial accelerometers must first be mounted onto a mounting block I.AM or I.AD (see Figure 2).
4. Bolt the mounting block onto head accelerometer base using the two socket head cap screws supplied with the mount. Mount the interface inside the head front assembly.
5. Replace the head rear assembly and tighten the four bolts.

Note: As shown in the head assembly section, it is advised to mount the head onto the neck, before placing the accelerometers in the head cavity.

To remove the accelerometers, the procedure described above must be performed in the reverse order.

Alternative Instrumentation

The cavity in a Q6 dummy head is large enough to accept an array of angular velocity sensors, type -01 or ARS-06 (flanged version) (Applied Technologies - ATA Sensors). To mount these sensors, the use of an alternative accelerometer mounting base is required (part No. 020-1014). On the standard head accelerometer mounting base (020-1013A) the application of DTS-ARS sensors is possible. For additional information on the mounting of these sensors, see Section 3. Instrumentation and Figure 5.

4.3 Neck

Construction

Table 7. Neck assembly parts

Description	Part No.	Qty. in Assembly
Neck Assembly Tested and Certified	033-2300	1
Neck Molded, pre-tested	033-2301	1
Neck cable assembly, pre-tested	033-2200	1
Nut	020-2204	1
Screw FHCS M3 x 8	5000116	2

The main part of the neck assembly consists of a rubber column, with bonded metal interface plates attached to the top and bottom. The neck assembly has four threaded inserts in the top surface which are used to mount the upper neck load cell (Humanetics model IF-217 or IF-218) or its structural replacement onto the neck. The upper neck plate has two cut-outs towards the rear to allow proper routing of the upper neck load cell cables.

The neck cable assembly contains high yield strength, low stretch synthetic fiber cord. This neck cable assembly is tested and pre-stretched to ensure the correct length and the performance of the neck assembly. **The cable assembly should not be disassembled by the user.** The neck cable will act as a safety measure in case of rubber failure.

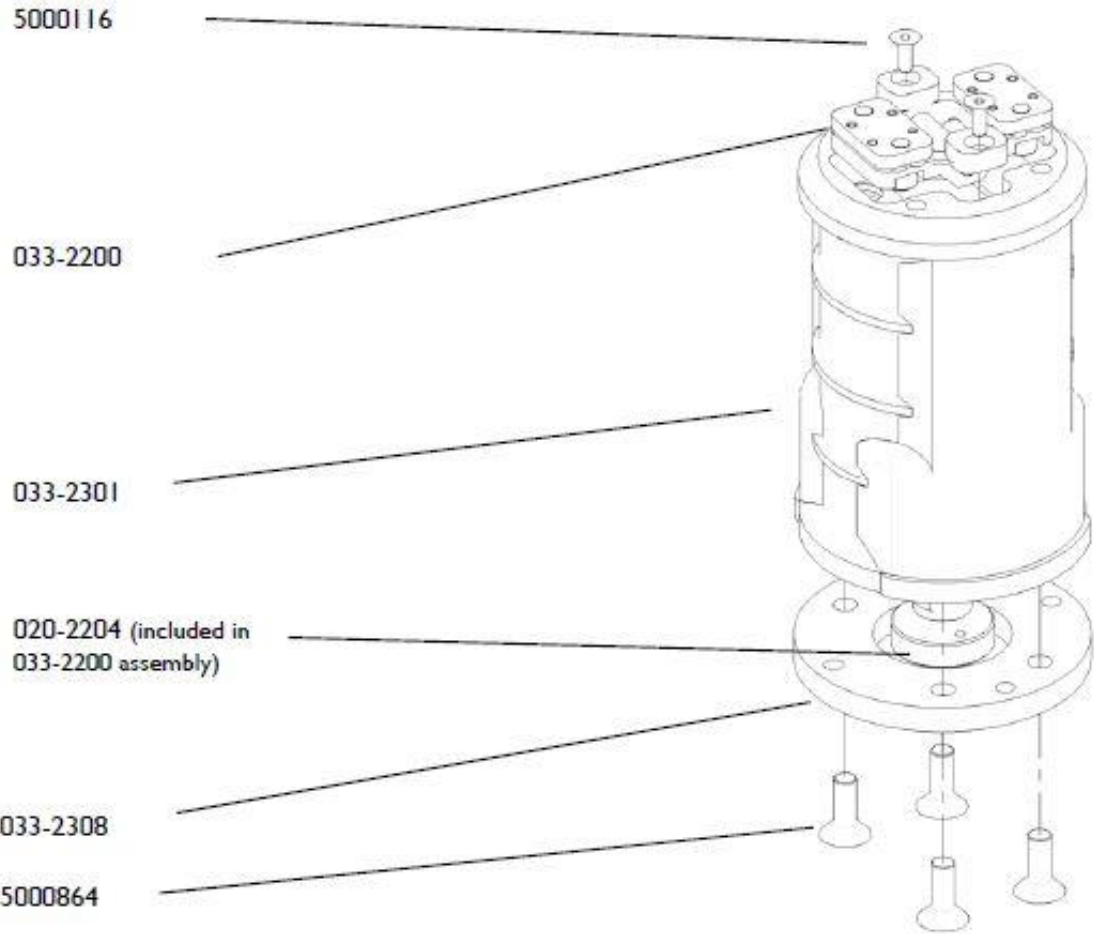


Figure 12. Q6 Neck assembly

Assembly and Disassembly

Disassembly

Head & neck

1. To disassemble the neck, remove the head and upper neck load cell structural replacement as described above.
2. After removing the head assembly and load cell structural replacement, the screws at the base of the neck can be reached and removed.
3. To inspect the neck-cable assembly, remove the two M3 x 8 FHCS screws at the top of the neck and undo the nut at the bottom of the neck. The Neck-cable assembly can now be pulled out from the top. **The neck cable assembly should NOT be disassembled.**

Note: Do not unscrew the screws at the bottom of the clamping plates on the neck cable assembly. The neck cable is pre-stretched and clamped down at manufacturing, and should not be disassembled. In case of cable damage, customers are recommended to replace the complete neck cable assembly (020-2200). There is no adjustable pretension in the cable. The nut (020-2204) can be tightened firmly.

Assembly

Head & neck

Perform the steps described under disassembly in reverse order.

Instrumentation

1. To install a load cell, first remove the load cell structural replacement. To do so, remove the head as shown above.
2. Remove the four M5 x 10 FHCS screws that attach the load cell to the base of the head assembly.
3. Remove the load cell structural replacement and install the load cell (Humanetics type IF-217 or IF-218). The round base plate should be facing up, and the cable exits facing downward at the rear and the back of the neck.

4. Fasten the load cell to the base of the head using the four M5 x 10 countersunk head cap screws.
5. Assemble head and load cell onto the top of the neck using the four M5 x 12 SHCS screws.
6. Mount the head instrumentation in the head and close the head with the skull cap

Note: Always mount the upper neck load cell on to the neck BEFORE the head accelerometers, as the accelerometer array will block the top access to the screws through the head.

4.4 Torso

Construction

The torso consists of a metal thoracic spine, left and right shoulder assemblies, a clavicle and a rib section. The rib cage is made of a deformable synthetic composite. The shoulders are connected with the clavicle element, which attaches to the left and right shoulders, and to the rib cage (sternum).

Table 8. Torso assembly parts

Description	Part No.	Qty. in Assembly
Torso Assembly Frontal Dummy	033-4000	1
Rib Cage Assembly Tested and Certified	033-4100	1
Clavicle Retainer	033-4200	1
Clavicle	033-3200	1
Neck-Torso interface plate	020-2308	1
Load cell Structural replacement	020-2007	1
Shoulder spine interface (RH)	033-3011	1
Shoulder spine interface (LH)	033-3015	1
Shoulder ball	033-3004	2
Shoulder Ball Retainer Ring	033-3003	2
Thoracic Spine Frontal Impact	033-4401	1
IR-TRACC attachment hardware	see instrumentation below	
Cable Guide	020-4411	1
Screw BHCS M4 x 12	5000005	8
Screw FHCS M5 x 10	5000084	6
Screw SHCS M5 x 12	5000002	8
Screw BHCS M5 x 16	5000416	6
Screw BHCS M5 x 12	5000096	5
Screw BHCS M3 x 12	5000415	4
Screw FHCS M5 x 8	5000662	1
Screw BHCS M5 x 14	5000684	2
Screw FHCS M4 x 16	5000447	2

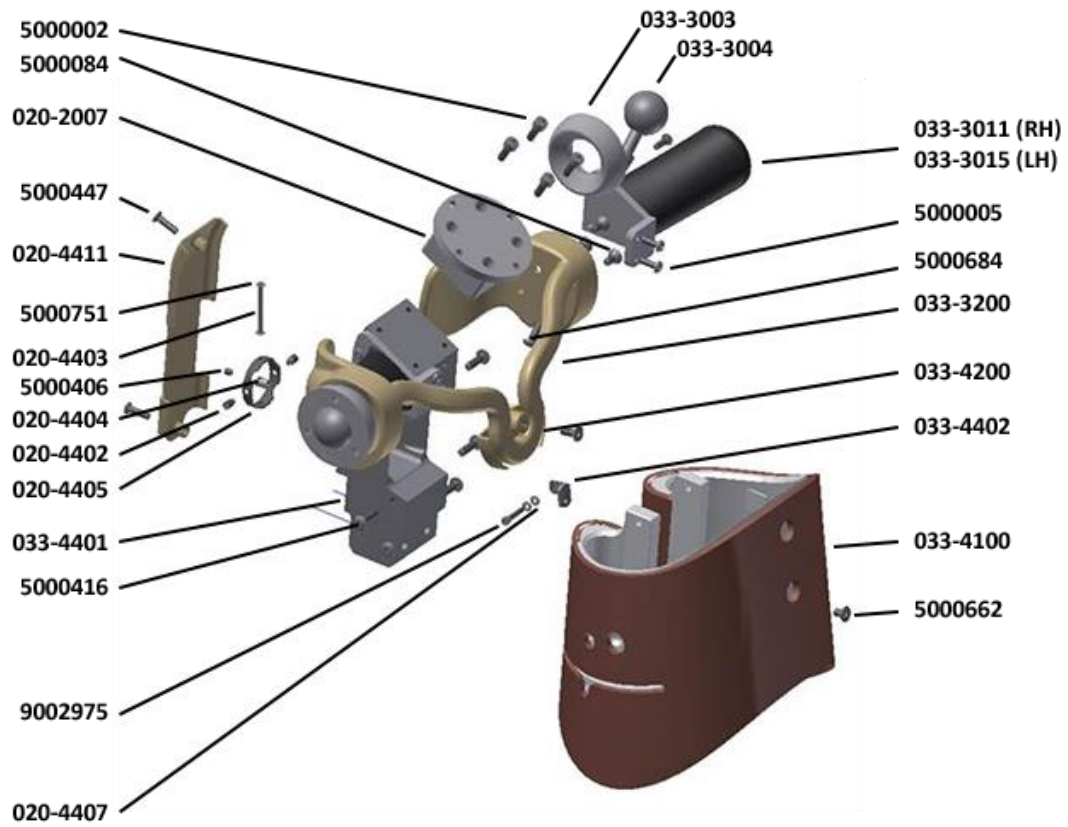


Figure 13. Q6 Thorax assembly

Assembly and Disassembly

Disassembly

Upper/Lower Torso

1. The suit should be removed for proper access to the thorax assembly.
2. Remove the cable cover at the back of the thoracic spine (020-4411).
3. The upper part of the body can easily be separated from the lower part of the body by removing the two M6 x 43 countersunk head screws located at the base of the thoracic spine. First loosen the two bottom screws at the base of the rib assembly than unscrew and remove the M6 x 43 countersunk screws. The upper body can then be lifted from the lower part of the dummy.

Note: when operating on the upper torso section of the dummy, for example when installing or removing components or installing instrumentation, it is convenient first to remove the head and neck (see the paragraphs above for the procedure how to do this), and then divide the dummy in two parts by removing the thorax/lumbar spine screws. This gives easy access to the internals of the upper torso and to the various bolts and screws.

Note: to prevent unnecessary wear, the rib cage and shoulders should not be removed from the thoracic spine under normal circumstances.

Arms

1. To remove the arms, turn the dummy sideways and remove the three M3 button head screws in the arm. Repeat this procedure for the other arm. Note the position of the steel and rubber washers for the arm friction setting (See right and left arm assemblies in section 4.8.).

Clavicle

2. The clavicle is attached to the shoulder spine interface with three M5 x 8 countersunk screws on each side. Remove these screws by turning the aluminum arm retaining ring (033-3003) until the screws become visible.

3. Remove the M5 x 12 countersunk head screw at the front of the rib cage which is used to mount the clavicle retainer (033-4200) and clamps the clavicle to the rib cage. Remove the screw and the clavicle retainer on the inside of the rib.

Rib Cage

4. Remove the rib cage by unscrewing the six M5 x 16 button head cap screws, three on each side of the thoracic spine.

Shoulders

5. Finally, the shoulder spine interfaces (033-3011 & 033-3015) can be removed by unscrewing the three M4 x 12 button head cap screws of each shoulder spine interface.

Assembly

To assemble the thorax, perform the operation described above in reverse order.

***Note:** The shoulder should be set to the 1-2 g friction setting. This can be done by tightening or loosening the three M3 button head screws. See section 4.8 of this manual.*

Instrumentation

Standard Instrumentation

Accelerometers

The thorax can be equipped with three uni-axial accelerometers or a tri-axial accelerometer in the cavity located at the back and top of the thoracic spine.

1. The uni-axial accelerometer must first be mounted onto the specified mounting block. The tri-axial accelerometer should be mounted using a mounting base (Endevco type 23898).

2. Use two SHCS M3 x 10 screws to attach the mounting block inside the cavity. The longest side of the mounting base should be facing upward.

Load Cell

1. To use the lower neck load cell (IF-217 or IF-218), remove the load cell structural replacement (020-2007). If the neck is installed, remove this first (four M5 x 10 button head cap screws).
2. Note that there is a Neck torso interface plate (033-2308) between the load cell structural replacement (020-2007) and the neck. Remove the load cell structural replacement and the neck torso interface plate together by unscrewing the four M5 x 12 socket head cap screws.
3. Remove the neck torso interface plate (033-2308) from the load cell structural replacement by unscrewing the four M5 x 10 countersunk screws.
4. Install the load cell by reversing the procedure described above. First, attach the neck torso interface plate (033-2308) to the load cell with the four countersunk screws.
5. Place the load cell on top of the thoracic spine (033-4401). The base plate should be facing upward, and the cable exits should be at the rear, cables leading downward. Fasten the load cell with the four socket head cap screws.
6. Finally, assemble the neck back on the torso.

IR-TRACC

The thorax rib cage is equipped with an IR-TRACC displacement sensor that fits into the cavity of the thoracic spine directly below the cavity for the accelerometers. Table 9 provides the part list for the IR-TRACC attachment while Figure 14 show the attachment parts for spine and rib side.

Table 9. IR-RTRACC attachment: part list frontal impact configuration

Description	Part No.	Qty. in Assembly
Pivot Pin – Gimbal	020-4402	2
Gimbal Shaft	020-4403	1
E-clip	RS 209-8839	2
Shaft Locking Boss	020-4404	1
Gimbal Ring	020-4405	1
Screw SSCP M5 x 5	5000406	1
Attachment IR-TRACC	033-4402	1
Spacer IR-TRACC Attachment	020-4407	2
Screw SHCS #5-40 x 5/8	9002975	1
Screw FHCS M5 x 8	5000662	1

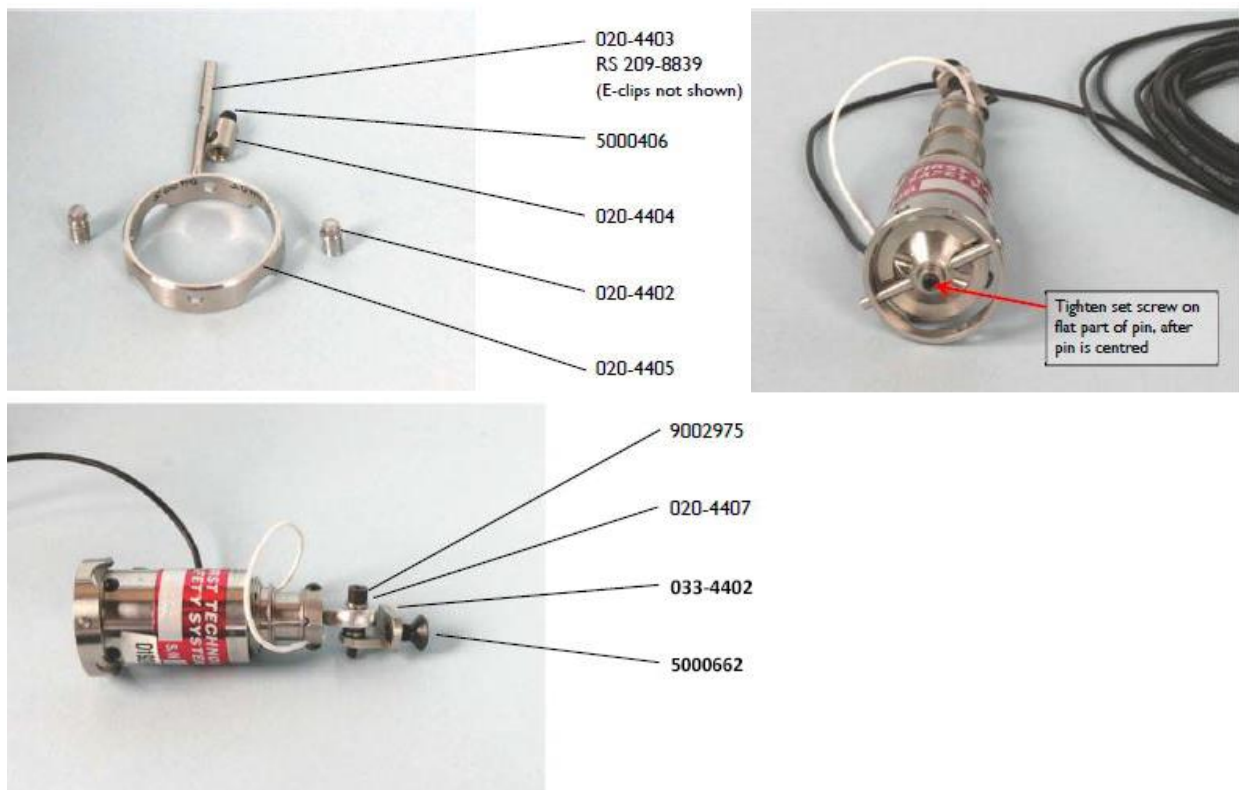


Figure 14. IR-TRACC attachment hardware spine frontal (top left and right) and rib cage side (bottom)



Figure 15. IR-TRACC should swing freely

Frontal Impacts

1. To use the IR-TRACC (IF-362) for frontal impacts, the IR-TRACC should first be equipped with its attachment hardware.
2. First place the holding boss (020-4404) onto the back of the IR-TRACC and unscrew the set screw.
3. Then hold the gimbal ring (020-4405) at the end of the IR-TRACC and slide the gimbal shaft (020-4403) through the holes in the gimbal ring and the hole in the back of the IR-TRACC.
4. Now center the gimbal shaft and tighten the set screw.
5. The two gimbal pivot pins can be inserted into the thoracic spine. Screw in until they will just appear on the inside of the thoracic spine.
6. Hold the gimbal ring before the pin and screw in further until it holds.
7. Attach the hardware at the other side of the IR-TRACC as shown in Figure 14.
8. Insert M5 screw in the rib cage hole and screw attachment to rib cage assembly.

Side Impacts

The IF-362 IR-TRACC can also be mounted in side impact orientation. The bracket shown below is mounted onto the inside of the rib cage, using the rib-attachment holes. These parts are not included in the standard dummy.

The side impact IR-TRACC mounting bracket assembly is listed in Table 10 below.

Table 10. IR-RTRACC attachment: part list frontal impact configuration

No.	Description	Part No.	Qty. in Assembly
1	Attachment IR-TRACC.	033-4403	1
2	Screw FHCS M5 x 8	5000662	1
3	IR-TRACC Bracket, Q6	033-4505	1
4	IR-TRACC Bracket arm, Q6	033-4502	1
5	Screw BHCS M5 x 22	5000571	2
6	Screw BHCS M4 x 20	5000007	2
7	Cone Spacer IR-TRACC attachment	020-4407	4
8	Screw FHCS #5 - 40x5/8	9002975	2
9	Rod end mount, base end	3620-44	1
10	Screw SHCS M2 x 6	5000082	1

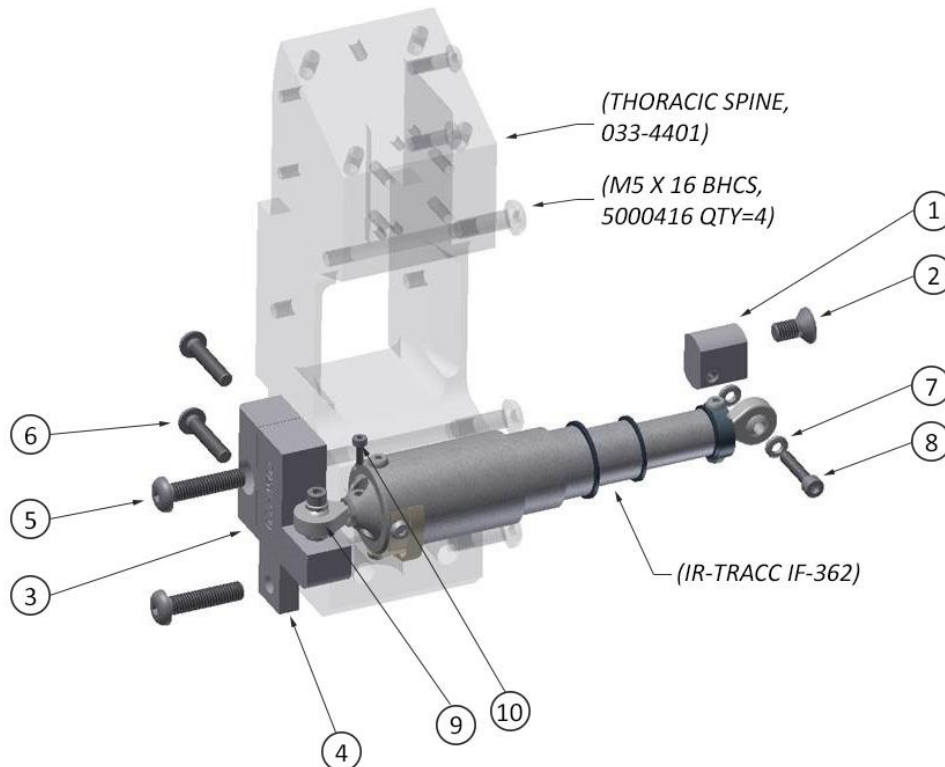


Figure 16. Q6 side impact IR-TRACC arrangement

1. To use the IR-TRACC (IF-362) for side impacts the IR-TRACC should first be equipped with its attachment hardware as shown in Figure 16.

2. First mount the rod end mount base in the end of the IR-TRACC and secure it with the M2 screw (item 11).
3. Attach the brackets (item 3 and 4) to each other using the M4 x 20 screws.
4. Connect the IR-TRACC rod end to the bracket (item 4) using the shoulder screw (item 9) and cone spacers (item 8).
5. Attach the rib attachment hardware to the top end of the IR-TRACC as shown in Figure 14.
6. Remove the lower two M5 button head rib cage attachment screws on the far side of the chosen impact side.
7. Mount the bracket with IR-TRACC onto the rib cage-spine attachment, with the three M5 x 22 screws.
8. Attach the top end of the IR-TRACC to the rib cage with the M5 countersunk screw.

4.5 Lumbar Spine and Abdomen

Construction

The lumbar spine assembly consists of a rubber column with metal interfaces bonded to the top and bottom. The top interface is U-shaped (vertical elements at the front and back). The thoracic spine fits into this bracket and is secured using the two M6 x 43 screws. At the bottom side, four M5 x 12 cap head screws are used to attach the lumbar spine assembly IF-217, IF-281 load cell or the load cell structural replacement (020-2007). The lumbar spine assembly has a cable fitted through the center. This is used to pre-tension the spine to achieve the correct dynamic properties, and as a security measure (protection in case of lumbar spine damage or failure).

The abdomen is full foam part covered by a plastic skin.

Table II. Spine and abdomen assembly parts

Description	Part No.	Qty. in Assembly
Lumbar Spine Assembly (tested and certified)	033-6000	1
Lumbar Spine central molding, pre-tested	033-6001	1
Lumbar Cable	033-6100	1
M6 nut (self-locking)	5000093	1
M6 Plain Washer	5000094	1
Load cell structural replacement	020-2007	1
Screw SHCS M5 x 12	5000002	4
Screw FHCS M5 x 10	5000084	4
Abdomen foam part	033-5000	1

Assembly and Disassembly

Disassembly

1. Remove the upper torso by removing the two M6 x 43 screws at the thoracic spine/lumbar spine interface.
2. Remove the abdomen from the lower torso.
3. Remove the four M5 x 12 countersunk head screws, which are used to fasten the load cell (or structural replacement) to the pelvis.
4. Remove the load cell (or load cell structural replacement) from the lumbar spine by removing the four M5 x 12 socket head cap screws.
5. The cable assembly should not need to be removed under normal circumstances. If it becomes necessary, use a screwdriver in the slot at the top of the cable to prevent the cable from turning, and unscrew the self-locking nut with a spanner. In the steel cable there is no pretension required the nut should be tightened up to the play is eliminated.

Assembly

Perform steps 1 to 4 under “Disassembly” in reverse order. If the cable is removed from the lumbar spine, it must not protrude more than 10 mm to fit the certification headform.

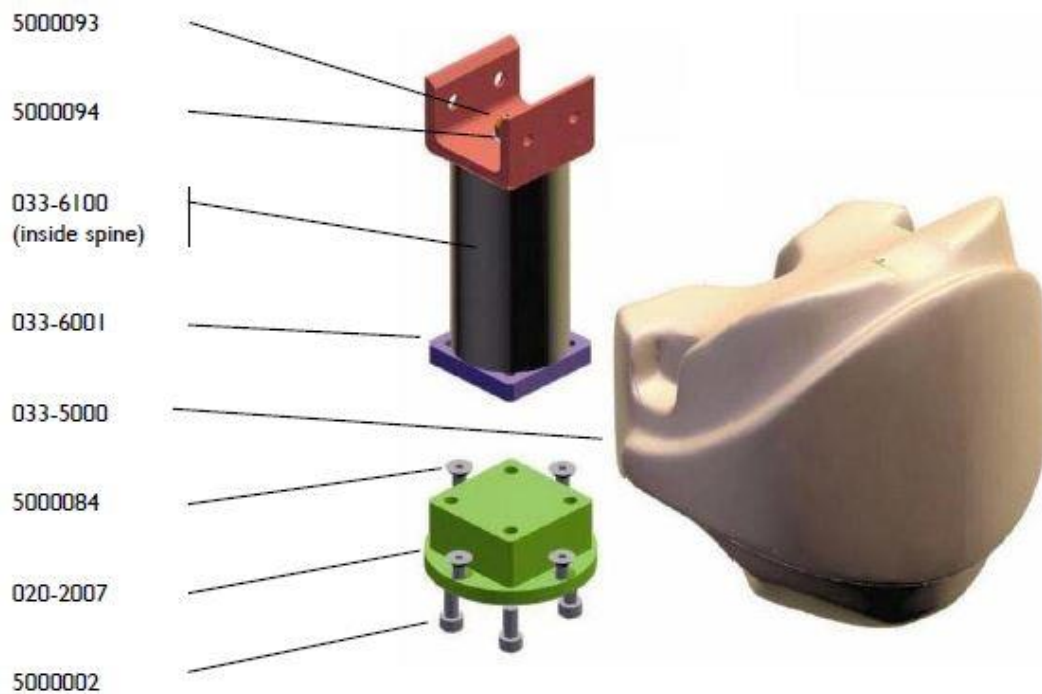


Figure 17. Lumbar spine assembly and abdomen

Instrumentation

Load Cell

A Humanetics IF-217 or IF-218 6-Axis Load cell may be mounted between the lumbar spine and pelvis.

1. To do so, first remove the upper torso from the lumbar spine by removing the two M6 x 43 screws.
2. Then unscrew the four M5 x 12 counter-sunk head screws attaching the structural replacement to the pelvis. Remove the lumbar spine/structural replacement assembly from the pelvis casting.
3. Unscrew the four M5 x 12 screws to remove the structural replacement from the lumbar spine.
4. Now replace the structural replacement with the actual load cell and install the four M5 x 12 cap head screws. The base plate of the load cell should be facing down, and the cable exits at the rear of the dummy when the assembly is put onto the pelvis casting.
5. Mount the assembly onto the pelvis casting using four M5 x 12 countersunk screws.

4.6 Pelvis

Construction

The pelvis casting is a single metal casting which fits into the pelvis flesh. The two items are completely separable. The upper legs, with the ball and socket hip joint assemblies, fit into the two openings at the left and right side of the pelvis.

Table 12. Pelvis assembly parts

Description	Part No.	Qty. in Assembly
Pelvis assembly	033-7000	1
Pelvis casting machined	033-7001	1
Pelvis Flesh	033-7002	1
Hip joint Lower	020-7201	2
Hip joint Upper	020-7202	2
Hip joint Spacer	020-7203	2
Screw SHCS M5 x 12	5000002	4
Screw BHCS M4 x 12	5000005	4

Assembly and Disassembly

Disassembly

1. If necessary, remove the dummy's upper part by removing the M6 x 43 bolts (020-9902) at the lumbar spine thorax interface.
2. Remove the lumbar spine and load cell (or load cell structural replacement) as described in section 4.5.

Legs

3. Remove the left and right legs. To do so, put the dummy on its back or front, and remove the four M5 x 12 screws in the crotch area that retain the hip joint assemblies.
4. With the screws removed from the dummy, the legs together with the hip joint assemblies can be removed from the pelvis by pulling them laterally outwards.
5. Hip joint assemblies can be removed from the legs through separation of the upper and lower hip joint. Do so by removal of the four button head M4 screws (see Figure I8).

Note: It is possible to change the friction setting of the hip joints. To do so the spacer between the hip cups must be removed. This is only done when doing out of position testing to lock the leg at the hip.

Skin

6. When the legs are removed, the pelvis flesh can be removed from the pelvis casting by pulling it downward.

Assembly

Perform steps 1 to 6 under “Disassembly” in reverse order.

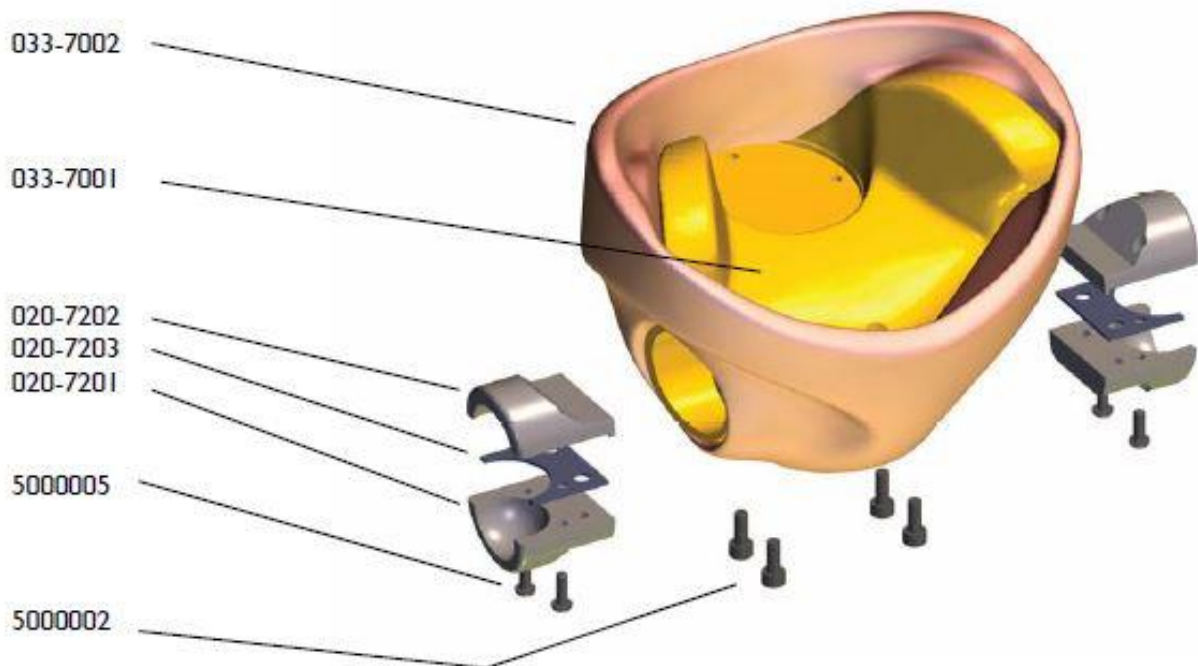


Figure 18. Pelvis and hip joint assembly

Instrumentation

Accelerometers

The pelvis can be equipped with a mounting block accepting three uni-axial accelerometers or a single tri-axial accelerometer. In order to use accelerometers in the pelvis, first mount them onto the mounting block. The tri-axial

accelerometer should be mounted on a mounting plate. Then remove the pelvis flesh as outlined in the paragraph above (assembly and disassembly). The mounting block should be attached at the inferior surface at the bottom of the pelvis casting, with the long side of the base plate facing backwards. The cables should be routed forward through the pubic area when replacing the pelvis flesh.

4.7 Legs

Construction

The legs consist of an upper leg and lower leg connected to each other with a knee joint. At the hip side, a ball and socket joint is used. This joint should not be taken apart under normal operating circumstances.

In the knee joint, a limited range of motion has been built in. At the end of this range, rubber stops are used to smoothly decelerate the motion and thereby prevent spikes on the measurement signals.

The parts of the legs are listed in Table 13 below.

Table 13. Legs assembly parts

Description	Part No. Left	Part No. Right	Qty. in each Assembly
Leg Assembly L or R	033- 9100	033- 9200	1
Upper Leg Assembly L or R	033- 9101	033- 9201	1
Lower Leg Assembly L or R	033- 9102	033- 9202	1
Rubber end stop	020-9903		2
Shoulder Screw SHSS M6 x 35 modified	033-9907		1
Stop Screw	020-9901		1

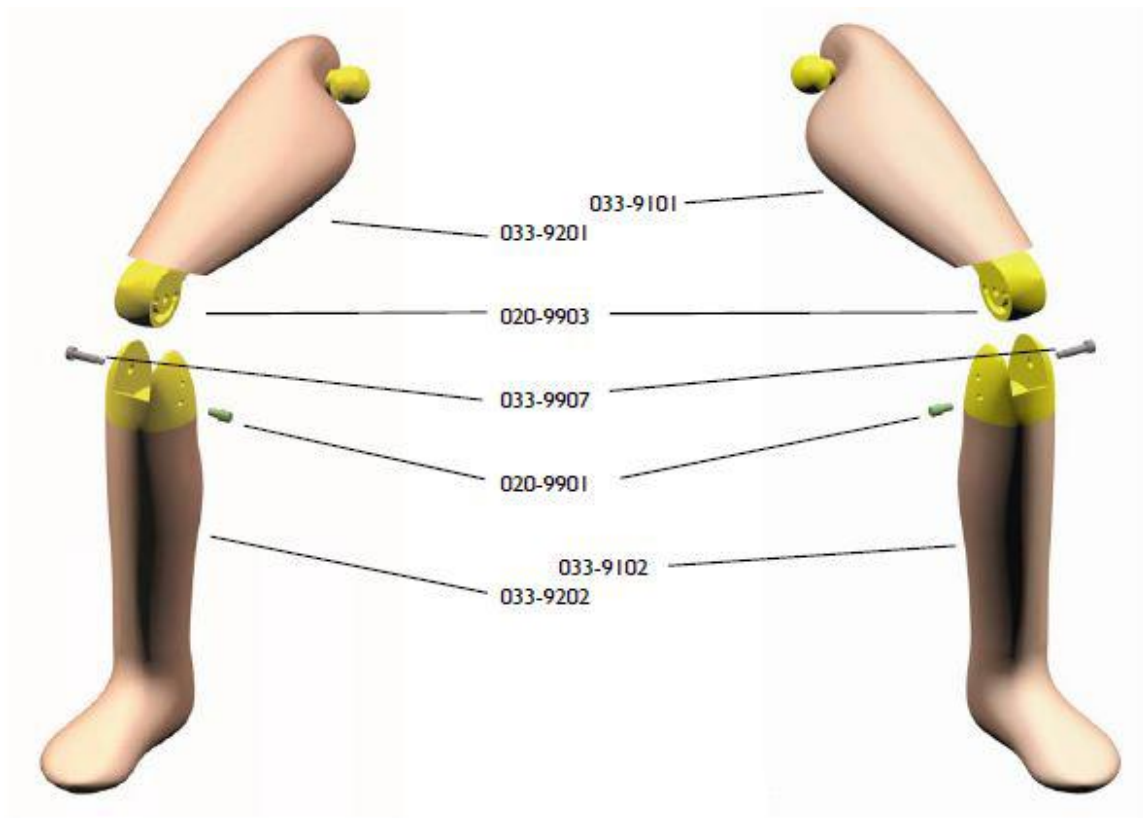


Figure 19. Leg Assemblies

Assembly and Disassembly

Disassembly

It is not advised to disassemble the legs, except to replace broken parts. To separate the lower from the upper leg:

1. Remove the motion stop screw (020-9901) located on the inside of the knee joint.
2. Remove the M6 x 35 socket head shoulder screw (033-9907) connecting the two parts of the leg.

Assembly

1. Check that the rubber end stops are in the correct positions inside the upper knee joint before assembly of the lower leg.
2. Align upper and lower leg at shoulder screw holes and screw in shoulder screw.
3. Before inserting the motion stop screw, place upper and lower leg in a 90° angle with respect to each other.

4. Turn the motion stop screw into the leg as far as it will go. Then turn it back half a turn and check that the motion of the lower leg is without significant friction.

Note: It is not possible to change the friction setting of the knee joint in the legs. The legs are fully supported and positioned by the child restraint system.

Instrumentation

No instrumentation is used in the legs.

4.8 Arms

Construction

The arms consist of an upper and lower section, connected at the elbow with a joint. At the upper end, a shoulder joint allows a number of degrees of freedom. The main joint is of the ball-and socket type, with a limited range of motion. The upper arm can rotate around its vertical axis. Furthermore, the entire arm can rotate around the shoulder lateral axis.

Table 14. Arm assembly parts

Description	Part No. Left	Part No. Right	Qty. in each Assembly
Arm Assembly L or R	033-9300	033-9400	1
Upper Arm Assembly L or R	033-9301	033-9401	1
Lower Arm Assembly L or R	033-9302	033-9402	1
Rubber end stop	020-9903		2
Shoulder Screw SHSS M5 x 20	5000626		1
Stop Screw	020-9901		1
Click Stop screw	5000328		1
Screw BHCS M4 x 12	5000005		3
Washer	033-3008		3
Friction washer	033-3007		3

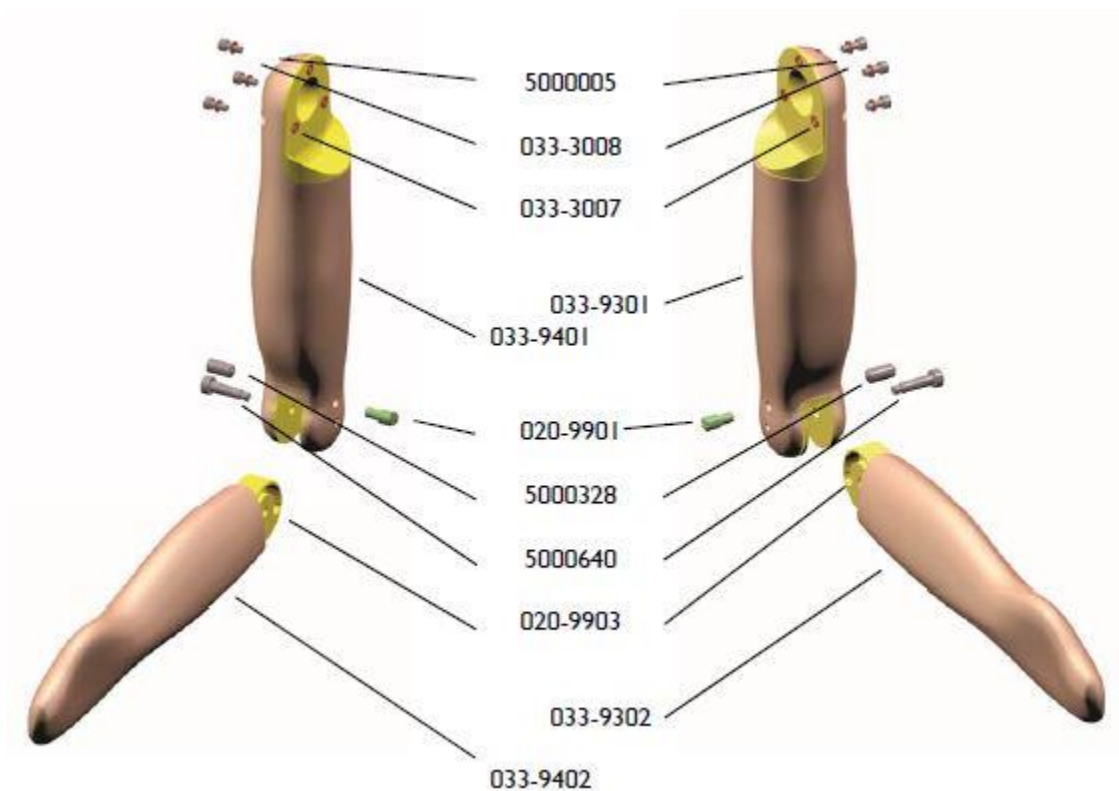


Figure 20. Arm Assemblies

The 1–2 G setting of the arm to shoulder joint can be changed by tightening or loosening the M3 attachment screws. The compression washers ensure a certain amount of tension on the screws and prevent them from loosening.

At the elbow joint, the range of motion is limited. At the end of the range of motion, rubber stops in the joint ensure a smooth arrest of motion. This prevents hard contact and reduces spikes on measurement signals.

Assembly and Disassembly

Disassembly

The arm should not need disassembly under normal circumstances. If the arm needs to be removed from the dummy, then follow the procedures described in section 4.4.

1. Remove the upper arm assembly by removing the three M3 screws at the top of the upper arm. It is recommended NOT to undo the shoulder ball.
2. Remove the spring plunger (5000328) and motion stop screw (020–9901).
3. Remove the shoulder screw connecting the upper and lower arm

Assembly

1. Perform steps 1–3 under assembly in reverse order.
2. Check that the rubber end stops are in the correct positions inside the elbow joint before assembly of the lower arm.
3. Align upper and lower arm at the shoulder screw hole and screw in shoulder screw.
4. Place upper and lower arm at a 90° angle with respect to each other.
5. Turn the motion stop screw into the arm as far as it will go. Then turn back half a turn and check that the motion of the lower arm is without significant friction. The correct position for motion stop screw is the inside of the arm.
6. Screw in the spring plunger in the hole next to the shoulder screw at the outside of the arm.
7. Check the correct settings for the spring plungers (see chapter 5).

Note: It is not possible to change the friction setting of the elbow joint. The positioning is done by means of the fixed “click stop” positions in the joint.

Instrumentation

No instrumentation is used in the arms.

4.9 Abdomen

Construction

The abdomen (033-5000) consists of one part, skinned foam, which is inserted between the pelvis and rib cage. It allows significant deformation of the dummy in the abdominal area. (See also Figure 17.)

Assembly and Disassembly

Disassembly

To properly remove the abdomen from the dummy, perform the following steps:

1. Remove the upper part of the dummy from the lower part (see procedure under lumbar spine and/or thorax paragraphs), by removing the two M6 x 43 screws from the lumbar spine thorax interface.
2. The abdomen can then easily be taken from the dummy.

Note: It is not advised to remove the abdomen from the assembled dummy, as this places forces and strains upon the material, which can in time result in wear and tear.

Assembly

1. The dummy should be divided into the upper and lower half by unscrewing the two M6 x 43 screws at the lumbar spine.
2. Insert the abdomen into the pelvis.
3. Put the top of the dummy (thorax and head) back on the lumbar spine with the two M6 x 43 screws at the lumbar spine.

Instrumentation

No instrumentation is used in the standard abdomen. See ATPS section 3.5 for abdomen with pressure sensors.

4.10 Neck Shield

Construction

The neck shield (033-2017) consists of a vinyl skin filled with foam that locates into the top of the rib, lays over the shoulders and wraps around the neck. The part is designed to help locate/guide the shoulder belt, protect the neck and provide a soft flesh covering. The part is soft and light so as not to effect neck performance.

Assembly and Disassembly

Disassembly

Tilt the head back and pull the neck shield upwards.

Assembly

Tilt the head back and insert the shield into the cavity between the clavicle and neck locating it inside the top of the ribcage. See Figure 21. Ensure the shield is central and aligned with the top of the ribcage as shown.

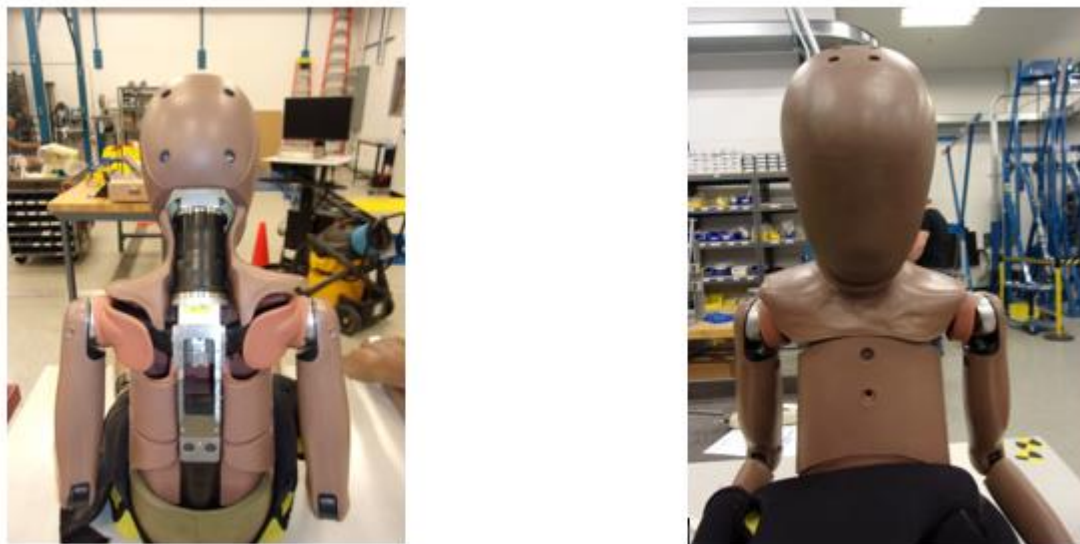


Figure 21. Neck Shield Installed: Left, Rear view; Right, Front view

Instrumentation

No instrumentation is used on the neck shield.

4.11 Suit

The dummy is dressed in a tight-fitting neoprene suit (033-8000). This suit is an integral part of the dummy and should be worn by the dummy during all tests. To put the suit on, first put on the lower half, legs first, and pull the pants section well into the crotch of the dummy. Then put the arms through the sleeves of the suit and pull it upward. Close the suit at the back using the hook and loop fasteners (Velcro). The dummy does not wear shoes.

4.12 Hip Insert

The hip insert is to be in regulation R129 to prevent the lap belt being trapped in the gap between the upper leg and the pelvis flesh, thus potentially restraining the dummy from submarining. The insert is made from a soft polyurethane to maintain dummy range of motion. There is some free range of motion for adduction for positioning. There is also an overlap at the top of the insert to help prevent the lap belt going under the abdomen. The insert is fitted to the dummy before fitting the suit see Figure 22 below. The insert makes the suit shorts more difficult to put on, as the legs will need to start straight. Therefore, after fitting feel through the suit to check the insert is fitted correctly, so that it feels smooth around the dummy flesh. This checks the insert has not been folded over. Push the insert back into place if not smooth. This can be done from the suit leg openings. The additional nominal weight of the insert is 327 grams.



Figure 22. Hip insert fitted on Q6: sitting position (left), straight legs (right)

5. Pre-Test Checks

5.1 Inspection

Before performing a test, a visual inspection of the dummy should be made. Special attention should be paid to the following items.

Neck

The rubber-molded part of the neck should not be damaged, that is: it should be complete and not show any tear and wear. By bending the neck slightly small cracks can also be detected. The neck cable should be checked carefully to check that there is no visible damage to the cord.

Shoulders

Periodically examine the shoulder to spine interface for damage.

Clavicle

Inspect the clavicle for cracks in the material.

Rib Cage

Check the rib cage for tears and cracks in the material. Deform the rib by hand, as this will show cracks if present. Cracks can be hidden by PVC skin that covers the outside of the rib cage. To find significant damage, pay special attention to the rib cage edges.

Lumbar Spine

The lumbar spine rubber may not be damaged. Inspect the rubber molding for tears and cracks. Replace if the spine is damaged. The cable must be inserted and the nut at the top properly screwed on. There is no pretension required, the nut should be tightened up to the play is eliminated.

Abdomen

The abdomen should be checked periodically (10 tests) for tearing of the PVC skin. Note that the wear of the abdomen is greatly reduced by observing the proper installation procedure. First remove the upper torso. The abdomen can then be removed by simply lifting it out of the pelvis.

Arms

Check the friction setting of the shoulder–arm regularly. Check the spring plungers in the elbows. See paragraph 5.2 for instructions.

Cable Routing

Always provide sufficient slack in the cables to allow the dummy to deform without putting any strain on the cables. This is especially important for the instrumentation located in the head (accelerometers, load cell). Please note that the slack can cause the cables to snag behind some other object in the test set-up, which can result in damage of the head instrumentation.

Dummy Certification

Besides the inspections to be performed before each test as described above, the dummy should be regularly certified to check its performance. It is advised to certify the dummy regularly as described in chapter 8.

5.2 Click Stops and Arm Adjustment

Arm adjustment

The correct arm–shoulder friction can be set by tightening or loosening the M3 screws in the upper arm. Rubber Friction washers (033–3007 see Figure 20) have been placed between the upper arm and retaining ring, to ensure a certain amount of tension in the screws at all times. This will prevent the shoulder screws from loosening in normal use. To set the correct 1–2 G setting of the shoulder joint, tighten the M3 screws evenly until the correct setting has been found.

Elbow

The spring plungers (click stops) in the elbow joint should keep the lower arm in one of two defined positions when a torque exerted by the lower arm mass and

gravity is exerted upon the joint. Adjust the click-stop by making small adjustments with a screwdriver. If the setting is correct, the arm should stay in its position even when small forces are exerted upon it, but start to rotate when significant forces are experienced. To verify this, push against the arm to force the arm out of the click stop position. If the click-stops are screwed in too far, the friction between them and the arm will be too large and the arm will not rotate under gravitation.

5.3 Time Interval between Tests

When conducting tests with the dummy or with dummy components a time-interval of at least 30 minutes should be observed between consecutive tests. Except for the head assembly, this also applies when a lateral test is followed by a frontal test, or vice versa, using the same dummy component. Due to the design and materials of the head assembly, it is only necessary to wait 30 minutes between tests on the same impact location.

6. Dummy Parts List and Recommended Spare Parts

6.1 *Dummy Parts*

The dummy parts list is provided in Table 15 below.

Table 15. Dummy parts list

Description	Part No.	Qty. in Assembly
Q6 Dummy Assembly, Test./Cert.	033-0001-B	1
Head Assembly, Test./Cert.	033-1100	1
Front Skull Assembly	033-1020	1
Rear Skull Cap Assembly	033-1002	1
Screw BHCS M5 x 0.8 x 12 (skull cap-skull)	5000654	4
Accelerometer Mounting Bracket Assembly	020-1013A	1
Head Accelerometer Bracket	020-1013	1
Screw SHCS M3 x 0.5 x 40 (bracket-head)	5000649	1
Screw SHCS M3 x 0.5 x 10 (bracket-head)	5000119	2
Loadcell Structural Replacement	020-2007	1
Neck Assembly, Test./Cert.	033-2100	1
Neck Moulding Pre-tested	033-2301	1
Neck Cord Assembly	033-2200	1
Screw FHCS M3 x 0.5 x 8 (neck cable-neck)	5000116	2
Neck Shield Frontal	033-2017	1
Torso Assembly Frontal Dummy	033-4000	1
Neck Torso Interface Plate	033-2308	1
Loadcell Structural Replacement	020-2007	2
Thoracic Spine Frontal Impact	033-4401	1
Lumbar Spine Assembly, Test./Cert.	033-6000	1
Lumbar Spine Central Moulding Pre-tested	033-6001	1
Lumbar Cable Assembly	033-6100	1
Hex-Nut M6 Nyloc (self-locking)	5000093	1
Washer Flat M6 (12.5 x 6.7 x 1.0)	5000094	1
Rib Cage Assembly Test./Cert.	033-4100	1
Shoulder Spine Interface Ass'y RH (rubber)	033-3011	1
Shoulder Spine Interface Ass'y LH (rubber)	033-3015	1
Clavicle Moulding Frontal	033-3200	1
Clavicle Retainer	033-4200	1
Shoulder Ball	033-3004	2

Shoulder Ball Retainer Ring	033-3003	2
Cable Guide	020-4411	1
Pivot Pin- Gimbal	020-4402	2
Gimbal Shaft	020-4403	1
Shaft Locking Boss	020-4404	1
Gimbal Ring	020-4405	1
Bracket IR-TRACC Attachment	033-4402	1
Spacer IR-TRACC Attachment	020-4407	2
Abdomen, Test./Cert.	033-5000	1
Pelvis Assembly	033-7000	1
Pelvis casting Machined	033-7001	1
Pelvis Flesh	033-7002	1
Hip Joint Lower	020-7201	2
Hip Joint Upper	020-7202	2
Hip Joint Spacer	020-7203	2
Screw BHCS M4 x 0.7 x 12	5000005	4
Screw BHCS M5 x 0.8 x 12	5000002	4
Screw FHCS M5 x 0.8 x 12 (struct. replacement and clavicle retainer)	5000096	9
Screw SHCS M5 x 0.8 x 12 (structural replacement-spine)	5000002	8
Screw BHCS M5 x 0.7 x 12 (Shoulder interface-spine)	5000005	8
Screw FHCS M5 x 0.8 x 10 (Clavicle-shoulder interface)	5000084	6
Screw BHCS M5 x 0.8 x 14 (shoulder ball-clavicle)	5000684	2
Screw BHCS M5 x 0.8 x 16 (rib cage-spine)	5000416	6
Lumbar Spine Mounting Screw	020-9902	2
Screw FHCS M4 x 0.7 x 16 (cable guide-spine)	5000447	2
Screw FHCS M5 x 0.8 x 8 (IR-TRACC bracket-rib cage)	5000662	1
Screw SHCS #5-40 x 5/8 (IR-TRACC-IRTRACC bracket)	9002975	1
Screw SSCP M4 x 0.7 x 5 (IR-TRACC-shaft locking boss)	5000406	1
Left Leg Assembly	033-9100	1
Upper Left Leg Assembly	033-9101	1
Lower Left Leg Assembly	033-9102	1
Shoulder Bolt, modified	033-9907	1
Stop Screw	020-9901	1
Right Leg Assembly	033-9200	1
Upper Right Leg Assembly	033-9201	1
Lower Right Leg Assembly	033-9202	1
Shoulder Bolt, modified	033-9907	1
Stop Screw	020-9901	1

Left Arm Assembly	033-9300	1
Upper Left Arm Assembly	033-9301	1
Lower Left Arm Assembly	033-9302	1
Shoulder Bolt, SHSS M5-20	5000626	1
Stop Screw	020-9901	1
M8 Spring Plunger	5000328	1
Right Arm Assembly	033-9400	1
Upper Left Arm Assembly	033-9401	1
Lower Right Arm Assembly	033-9402	1
Shoulder Bolt, SHSS M5-20	5000626	1
Stop Screw	020-9901	1
M8 Spring Plunger	5000328	1
IR-TRACC IF-362 Assembly	IF-362	1
Suit	033-8000	1
Screw FHCS M5 x 0.8 x 12 (head-structural replacement)	5000096	4
Screw SHCS M5 x 0.8 x 12 (structural replacement-neck)	5000002	4
Screw BHCS M5 x 0.8 x 10 (neck-torso)	5000003	4
Screw FHCS m4 x 0.7 x 12 (arm-shoulder)	5000005	6
Friction Washer (shoulder)	033-3007	6
Shoulder Washer	033-3008	6

6.2 Recommended Spare Parts

During operation dummy parts can fail. When the dummy is exposed to extreme pulses a failure can suddenly occur. Normally, however, an early warning for a part that may fail soon is given by the certification procedures. It is recommended inspect the dummy as described in chapter 5 before each test and certify the dummy regularly as described in chapter 8. To safeguard continuous operation with the Q6 dummy it is recommended to take and maintain the following spare parts in stock are listed in Table 16.

Table 16. Recommended spare parts

Description	Part No	Qty. in Assembly
Rib Cage Assembly Test. Cert.	033-4100	1
Upper Left Leg Assembly	033-9101	1
Lower Left Leg Assembly	033-9102	1
Upper Right Leg Assembly	033-9201	1
Lower Right Leg Assembly	033-9202	1
Upper Left Arm Assembly	033-9301	1
Lower Left Arm Assembly	033-9302	1
Upper Right Arm Assembly	033-9401	1
Lower Right Arm Assembly	033-9402	1

7. Certification Equipment

7.1 Requirements

The frequency of the Q6 certification and the number of tests that can be performed between certifications strongly depends on the type and severity of the tests in which the dummy is used, as well as the test frequency. Which certification tests have to be carried out depends on the dummy application (ECE-R44, NCAP, Airbag), and is different for frontal and side impact tests. When used in side impact applications, the dummy must be certified depending on the side of impact.

The dummy and dummy parts should be kept in the test environment at least 4 hours prior to the use in a test. The testing laboratory environment should be controlled to have:

- a temperature of 20 ± 2 degrees Celsius.
- a relative humidity of $40 \pm 30\%$.

When conducting certification tests a time interval of at least 30 minutes should be observed between two consecutive tests. This also applies when, for example, a lateral test is followed by a frontal test using the same dummy or dummy component.

When certifying the dummy, a particular order of operation should be observed:

- first perform the component tests: head, neck, lumbar spine and abdomen,
- then perform the full body test on the dummy with the certified components: thorax.

To perform the certification tests, certain equipment is required: a head drop table, a wire-suspended pendulum for the full body impacts, an abdomen compression device, a part 572 pendulum and a Q-series head form for neck and lumbar spine certifications.

7.2 Equipment

Head Drop Table

For the free-fall head drop test a support and release mechanism is necessary as well as steel plate with a thickness of at least 50 mm which will act as an impact surface. This plate should be similar to the plate described in CFR 49, Part 572 Hybrid III head drop test, and should have equivalent roughness and size.

Neck and Lumbar Spine Certification Equipment

A pendulum which meets the requirements of CFR 49 part 572.33(c) is needed to perform the certifications of the neck and lumbar spine, see sections 8.6 and 8.7. The spine or neck is mounted upside down on the pendulum arm using an interface plate which replaces the standard part 572 pendulum mounting plate. To load the part, a head form is used, which is shown Figure 23 and Figure 24.

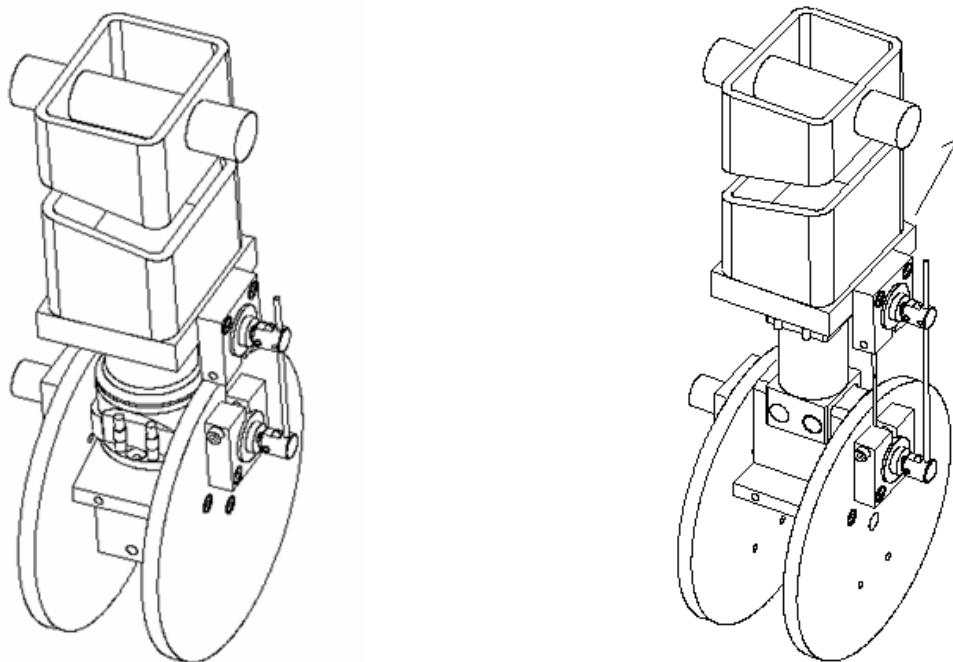


Figure 23. Neck and lumbar spine head form test set-up for frontal test

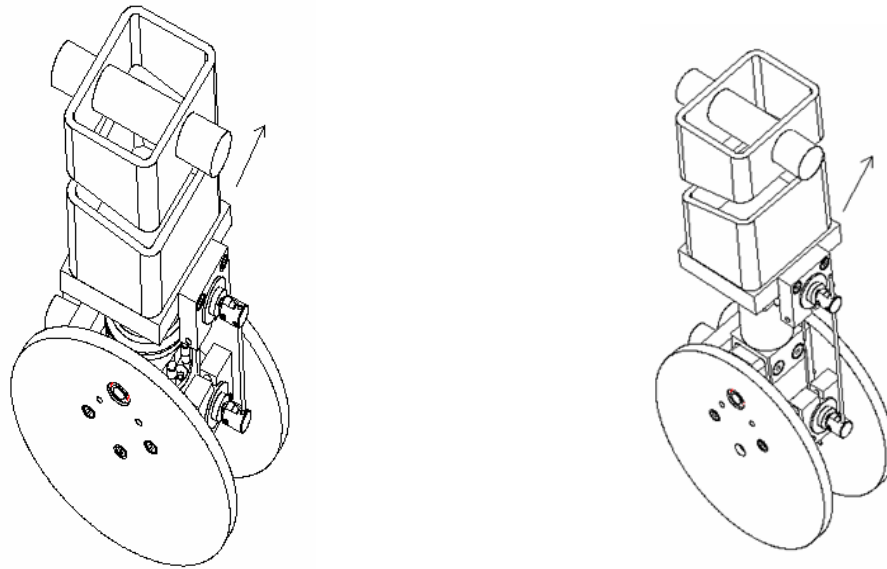


Figure 24. Neck and lumbar spine head form test set-up for lateral test

The total mass of the head form is 2.69 ± 0.05 kg, including the instrumentation but not the loadcell or structural replacement. The interface assembly to the part 572 pendulum weigh is 0.95 ± 0.02 kg.

The neck or lumbar spine is attached upside down to this pendulum. A head form is used to load the neck or lumbar spine. This head form consists of two flat disks connected by an interface, which allows certification of both the neck and the lumbar spine.

The head form has different configurations: one for testing the neck and one for testing the lumbar spine.

- For testing the neck the large end of the central block is facing towards the pendulum arm and a steel disk is assembled between the neck and the central block (see Figure 23 left and see Figure 24 left). When testing the neck a load cell (IF-217) or load cell structural replacement is mounted between the neck and the head form (see Figure 23 left).
- For testing the lumbar spine the discs need to be removed and mounted on the central block upside down. Consequently the large end of the central

block is facing away from the pendulum. The lumbar mounts directly to the small end of the central block. In the lumbar spine test no load cell or load cell structural replacement is required between the lumbar spine and the head form. (See Figure 23 right and Figure 24 right.)

Two rotational potentiometers are used to measure the angle of the head form relative to the pendulum arm. One potentiometer is attached to the pendulum interface, the other to the head form (see Figure 23 and Figure 24). A thin rod connects the potentiometers. The rod should be fixed to the head form potentiometer (using an M3 set screw), but be able to slide freely through the hub on the axis of the pendulum interface potentiometer. The rod must be protruding from both potentiometer axes equal length. A balance mass is attached to the opposite side of the head form to assure symmetrical loading of the neck and lumbar spine. The potentiometer and balance mass are mounted on the sides of the head form with their common centerline perpendicular to the movement of the pendulum. This can be seen in Figure 23 and Figure 24.

The neck and lumbar spine test fixture can be used for both frontal and lateral testing of the head and lumbar spine. For testing in frontal direction the head form discs are parallel to the axis of the pendulum, see Figure 23. For lateral testing the head form center line is perpendicular to the axis of the pendulum, see Figure 24. Both configurations use three screws for fixing the discs to the central block and the positions (frontal and lateral) of the angle transducer. The angle transducer and the balance weight of the head form must be repositioned when changing from frontal to lateral testing and vice versa.

Full Body Pendulum

The full body pendulum, part number 033-9920 “Q6 Probe Assembly” (see Figure 25), consists of a hollow metal tube closed at both ends, two axles with suspension pulleys and a speed vane. An accelerometer which measures the longitudinal acceleration must be mounted on the rear end. An Endevco model 2262CA-200 or equivalent is recommended.

The total mass, including instrumentation, suspension pulley wheels and speed vane as well as the impactor face dimensions are specified in the table below.

Table 17. Q6 full body pendulum specifications

Description	Q6 Probe
Probe weight, including speed vane, accelerometers and hardware.	5.30 ± 0.10 kg
Probe Diameter	90 mm
Round off radius	5 mm



Figure 25. Q6 full-body impactor (accelerometer not shown)

The impactor is suspended as a guided pendulum by eight 7 x 7 stainless steel wires (2 mm diameter). Figure 26 shows a front view of the impactor and four of the suspension wires in the required cross configuration

A flat, horizontal surface should be available to sit the dummy on. The impact velocity of the impactor must be measured and recorded.

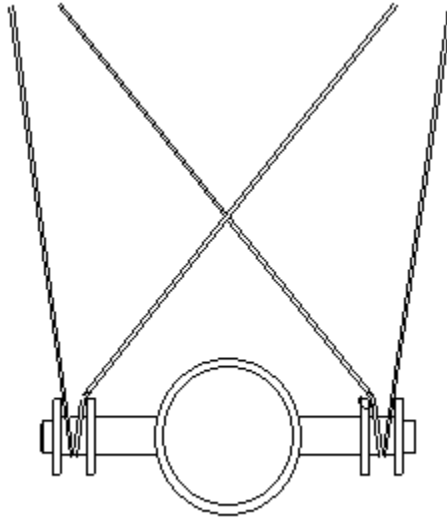


Figure 26. Full body pendulum impactor suspension wire diagram

Abdomen Test Rig

The abdomen test compresses the abdominal insert between a Q6 abdomen certification support block (Part number TE-033-9910) and a flat plate. The support block shape matches the shape of the inside of the abdomen. The support is placed on a horizontal surface, and the abdomen is placed on the block with the front outer surface facing up. A flat plate should be placed parallel to the horizontal base plate on top of the abdomen. The dimensions of this plate are 300 by 250 mm, and the mass is 2.05 ± 0.025 kg. A picture of the set-up is shown in Figure 33.

7.3 Equipment Parts List

Table 18. Q-Dummy certification equipment parts list

Part No.	Description	Test
020-1050	Head Certification Mass Q Dummies	Head Drop Test
TE-2651	Head Positioning Basket	Head Drop Test
TE-2650	Head form Q-Dummies	Neck And Lumbar Spine Test
TE-2650-Q6KIT	Intermediate Plate TE-2650-15 and screws	Neck Test
TE-033-9910	Abdomen Certification Support	Abdomen Test Q6
TE-033-9920	Full Body Probe Q6	Thorax Test Q6

8. Certification Tests

Besides the inspections to be performed before each test as described in chapter 5, the dummy should be regularly certified to check its performance. It is advised to certify the dummy each 10 tests, when doubts on obtained measurements arise, when parts are replaced and when injury criteria are significantly exceeded. In this chapter the certification procedures are described.

8.1 Head Certification

General

To certify the Q6 head, remove it from the neck. The parts list for the head assembly is shown below.

Description	Part No.	Qty.
Head front assembly	033-1020	1
Head rear assembly	033-1025	1
Head Accelerometer Mounting Base	020-1013	1
Screw BHCS M5 x 12	5000565	4
Screw SHCS M3 x 10	5000119	1
Screw SHCS M3 x 40	5000649	2
Load cell blank (drop test) (mass block, representing half the load cell)	020-1050	1
Screw FHCS M5 x 10	5000084	4

No tears or cracks in the skin or skull materials are allowed. Also check that all screws have been tightened properly.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

Instrumentation

Mount three uni-axial accelerometers on the accelerometer mount I.AD or I.AM (see Figure 2) in the head on the mounting base 020-1013A or 020-1014.

Data Processing

1. All three accelerations should be filtered at CFC1000.
2. Determine the resultant head acceleration.

Frontal Impact Head Certification

Test Procedure

1. The head is suspended above a Part 572 plate. Users are advised to use a thin wire basket (TE-2651) to position the head. The net has a piece of steel attached to it, which allows the use of a magnet to keep the head in place. The net allows easy adjustment of the head in any orientation.
2. The z-axis of the head should make an angle of 28 ± 2 degrees with the horizontal plane, and the medial-lateral axis should be horizontal, ± 1 degree. When released, the head should impact the surface with its forehead. The z-axis of the head is parallel to the skull cap plane, see Figure 27.
3. The lowest point of the head should be 130 ± 1 mm above the impact surface.
4. Release the head.
5. The minimum time interval to observe between tests on the head is 30 minutes.

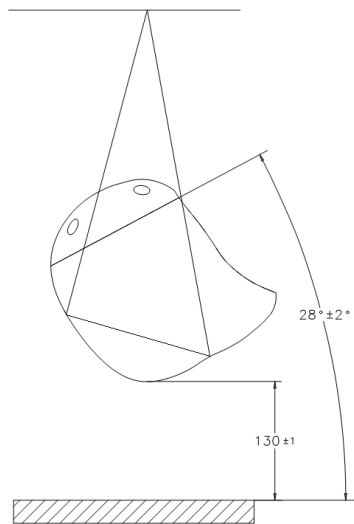


Figure 27. Frontal Head drop certification set-up

Data Processing

1. All three accelerations should be filtered at CFC1000.
2. Determine the resultant head acceleration.

Requirement

1. The maximum resultant head acceleration response should be between 105 g and 135 g.
2. The acceleration in Y-direction should be between -10 and 10 g.

Lateral Impact Head Certification

Test Procedure

1. The head is suspended above a rigid, heavy, metal plate. The properties of this plate are described in section 7.2 under the heading “Head Drop Table” of this manual. Users are advised to use a thin wire basket (TE-2651) to position the head. The net has a piece of steel attached to it, which allows the use of a

magnet to keep the head in place. The net allows easy adjustment of the head in any orientation.

2. Position the head in such a way that the mid-sagittal plane has an angle of 35 ± 2 degrees with the horizontal axis, and the anterior-posterior axis is horizontal, ± 1 degree. This corresponds to an angle between the horizontal plane and the head base plane of 55 ± 2 degrees, see Figure 28. When released, the head should impact the surface with the side of its head.
3. The lowest point of the head should be 130 ± 1 mm above the impact surface.
4. Release the head.
5. The minimum time interval to observe between tests on the head is 30 minutes.

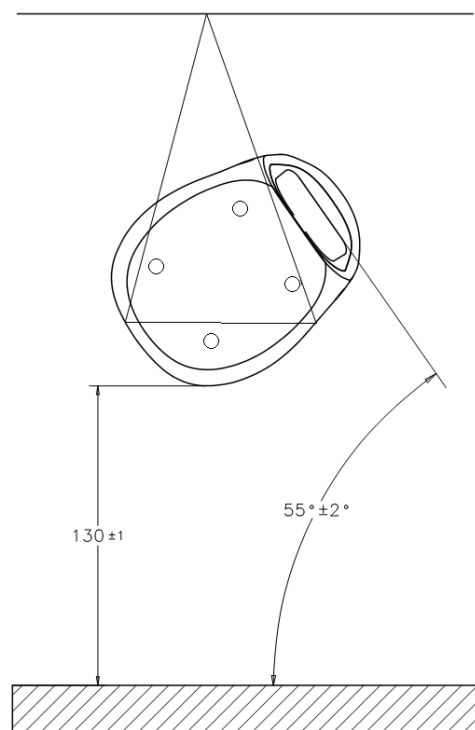


Figure 28. Lateral Impact Head certification set-up – rear view of head

Data Processing

1. All three accelerations should be filtered at CFC1000.

2. Determine the resultant head acceleration.

Requirement

1. The maximum resultant head acceleration response should be between 110 and 140 g.
2. The acceleration in X-direction should be between -20 and 20 g.

8.2 Certification of the Neck

General

The neck test is a component test, which is performed using a pendulum as defined in CFR49 part 572. To certify the Q6 neck, remove it from the dummy. The complete neck consists of the following parts:

Description	Parts No.	Qty.
Neck Molding	033-2301	1
Neck Cable assembly	033-2200	1
Screw FHCS M5 x 10	5000084	4
Screw SHCS M5 x 10	5000291	4
Load cell or load cell structural replacement	IF-217 or 020-2007	1

The neck is attached upside down to this pendulum. A head form is used to load the neck. This head form consists of two flat discs connected by an interface, which allows certification of both the neck and the lumbar spine. The head form rotation during the test is measured using two rotational potentiometers. One is installed on the base of the neck-pendulum interface the second one is attached to the head form. Both potentiometers are linked with a thin shaft (see Figure 29 and Figure 30). The sum of the two angles measured on the potentiometers is the angle of the head relative to the pendulum. Moment is measured using an upper neck load cell IF-217 mounted between the head form and the neck.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

The pendulum acceleration should be measured with an accelerometer, which is located on the pendulum arm, 1657.4 mm from the pendulum pivot in accordance with the CFR 49 Part 572.

Frontal Neck Test

Set-up

1. Assemble the complete neck, as described in section 4.3 with interface plate 033-2308.
2. Attach the IF-217 6 AXIS LOAD CELL and TE-2650-11 SPACER FLEXION HEAD FORM to the head form. Slide the head form over the neck and attach with 4 M5 x 12 SHCS.
3. Attach the neck to the pendulum interface plate (4 x M5). Place the (modified) 020-2015 (TE-2650-15) intermediate plate between the neck and pendulum interface. Align the neck and the interface, making sure that longitudinal axis of the neck is in the direction of movement of the pendulum arm (see Figure 29).
4. Attach the head form-neck system to the Part 572 pendulum. The front of the head form should point in the direction of motion of the pendulum (see Figure 29).
5. Install the potentiometers to the mounting interface and the on the head form. Mount the balance mass for the potentiometer on the other side of the head form. This ensures that the inertial properties of the head are symmetrical in the impact direction.
6. Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom-most axis to secure the rod. The other end of the rod should be able to slide freely through the upper most transducer axis. The rod must be protruding from both sides of the transducers axes equal length.
7. The minimum time interval to observe between tests on the neck is 30 minutes.

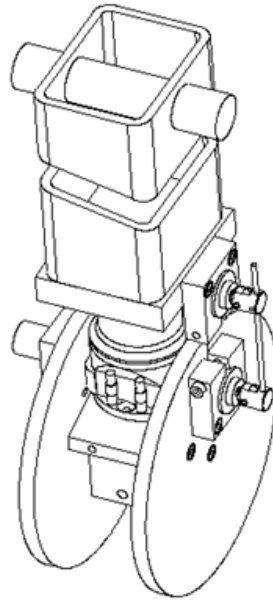


Figure 29. Q6 neck certification test set-up for frontal test

Performing the Test

1. Attach honeycomb material to arrest the pendulum. Proposed is to use sheets of 28.8 kg/m^3 with crush strength of 1.8 lbs./cu.ft. , with a nominal length of 152.4 mm (6 inches).
2. Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.
3. Lift the pendulum up to its pre-test height and check that the head form is in the correct initial position (symmetrical with respect to neck top yoke). Do not leave the head form-neck system in this position for more than 1 minute, as the neck will start to deform due to the mass of the head form.
4. Release the pendulum.

Data Processing

1. Filter the pendulum acceleration at CFC180.
2. Filter the potentiometer readings at CFC600.
3. Filter the load cell readings at CFC600.
4. Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after software filtering).

5. Software—zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.
6. Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.
7. Sum the potentiometer signals to derive the total head angle of the head form relative to pendulum arm.

Requirements

1. The impact velocity should be between 3.8 and 4.0 m/s.
2. The pendulum velocity decrease should be as indicated in the table below.

Time ms	Lower limit [m/s]	Upper limit [m/s]
10	0.5	1.5
20	1.3	2.5
30	2.0	3.3

To meet the requirements of the frontal neck certification test (see note below):

3. The maximum head angle (first maximum) should be between 36.9 and 45.8 degrees.

The peak moment shall be between 22.6 and 28.0 Nm.

Lateral Neck Test

Set-up

1. Assemble the complete neck, as described in section 4.3 with interface plate 033-2308. See Figure 12.
2. Attach the IF-217 6 AXIS LOAD CELL and TE-2650-11 SPACER FLEXION HEAD FORM to the head form. Slide the head form over the neck and attach with four M5 x 12 SHCS.
3. Attach the neck to the pendulum interface plate (4 x M5). Place the (modified) 020-2015 (TE-2650-15) intermediate plate between the neck and pendulum interface. Align the neck and the interface, making sure that lateral axis of the neck is in the direction of movement of the pendulum arm (see Figure 31). Also, make sure that the bending direction of the neck in the

certification is the same as the initial bending direction experienced in the test the dummy is being certified for (LHS or RHS).

4. Attach the head form–neck system to the Part 572 pendulum. The side of the head form should point in the direction of motion of the pendulum (see Figure 30).
5. Install the potentiometers to the mounting interface and on the head form central block. Mount the balance mass for the potentiometer on the other side of the central block. This ensures that the inertial properties of the head are symmetrical in the impact direction. Figure 30 indicates the proper position and orientation of the potentiometers.
6. Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom–most axis to secure the rod to the potentiometer. The other end of the rod should be able to slide freely through the upper most transducer axis. The rod must be protruding from both sides of the transducers axes equal length.
7. The minimum time interval to observe between tests on the neck is 30 minutes.

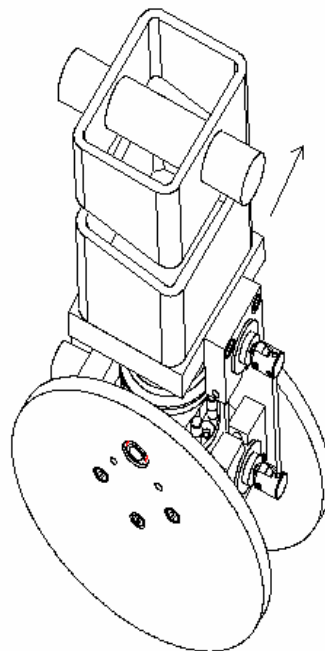


Figure 30. Q6 neck certification test set-up for lateral test

Performing the Test

1. Attach honeycomb material to arrest the pendulum. Proposed is to use sheets of 28.8 kg/m³ with crush strength of 1.8 lbs/cu.ft, with a nominal length of 152.4 mm (6 inches).
2. Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.
3. In this position for more than 1 minute, as the neck will start to deform due to the mass of the head form.
4. Release the pendulum. Lift the pendulum up to its pre-test height and check that the head form is in the correct initial position (symmetrical with respect to neck top yoke). Do not leave the head form-neck system

Data Processing

The data processing procedure of the lateral test is equal to the procedure mentioned in the frontal test.

Requirements

1. The impact velocity should be between 3.8 and 4.0 m/s.
2. The pendulum velocity decrease should be as indicated in the table below.

Time ms	Lower limit m/s	Upper limit m/s
10	0.5	1.5
20	1.3	2.5
30	2.0	3.3

To meet the requirements of the lateral neck certification test (see note below):

3. The maximum head angle (first maximum) should be between 41.6 and 51.6 degrees.

The peak moment shall be between 21.6 and 26.9 Nm.

8.3 Certification of the Lumbar Spine

General

The lumbar spine test is a component test, which is performed using a pendulum as defined in CFR49 part 572. To certify the Q6 lumbar spine, remove it from the dummy. The complete Lumbar Spine consists of the following parts:

Description	Parts No.	Qty.
Lumbar Spine Molding	033-6001	1
Lumbar Spine Cable	033-6100	1
Lumbar Spine mounting screw	020-9902	2
Nyloc Nut	5000093	1
Plain Washer	5000094	1
Screw SHCS M5 x 12	5000002	4

The lumbar spine is attached upside down to this pendulum. A head form is used to load the lumbar spine. This head form consists of two flat disks connected by an interface, which allows certification of both the neck and the lumbar spine. The head form rotation during the test is measured using two rotational potentiometers. One is installed on the base of the neck-pendulum interface the second one is attached to the head form. Both potentiometers are linked with a thin shaft (see Figure 31 and Figure 32). The sum of the two angles measured on the potentiometers is the angle of the head relative to the pendulum.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

The pendulum acceleration should be measured with an accelerometer which is located on the pendulum arm, 1657.4 mm from the pendulum pivot in accordance with the CFR 49 Part 572.

Frontal Lumbar Spine Test

Set-up

1. Remove the lumbar spine assembly from the dummy. Disassemble the discs of the head form and mount them in the correct position for lumbar spine testing.
2. Slide the head form over the lumbar spine thorax interface bracket. Insert and tighten the two M6 countersunk screws.
3. Attach the lumbar spine and head form to the pendulum interface plate. Align the lumbar spine and the interface plate, making sure that longitudinal axis of the lumbar spine is in the direction of movement of the pendulum arm (see Figure 31).
4. Attach the head-spine system to the part 572 pendulum. The front of the head form should point in the direction of motion of the pendulum (see Figure 31).
5. Install the potentiometers to the mounting interface and on the head form. Mount the balance mass for the potentiometer on the other side of the head form. This ensures that the inertial properties of the head are symmetrical in the impact direction.
6. Insert the rod connecting in the axes of the potentiometers and tighten the screw on the bottom-most axis to secure the rod to that potentiometer. The other end of the rod should be able to slide freely through the upper most transducer axis. The rod must be protruding from both sides of the transducers axes equal length.
7. The minimum time interval to observe between tests on the lumbar spine is 30 minutes.

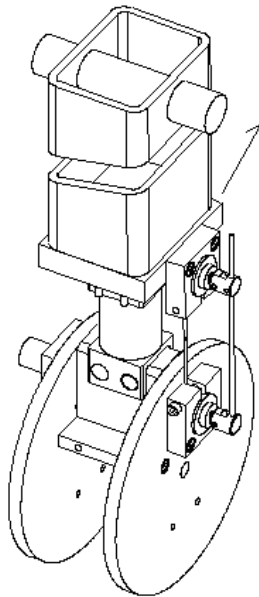


Figure 31. Q6 lumbar spine certification test set-up for frontal test

Performing the Test

1. Attach honeycomb material to arrest the pendulum. Proposed is to use Hexcel (28.8 kg/m^3) with crush strength of 1.8 lbs/cu.ft, with a nominal length of 152.4 mm (6 inches).
2. Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.
3. Lift the pendulum up to its pre-test height and check that the head form is in the correct initial position. Do not leave the head-lumbar spine system in this position for more than 1 minute, as the neck will start to deform due to the mass of the head form.
4. Release the pendulum.

Data Processing

1. Filter the pendulum acceleration at CFC180.
2. Filter the potentiometer readings at CFC600.
3. Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after filtering).
4. Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.

5. Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.
6. Sum the potentiometer signals to derive the total head relative to pendulum arm angle.

Requirements

1. The impact velocity should be between 4.3 and 4.5 m/s.
2. The pendulum velocity decrease should be as indicated in the table below:

Time ms	Lower limit m/s	Upper limit m/s
10	1.3	1.7
20	2.7	3.7
30	4.1	4.9

To meet the requirements of the frontal lumbar spine certification test:

3. The maximum head angle (first maximum) should be between 54.0 and 69.0 degrees.
This value should occur between 45 and 75 ms from the time-zero point.
4. The minimum head angle (first minimum) should be between -33.0 and -23.0 degrees.
This value should occur between 165 and 195 ms from the time-zero point.

Lateral Lumbar Spine Test

Set-up

1. Slide the certification head form over the spine-thorax interface bracket.
2. Attach the spine to the pendulum interface plate. Align the lumbar spine and the interface, making sure that lateral axis of the head form is in the direction of movement of the pendulum arm (see Figure 32). Also, make sure that the bending direction of the neck in the certification is the same as the initial bending direction experienced in the test the dummy is being certified for (LHS or RHS).

3. Attach the head–spine system to the part 572 pendulum. The side of the head form should point in the direction of motion of the pendulum (see Figure 32.)
4. Lift the pendulum up to its pre–test height and check that the head form is in the correct initial position.
5. Install the potentiometers to the mounting interface and the on the head form central block. Mount the balance mass for the potentiometer on the other side of the central block. This ensures that the inertial properties of the head are symmetrical in the impact direction.
6. Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom–most axis to secure the rod to the potentiometer. The other end of the rod should be able to slide freely through the upper most transducer axis. The rod must be protruding from both sides of the transducers axes equal length.
7. The minimum time interval to observe between tests on the lumbar spine is 30 minutes.

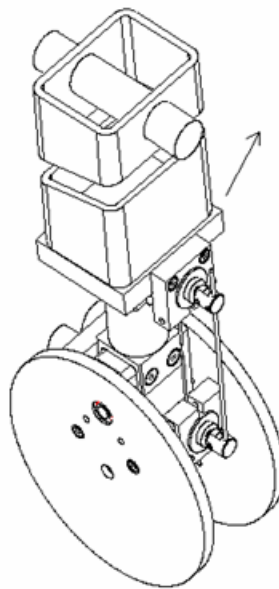


Figure 32. Q6 lumbar spine certification test set-up for lateral test

Performing the Test

1. Attach honeycomb material to arrest the pendulum. Proposed is to use sheets of 28.8 kg/m³ with crush strength of 1.8 lbs/cu.ft, with a nominal length of 152.4 mm (6 inches).
2. Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.
3. Lift the pendulum up to its pre-test height and check that the head is in the correct initial position. Do not leave the head-spine system in this position for more than 1 minute, as the neck will start to deform due to the mass of the head form.
4. Release the pendulum.

Data Processing

The data processing procedures of the lateral test is equal to the procedure mentioned in the frontal test.

Requirements

1. The impact velocity should be between 4.3 and 4.5 m/s.
2. The pendulum velocity decrease should be as indicated in the table below:

Time ms	Lower limit m/s	Upper limit m/s
10	1.3	1.7
20	2.7	3.7
30	4.0	4.8

To meet the requirements of the lateral lumbar spine certification test:

3. The maximum head angle (first maximum) should be between 55.0 and 70.0 degrees.
This value should occur between 45 and 75 ms from the time-zero point.
4. The minimum head angle (first minimum) should be between -33.0 and -23.0 degrees.
This value should occur between 165 and 195 ms from the time-zero point.

8.4 Certification of the Abdomen

General

The abdomen test is a component test. The abdomen should be removed from the dummy. The test equipment is described in paragraph 7.2. To test the correct performance of the dummy abdomen an “Additional mass” is placed on the top plate.

Instrumentation

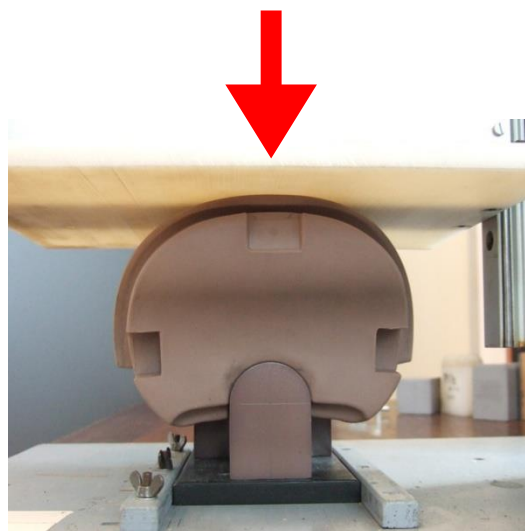
The only instrumentation necessary to perform this test is a tape measure or calipers rule to measure the distance between the two plates.

Equipment required:

Description	Q6
Top plate mass	2.05 ± 0.025 kg
“Additional mass”	8.05 ± 0.025 kg
“Total mass”	10.10 ± 0.05 kg
Abdomen support part no.	TE-033-9910



Figure 33.



Abdomen certification test set-up

Performing the Test

1. Place the abdomen on the appropriate Q6 abdomen certification support block TE-033-9910. Ensure a good fit and orientation of the abdomen over the block. Lower the top plate (with a mass of 2.05 ± 0.025 kg.) on the abdomen. Determine this point as zero for the displacement measurement.
2. Place the “additional mass” (8.05 ± 0.025 kg.) on the top plate. This mass differs for the Q1, Q1.5 and Q3, Q6 dummies. Let the force exerted by this mass apply as indicated in Figure 33. This must be done within 10 seconds after placing the initial load.
3. Let the top plate compress the abdomen for a period of 2 minutes (± 10 sec.).
4. Read the displacement measurement.
5. Remove the mass and top plate.
6. Observe an interval of at least 30 minutes between successive tests on the same abdomen.

Data Processing

1. Subtract the final reading from the initial reading

Requirement

The deformation of the abdomen should be between 6 and 10 mm.

8.5 Certification of the Thorax

General

A complete standard Q6 dummy, **without neck shield, ATPS sensors or hip insert** must be used in this test. The dummy is to be tested with the suit. Prior to the test, the dummy should be inspected for possible damage. It is particularly important for the thorax tests to check the condition of the rib cage, the shoulder spine interface and the clavicle. No cracks or tears are allowed. Also check that all screws have been tightened properly.

As the performance of several components will affect this full body thorax impact test, make sure that this test is performed as the last test in the certification

procedure, where all dummy parts have passed their applicable certifications tests successfully.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

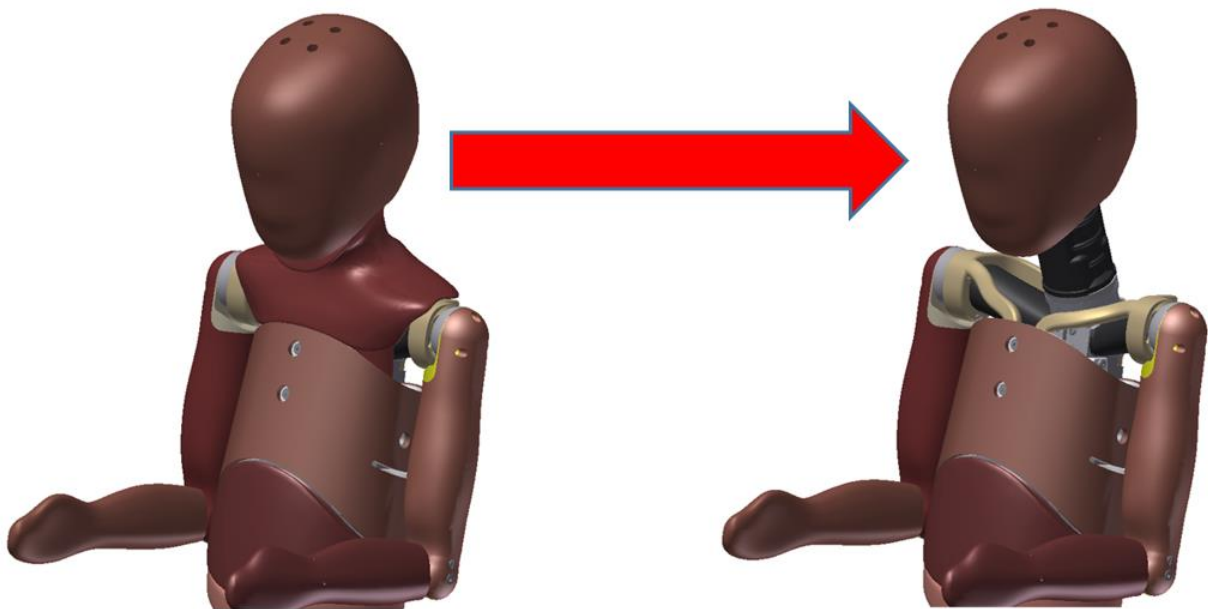


Figure 34. Neck Shield Installed and Removed

See Section 4.10, *Neck Shield* install/removal instructions

Frontal Impact Thorax Test

Instrumentation

The dummy must be equipped with the standard IR-TRACC to measure frontal chest deflection. Use the 5.30 kg test probe as described in section 7.2, equipped with an accelerometer to measure the impact deceleration. The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

Test procedure

1. Dummy positioning

- The dummy should be seated on a clean dry surface, consisting of two 0.76 x 0.56 m flat plates of 2 mm Teflon sheeting.
- Place the dummy with its thoracic spine in a vertical orientation, within ± 1 degree with the vertical. To stabilize the sitting position of the dummy rotate the upper legs outwards (toes point outwards), and place the legs in a v-shape. The angle between the feet should be between 40 and 60 degrees.
- Make sure the dummy is motionless.
- Place the upper arms vertically alongside the body, and let the lower arms rotate downward to let the hands touch the seating surface.

2. Impactor alignment

- Let the impactor hang in its lowest position. Check that the probe is in a horizontal position, that is, within ± 2 degrees.
- The impactor front surface should be directly in front of the dummy sternum within 5 mm.
- The height of the center line of the impactor over the seating surface should be chosen in such a way, that the center line of the impactor aligns with the sternum halfway between the upper and lower edge of the rib. This aligns the impactor with the IR-TRACC attachment point on the rib cage.
- The center line of the Impactor should be in the mid-sagittal plane.

3. Measure and record the impact velocity with the speed vane on the probe.

4. The minimum time interval to observe between tests on the thorax is 30 minutes.

Data Processing

1. All data channels should be filtered at CFC600.

2. Set time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).

3. Calculate the Impactor force by multiplying the impactor acceleration (in m/s^2) with the impactor mass.

Requirement

To pass the certification requirements for frontal thoracic impact:

1. The impactor velocity should be between 4.2 and 4.4 m/s.
2. The maximum thorax deflection should be between 21.5 and 26.5 mm.
3. The force at the maximum deflection should be between 1.15 and 1.45 kN.

Lateral Impact Thorax Test

Instrumentation

The dummy does not need to be equipped with the standard IR-TRACC to measure the chest displacement. **CAUTION! It is recommended to remove the IR-TRACC from the dummy or to mount it in the side impact position. Do not leave the IR-TRACC in its “frontal” test position, as the side impact test can cause damage to the IR-TRACC.**

Use the 5.30 kg test probe as described in section 7.2 equipped with an accelerometer mounted along the impactor’s longitudinal centerline to measure the impact deceleration.

The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

Test procedure

1. Dummy positioning

- Put the suit on the dummy and roll down the top half of the suit to expose the rib.
- The dummy should be seated on a clean dry surface consisting of two flat Teflon sheets that are approximately 0.76 m (30”) x 0.56 m (22”) x 2mm.
- Place the dummy with its thoracic spine in a vertical orientation, within ± 1 degree with the vertical. To stabilize the sitting position of the dummy, rotate the upper legs outwards (toes point outwards), and place the legs in a V-shape. The angle between the feet is not important, but slightly passed shoulder length apart tends to improve dummy stability.

- Place the upper arms vertically alongside the body, and let the lower arms rotate downward to let the hands touch the top Teflon sheet.
- Lift the arm on the impact side above and over the head. Tape the arm to the head to make sure the impactor cannot come in contact with the arm.

2. Impactor alignment

- Let the impactor hang in its lowest position. Verify that the impactor is in a horizontal position by placing a bubble level on the flat top surface of the impactor as necessary.
- Find the mid-point between the upper and lower edge of the rib directly above and below the lateral IR-TRACC attachment point. Adjust table or probe as necessary so that the longitudinal centerline of the impactor is at the same height as this mid-point.
- Put the upper half of the suit back on the dummy and re-tape the upper arm on the impact side to the head.
- Adjust the dummy so the center of the impactor face is 20+/-10mm forward of the IR-TRACC attachment point. Moving the pendulum forward from the 20 mm position will lower the impact force and moving back will increase impact force.

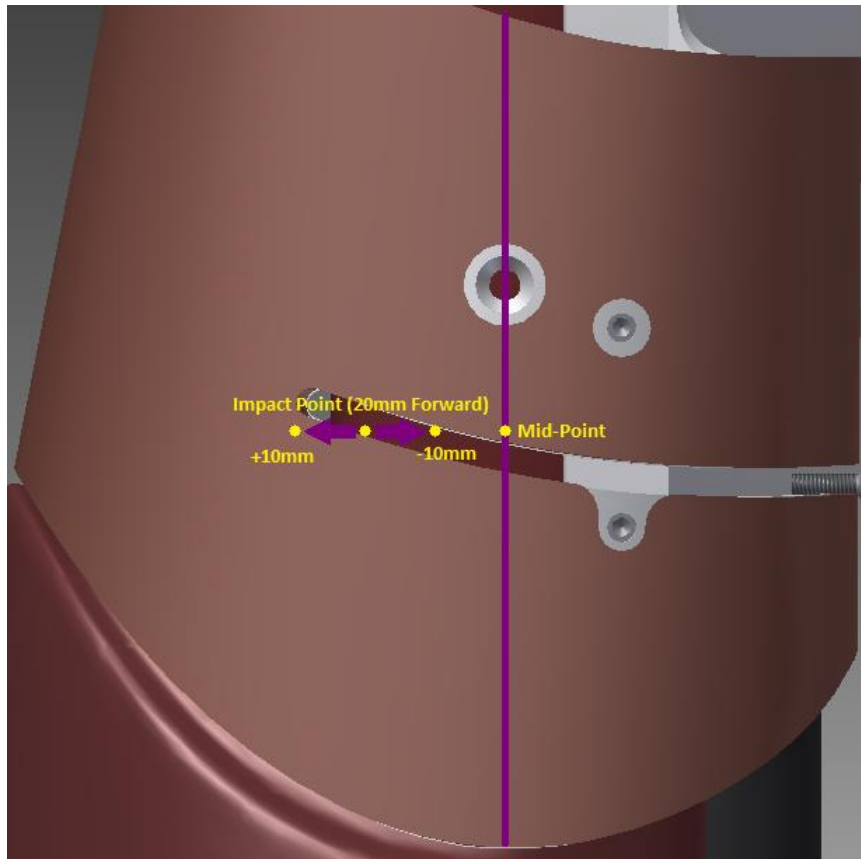


Figure 35. Impact Location Point Lateral Thorax Certification

- The impactor front surface should be just barely touching the suit while the probe is hanging in its lowest position
 - Dummy's X-axis should be perpendicular to impactor as close as possible.
3. Make sure that the IR-TRACC is not mounted for frontal impact as the side impact test can cause damage to the IR-TRACC when it is in its set-up position for frontal impacts.
 4. Measure and record the impact velocity with the speed vane on the probe.
 5. The minimum time interval to observe between tests on the thorax is 30 minutes.

Data Processing

1. All data channels should be filtered at CFC600.
2. Set the time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).

3. Calculate the impactor force by multiplying the impactor acceleration (in m/s^2) with the impactor mass.

Requirement

To pass the certification requirements for lateral thoracic impact:

1. The impactor velocity should be between 4.2 and 4.4 m/s.
2. The maximum impact force should be between 1.65 and 1.95 kN.

9. Markers Location Coordinates and Relevant Dimensions

Marker locations on the dummy are depicted in Figure 36 and listed in Table 19 through 22 on the next page. The markers dummy have different character. Anticipating the use of a FARO–arm with a pointer ball (radius of 2 mm), the ball point centre is specified. The different marker characters are:

- Dimple
 - Spherical diameter 3.4 mm and diameter at dummy surface 3.0 to 3.5 mm.
 - Anticipated Ball Centre (BC) 1.0 mm outside dummy contour.
- Hex recess of screw head:
 - Hex 2.5 to 3 mm: Anticipated Ball Centre (BC) 1.0 mm outside screw head top face
 - Hex 4: Anticipated Ball Centre (BC) 2.0 mm from bottom of Hex recess

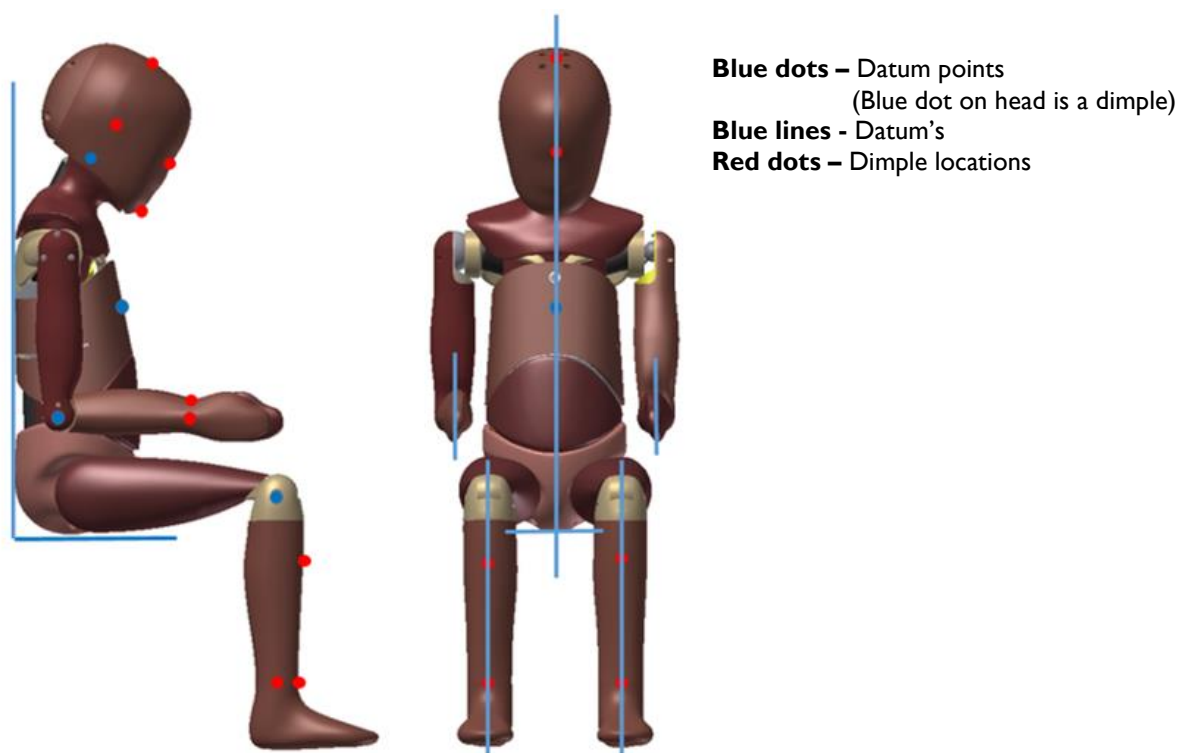


Figure 36. Marker Positions on the Dummy

Table 19. Markers Head, Origin: Occipital Condoyle

Point Description	X [mm]	Y [mm]	Z [mm]	Remark
Occipital Condoyle (OC) (Upper Neck load cell centre)	0.0	0.0	0.0	
Centre of Gravity (CoG)	10.4	0.0	-54.5	
Marker dimples OC Left and Right	0	±57.0	0	BC - Dimple
Marker dimples CoG Left and Right	10.4	±69.0	-54.5	BC - Dimple
Marker dimple CoG Top	10.4	0.0	-142.2	BC - Dimple
Marker dimple CoG Front	95.0	0.0	-54.5	BC - Dimple
Marker dimple Chin	80.4	0.0	38.4	BC – Dimple

Table 20. Markers Torso, Origin: Erected seating, Seat back (cable guide), bottom of pelvis flesh- and Mid-sagittal-plane

Point Description	X [mm]	Y [mm]	Z [mm]	Remark
Ball centres Shoulder joints	63.0	(±125.7)	(-357.0)	
Screw head recess IRTRACC to rib attachment (frontal)	(122.0)	0.0	(-328.4)	BC – Hex 3 mm
Screw head recess IRTRACC to rib attachment (lateral)	(62.9)	(±78.0)	(-262.3)	BC – Hex 3 mm
Ball centres Hip joints	77.4	± 53.1	-48.9	

Table 21. Markers Arms, Origin: Elbow joint centre, Upper arm bone vertical, lower arm bone horizontal

Point Description	X [mm]	Y [mm]	Z [mm]	Remark
Screw head recess of Top screw of shoulder joint	0.0	-20.3	-228.0	BC - Hex 2.5 mm
Screw head recess Elbow	0.0	16.6	0.0	BC - Hex 3 mm
Ball centre Shoulder joint	0.0	-3.4	-149.0	
Marker dimple Wrist (outer)	160	16.0	0.0	BC - Dimple
Marker dimple Wrist (top)	160	0.0	-19.3	BC - Dimple

Table 22. Markers Legs, Origin: Knee joint centre, Upper leg bone horizontal, lower leg bone vertical

Point Description	X [mm]	Y [mm]	Z [mm]	Remark
Screw head recess Knee (LHS, RHS opposite)	0.0	-27	0.0	BC - Hex 4 mm
Ball centre Hip joint	-256.5	0.0	0.0	
Marker dimple Tibia (front mid tibia)	24.5	0.0	88.0	BC - Dimple
Marker dimple Ankle (front)	24.5	0.0	238.0	BC - Dimple
Marker dimple Ankle (outer)	0.0	28.6	238.0	BC - Dimple
Distance between Knee centres and Tibia centre lines				Distance 168.0 mm
Gap between Knees				Distance 102.0 mm

10. Manual Update Log

July 2009

Pg. 27, Attachment IR-TRACC 033-4402 was 033-4505.

Rev. B, June 2011

Manual changed from FTSS to Humanetics.

Rev. C, April 2012

Remove provisional note on Pg. 67

Rev. D, Jan. 2013

Update Pelvis assembly, part list and pelvis exploded view, Pg. 37 &38

Rev. E, Jan. 2014

Updated Time Interval paragraph, Pg. 45, Section 5.3

Rev. F, Mar. 2014

In section 8.5, a sentence was added under the General paragraph, that the Thorax tests should be done without the neck shield. In the Side Impact paragraph the sentence; Do not leave IR-TRACC in its frontal test position, as the side impact test can cause damage, is now in bold as a warning.

Rev. G, Jul. 2015

Page 2: Added lead material statement
Updated exploded views, was unaligned.

Rev. H, Nov. 2015

Fix reference figure errors

Rev. I, Jan. 2016

Update Lateral Impact Thorax Test, Test Procedure, Step 2, Impactor alignment;
In the Torso Section, Thorax assembly table and in the Dummy Parts List and
Recommended Spare Parts Section, Dummy Parts Table, removed part number 033-
3006; Shoulder Ball Retainer Ring, 033-3003, Quantity 2 was 1; Removed 033-3006
from Figure 7;

Dummy Parts List and Recommended Spare Parts, Dummy Parts Section & Certification,
General section, Neck Table, 033-2301 was 033-2101;

Abdomen, Construction Section, 033-5000 was 020-5000;

Suit Section, 033-8000 was 020-8000;

Rev. J, Feb. 2016

Section 2.6 Mass Distribution: Total Mass 22.95 was 22.90 and Tolerance 0.80 was
0.40;

Section 3.1 General: Added last paragraph;

Section 4.4 Torso, Thorax Parts List Table: 5000084 QTY 6 was 10, 5000002 QTY 8 was
4, Screw BHCS M5 x 16 was M5 x 8 and QTY 6 was 8, Screw BHCS M5 x 12 was M5 x 16
and QTY 5 was 4, added Screw FHCS M5 x 8 5000662 QTY 1, Screw BHCS M5 x 14
5000684 QTY 2, and Screw FHCS M4 x 16 5000447 QTY 2;

Figure 7: Q6 Thorax assembly: Added missing call out 5000447, 5000684 was
5000084, 5000662 was 5000096

Figure 9: IR-TRACC attachment hardware: 5000662 was 5000096

Side Impact IR-TRACC mounting bracket assembly table, Item No. 1, Attachment IR-
TRACC 033-4403 was 033-4402, removed IR-TRACC and updated figure and made IR-
TRACC referenced

Added Section, "Neck Shield" and figure

Section 7.3 Equipment Parts List, Part Number TE-2650 was Q.AB and TE-2650-15 was
TE-2650-9;

Section 8.2 Certification of the Neck: Frontal Neck Test, Set-Up, Step 1: Added 'with
interface plate 033-2308; Step 3: (TE-2650-15) was (TE-2650-9); Lateral Neck Test,
Set-Up, Step 1: Added 'with interface plate 033-2308. See Figure 6'; Step 3: (TE-
2650-15) was (TE-2650-9);

Section 8.5 Certification of the Thorax, Frontal Impact Thorax Test, Test Procedure, Step
1: 0.76 x 0.56 was 0.60 x 0.65, Lateral Impact Thorax Test, Test Procedure, Step 1:
0.76 x 0.56 was 0.60 x 0.65

Added Section, "Markers Location Coordinates and Relevant Dimensions" and figure

Updated Table of Contents and List of Figures; added List of Tables

Rev. K, Jun 2016

Introduction, dummy status updated.

Head levelling tool detail added

In main dimensions 305 was ± 9 now ± 7 , 366 was ± 9 now ± 5 and 299 was ± 9 now ± 5

Section 3.5 added. Previous 3.5 now 3.6

Section 4.12 (Hip insert) added

Removed provisional note on frontal neck corridors

Abdomen test weights were ± 0.05 now ± 0.025

Rev. L, Oct 2016

Section 4.1 removed head levelling TF-100-1060 tool was figure 11

Section 4.5, Assembly, added lumbar cable 'must not protrude more than 10 mm'

Section 4.6, Legs, in Notes, added hip inserts can be locked for out of position testing

Section 4.12 added weight to hip insert

Section 7.2, below figure 24, total head form mass includes instrumentation, but not loadcell

Section 7.3, equipment list table, added part TE-2650-Q6KIT

Section 8.5, Lateral Impact Thorax Test, revised text; Added figure for impact location, roll down suit and approx. to Teflon sheet dimensions; Removed "between 40 and 60°" for leg stability, 2° for impactor alignment and bullet point "make sure dummy is motionless"; Rewrote impact alignment section removing if does not pass move probe forward 10 mm up to 30 mm in 10 mm steps to reduce force and rearward 10 mm to increase force; Removed ± 12 vertical probe adjustment.

Rev. M Nov 2016

033-2308 neck interface plate was 020-2015 in parts tables and instrumentation text. Thorax figure also revised for 033-2308.

4.12 prototype removed for hip insert, will be incorporated in regulation R129

In thorax certification section added ATPS and hip insert must not be fitted.