Q0 (6 week old, Newborn)
User Manual

Figure 1: Q0 dummy

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Section 1. Introduction

1.1 Introduction

In the late 1970's and early 1980's, 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 with 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 of the Q-dummies has taken place within the European Research programs CREST[1], CHILD[2] and EPOCh[3] that aimed at improving child safety in cars.
As of September 2004 the series is available in five age groups, representing a Newborn, 1 year, 1½ year, 3 year and 6 year old child. In 2004 a major update of the Q-dummy series was performed resulting in the completion of the series from Q0 till Q6. In 2010 the prototype Q10 that completes the Q-family became available.

Figure 2. Q-dummy family (left to right Q0, Q1, Q1.5, Q3, Q6 and Q10)

The Q series dummies are available in the following age groups: Newborn, 1 year, 1 ½ year, 3 year, 6 year and 10 year old child. The Q3s is a side impact only adaptation of the Q3 dummy designed to complement the Part 572 Subpart P, Hybrid III 3 year old child dummy. A Q6s dummy is also available.
The European Enhanced Vehicle-safety Committee (EEVC Working Group 12 and 18) has performed an extensive evaluation program of the Q-series in 2004; a full report on a recommendation for use of the dummies in ECE-44 test was published in April 2008 [i]. In this report background information on the development the Q-series can be found.
In 2006 the New Programme for the Assessment of Child-restraint Systems (NPACS) adopted the Q dummies for their test protocols. Moreover a GRSP Informal Group is since 2008 preparing new regulations for Child Restraint System testing that applies the Q-dummies at anthropomorphic test devices.

This manual describes the Q0 and provides guidelines for its application in crash tests.

Humanetics controls the configuration of the Q-dummies in close contact with dummy user groups and regulatory bodies like EuroNCAP and UNECE-GRSP. Since spring 2004 the design of the Q-dummies was frozen and no changes, that affect the dummy performance or interchangeability of parts, were implemented.

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[1] CREST : "Child Restraint System for Cars", EC-contract number C-RTD SMT4-CT95-2019. 1996-2000.
[2] CHILD : "Child Injury Led Design", EC contract number G3RD-CT2002-00791. 2002-2006.
[3] EPOCh : "Enabling Protection for Older Children" EC contract number SCP7-GA-2008-218744. 2009-2012.

Section 2. General Description and Features

2.1 Development History

The Q0 newborn child dummy development started with the CHILD project in 2002. The prototype Q0 dummy became available for evaluation testing in the CHILD-project in 2003. Results of the first evaluations have been published and the 19th Enhanced Safety of Vehicles conference in 2005 [[ii]]. In 2004 the design was frozen, since then the dummy is commercially available. The current Standard Build Level (SBL) is A from this date.

2.2 Applications

The Q0 dummy (see Figure 1) is designed as a tool to evaluate the protection offered to newborn children and babies by an appropriate child restraint used in cars as specified in the restraint manual in frontal, rear and side impact and rollover crash conditions. The dummy design is suitable for use in the standard EuroNCAP and UNECE Regulation R129 child restraint evaluation test procedures. In UNECE R44 the P0 dummy was only specified, however Q0 can also be used in R44 since 12 May 2017 as production of P0 has been stopped. See link below.

This dummy allows a qualitative assessment of the protection in terms of remaining in the child restraint as well as not exceeding certain specified space envelops. The Q0 dummy enables besides the qualitative aspect also a quantitative assessment of the safety through the data obtained by the built in instrumentation. The measurement capabilities of the Q0 dummy make it suitable for application in accident scenario research. Moreover the Q0 dummy can be applied in forensic research such as baby-shake and drop incidents.

http://www.unece.org/fileadmin/DAM/trans/doc/2017/wp29grsp/ECE-TRANS-WP.29-GRSP-2017-14e.pdf

2.3 Features

- The Q-dummies have improved biofidelity over the P-series. Biomechanical information from children and scaled adult biomechanical response curves have been used to define the dummy response. The anthropometry of the dummy is based on CANDAT.
- The dummies can be equipped with accelerometers and a load cell. 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 with the use of metric hex keys.

Head

The head is largely made from polyurethane synthetics. The head cavity is large enough to allow use of several instruments, including linear accelerometers and an upper neck load cell (six channels).

Neck

The neck is flexible and allows shear and bending in all directions. The segmented design prevents buckling and allows realistic rotational behavior. The neck is fitted with a flexible stainless steel wire at its core to prevent failure under high load.

Thorax

The thorax is represented integrally with the torso flesh, made of a PVC skin filled with polyurethane foam. The thoracic spine is made of hard polyurethane. In a cavity at the back, at T4 location, a three accelerometer array can be mounted. In the shoulder area a metal bracket provides attachment points for the arms.

Abdomen
The abdomen is represented integrally with the torso flesh.

Lumbar Spine
The lumbar spine is a flexible rubber column. This part identical to the neck.

Pelvis
The pelvis flesh is represented integrally with the torso flesh made of a PVC skin filled with polyurethane foam. A metal bracket mounted to the lumbar spine represents the pelvis bone structure. This provides attachment points for the legs and in a cavity at the back a three accelerometer array can be mounted.

Arms
The arms are integrally made of flexible solid polyurethane with a fixed angle between upper and lower arm. The shoulder joint allows rotation of the arm about the Y-axis.

Legs
The legs are integrally made of flexible solid polyurethane with a fixed angle between upper and lower leg. The hip joint allows rotation of the arm about the Y-axis.

Suit
The dummy is dressed in a tight-fitting neoprene suit with short sleeves and trousers

Main Dimensions and Mass Distribution
See Section 3.9.

Standard Dummy (delivery)
The standard Q0 dummy is delivered with the following items (if not ordered otherwise):

- Clothing (a yellow suit);
- Structural replacements at the upper neck load cell location;
- Mounting blocks for use of uni-axial accelerometers to customer requirements at head, thorax and pelvis location.
- Manual

2.4 Instrumentation

In this chapter the instrumentation options of the Q0 dummy are presented. First an overview of the instrumentation options is given. Subsequently the instrumentation options per body part are described.

2.4.1 Instrumentation Overview

The Q0 dummy is designed to accept 15 instrumentation channels (see also Figure 3):

- Head: Three uni-axial accelerometers in the center of gravity of the head
  Ax, Ay, Az (forward, lateral, downward)
- Neck: Upper neck load cell for three force and three moment channels
  Fx, Fy, Fz (forward, lateral, downward)
  Mx, My, Mz (RH ear down, nose up, nose right)

- Thorax: Three uni-axial accelerometers at about the T4 location
  Ax, Ay, Az (forward, lateral, downward)
- Pelvis: Three uni-axial accelerometers at about the sacrum location
  Ax, Ay, Az (forward, lateral, downward)

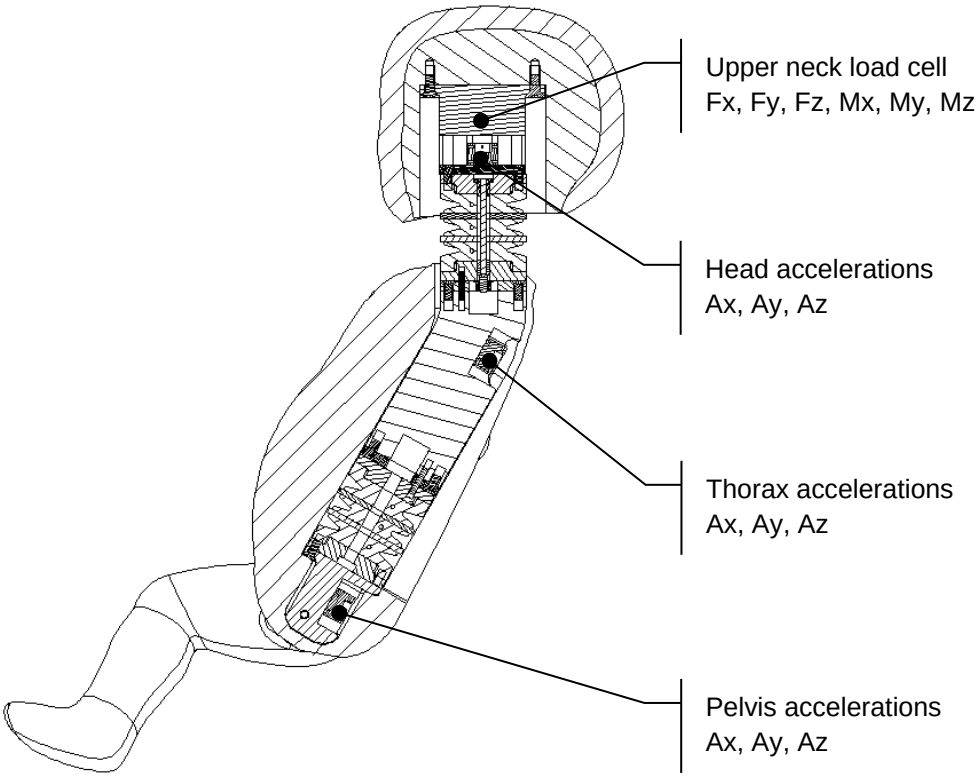


Figure 3. Q0 dummy instrumentation scheme

For all instrumentation channels a channel filter class according to ISO 6487: 2000 or SAE J211 (March 1995) is recommended.

Table 1: Uni Axial Accelerometer mounting blocks

Accelerometer Type	**Location and Mount Part No**		
	Head	Thorax	Pelvis
Endevco 7264, 7264C, Kyowa ASM-200BA, MSC 126/CM	I.AM	I.AM	I.AM
Endevco 7264A, 7264B, Entran EGAS-FS-50,	I.AD	I.AD	I.AD

2.4.2 Head

Three uni-axial accelerometers can be mounted in the accelerometer-mounting bracket located on top of the neck. The mounting bracket is equipped with a recess that can accommodate a small block with three uni-axial accelerometers. See Table 1 for appropriate accelerometers and their mounts and Figure 4 for a typical accelerometer arrangement. The I.AM mount accelerometer cables are a tighter fit than the I.AD and the seismic mass locations are slightly away from the centerline of the dummy on I.AM.
A Channel Filter Class of 1000 according to ISO 6487 or SAE J211 is recommended for the head acceleration signals.

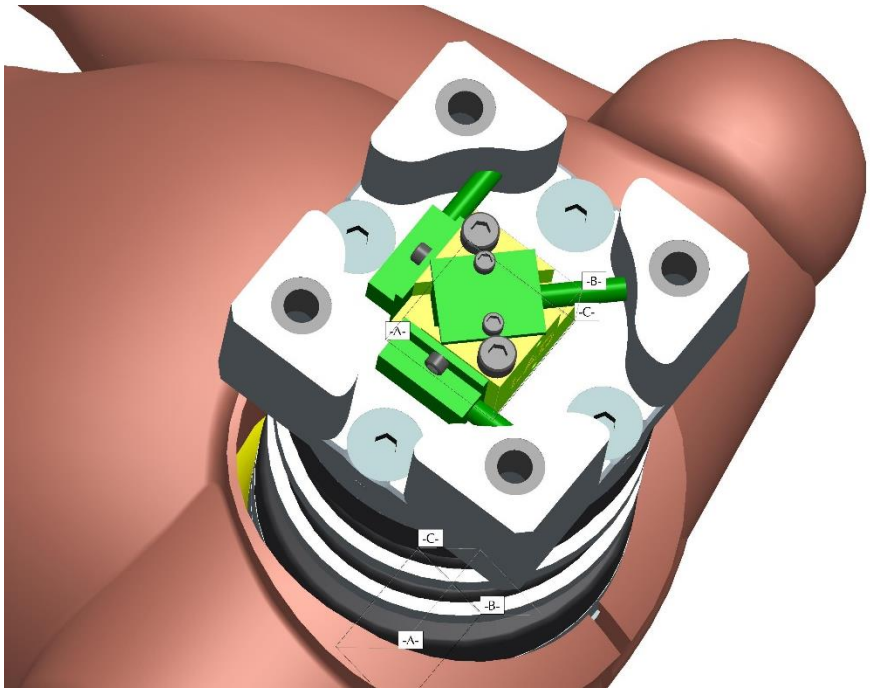


Figure 4: Q0 Head Accelerometer example Endevco 7264A/B with I.AD mount

It should be noted that the position of the accelerometers do not coincided with the center of gravity of the head. The Head CG (-6.3, 0.0, 19.0) is 6.3 mm rear and 9.5 mm above the center of the accelerometer mounting block (0.0, 0.0, 9.5). (For Head CG see green dot in Figure 55)

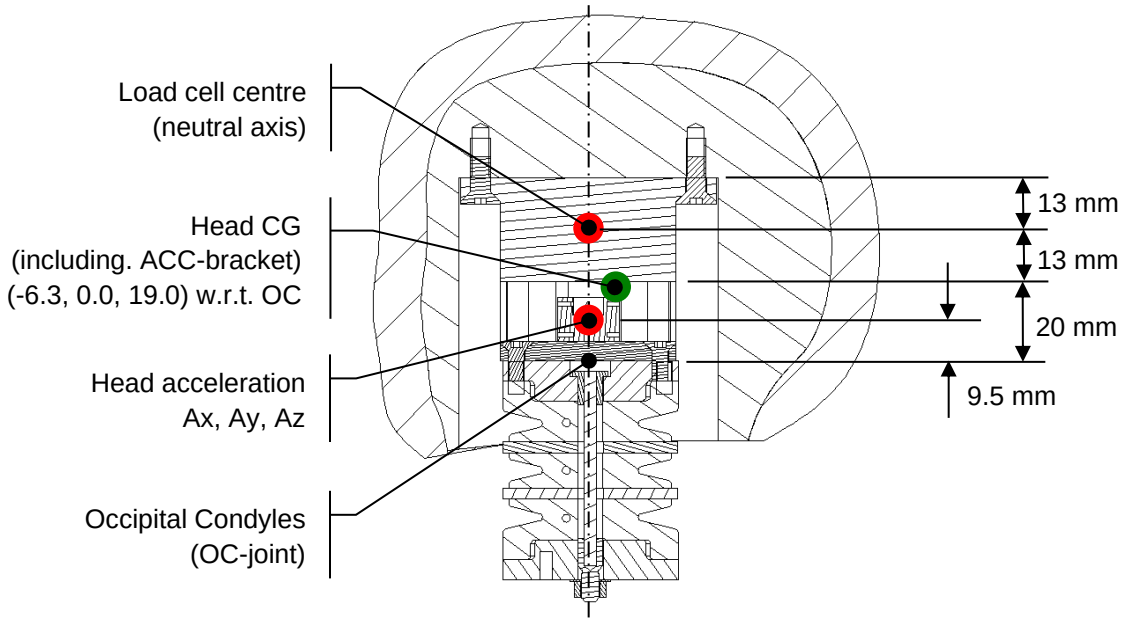


Figure 5. Q0 dummy head and neck instrumentation location

2.4.3 Neck

The head-neck interface is equipped with a 6-axis upper neck load cell. The load cell used in Q0 is identical to that of the other Q dummies except in the Q10 dummy.
The capacity specification of this load cell is

- Fx = 5 kN (1125 lbf)
- Fy = 5 kN (1125 lbf)
- Fz = 6 kN (1350 lbf)
- Mx = 150 Nm (1325 in-lbf)
- My = 150 Nm (1325 in-lbf)
- Mz = 80 Nm (700 in-lbf)

To obtain the loads and moments at the OC-joint a transformation should be applied to the values measured by the load cell (In the formulas below loads are in N and moments in Nm):

$Fx_{OC} = Fx_{LC}$
$Fy_{OC} = Fy_{LC}$
$Fz_{OC} = Fz_{LC}$
$Mx_{OC} = Mx_{LC} + 0.033 * Fy_{LC}$
$My_{OC} = My_{LC} – 0.033 * Fy_{LC}$
$Mz_{OC} = Mz_{LC}$

Appropriate load cells for this application are Denton model 3715 and FTSS IF-217 (see Figure 15). A structural replacement of the load cell is available.

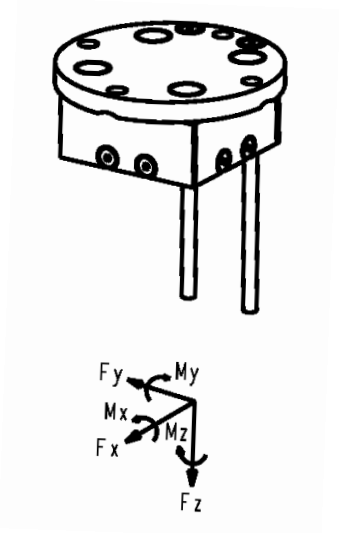


Figure 6. Child dummy load cell (IF-217) (used in Q0, Q1, Q1.5, Q3 and Q6)

2.4.4 Thorax

Three uni-axial accelerometers can be mounted in the recess at the rear side of the thoracic spine at about the T4 location (See figure 7). The recess can accommodate a small block with three uni-axial accelerometers. See Table 1 for appropriate accelerometers and their mounts and Figure 7 for a typical accelerometer arrangement. The I.AM mount accelerometer cables are a tighter fit than the I.AD and the seismic mass locations are slightly away from the centerline of the dummy on I.AM.

A Channel Filter Class of 1000 according to ISO 6487 or SAE J211 is recommended for the thorax acceleration signals.

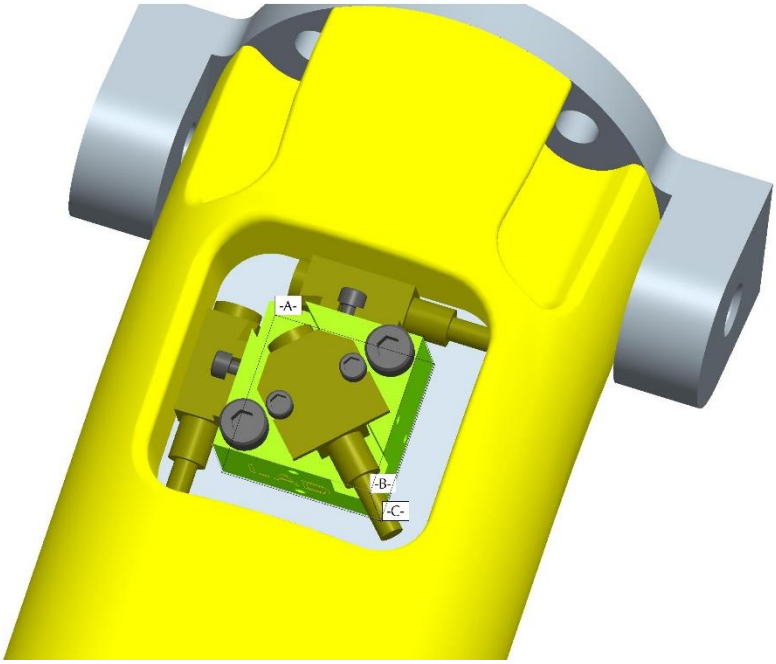


Figure 7: Q0 Thorax Accelerometer example EGAS FS-50 with I.AD mount

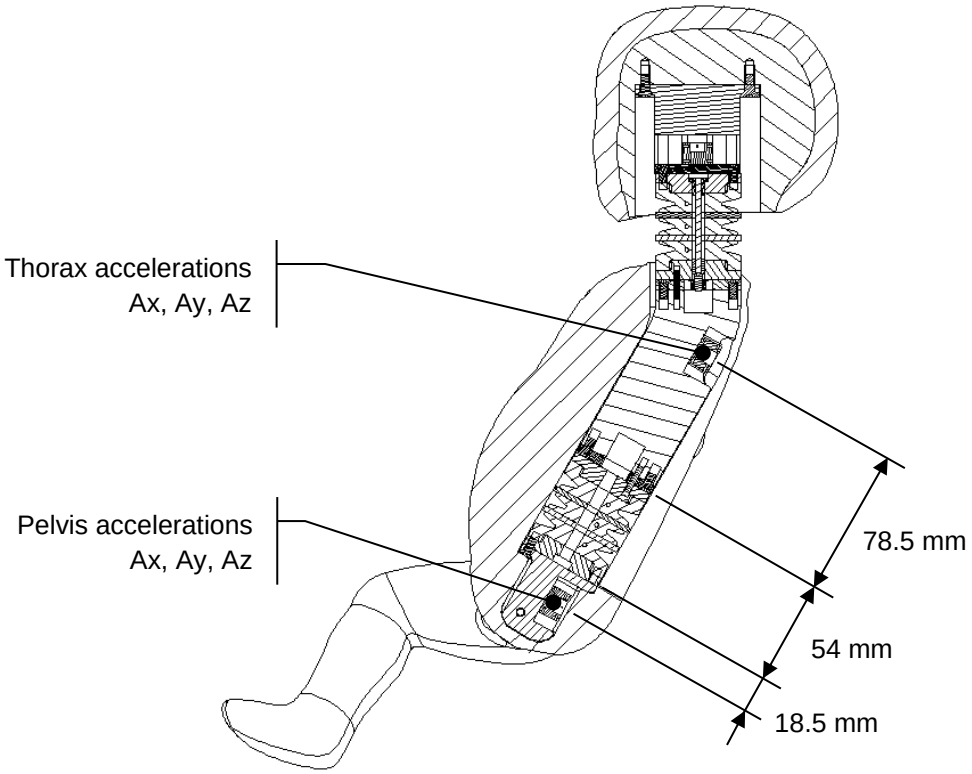


Figure 8: Q0 dummy thorax and pelvis instrumentation location

2.4.5 Pelvis

Three uni-axial accelerometers can be mounted in the recess at the rear side of the pelvis bracket at sacrum location. The recess can accommodate a small block with three uni-axial accelerometers.
See Table 1 for appropriate accelerometers and their mounts and Figure 9 for a typical accelerometer arrangement. The I.AM mount accelerometer cables are a tighter fit than the I.AD and the seismic mass locations are slightly away from the centerline of the dummy on I.AM.
A Channel Filter Class of 1000 according to ISO 6487 or SAE J211 is recommended for the pelvis acceleration signals.

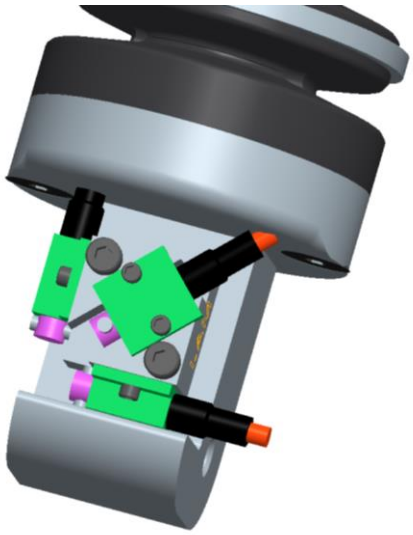


Figure 9: Q0 Pelvis Accelerometer example Endevco 7264C with I.AM mount

2.5 Tools

The Q0 child dummy is supplied without special tools for disassembly and re-assembly. The dummy can be disassembled and re-assembled with standard tools like Allen-keys (2.5, 3 and 4 mm) flat end screwdriver (width 3.5 mm) and a box-wrench (8 mm). To reach the thoracic spine to neck and the thoracic spine to lumbar spine attachment screws an Allen-key with a reduced short end can be helpful.

Section 3. Detailed Dummy Description

3.1 Detailed Dummy Description

In this chapter a description of the Q0 dummy design is given.

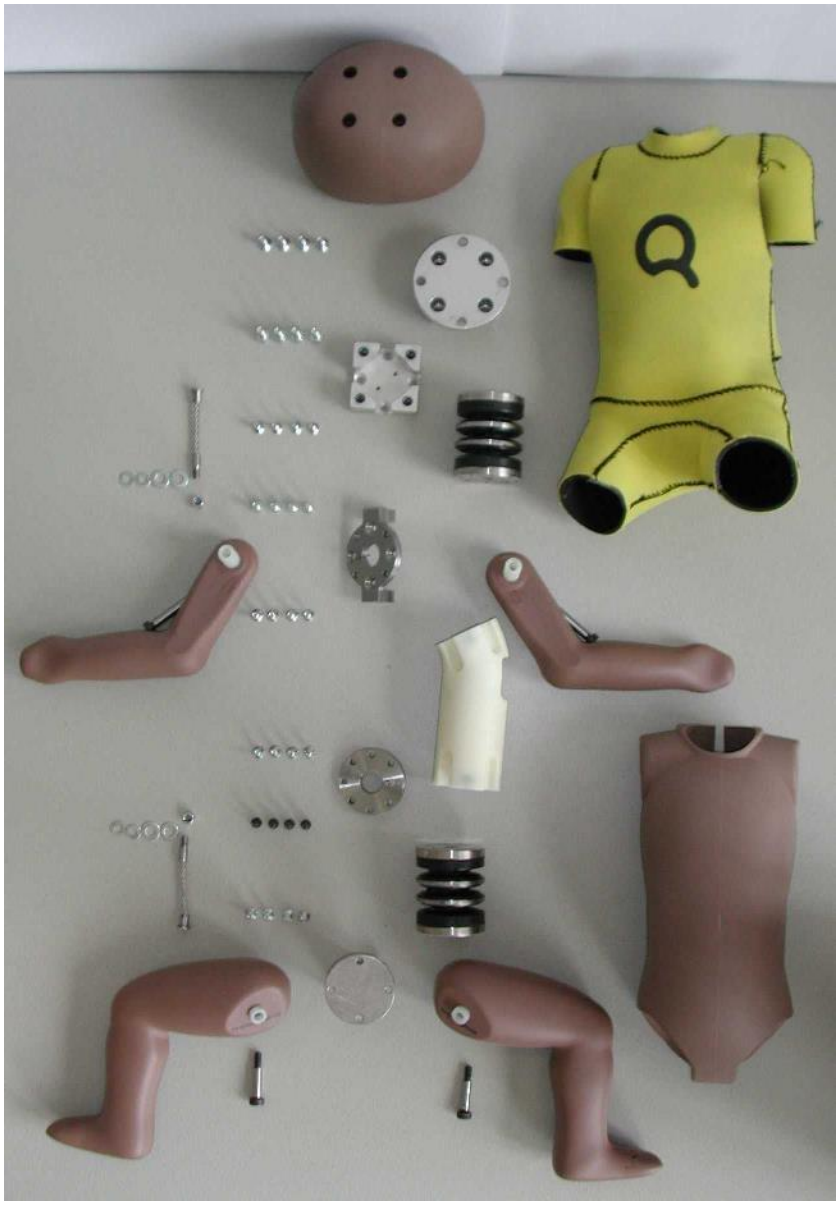


Figure 10: Q0 dummy parts

3.2 Head

The head of the Q0 dummy comprises of three parts and two sets of bolts (Figure 11):

- Polyurethane (PU) core covered with a bonded vinyl (PVC) skin.
- Upper neck load cell or load cell replacement
- Accelerometer mounting bracket.
- Four head to upper neck load cell attachment screws (countersunk screws)
- Four upper neck load cell neck to accelerometer mounting bracket attachment screw (hexagon-socket screws)

The head outer shape is suitable to accept impacts from any direction and has featureless face. In the head core a large cavity provides accommodation for the upper neck load cell and the head accelerometer-mounting bracket (see Figure 4). The upper neck load cell, the accelerometer mounting bracket and two sets of interface attachment bolts (head to load cell and load cell to accelerometer mounting) belong to the head mass.

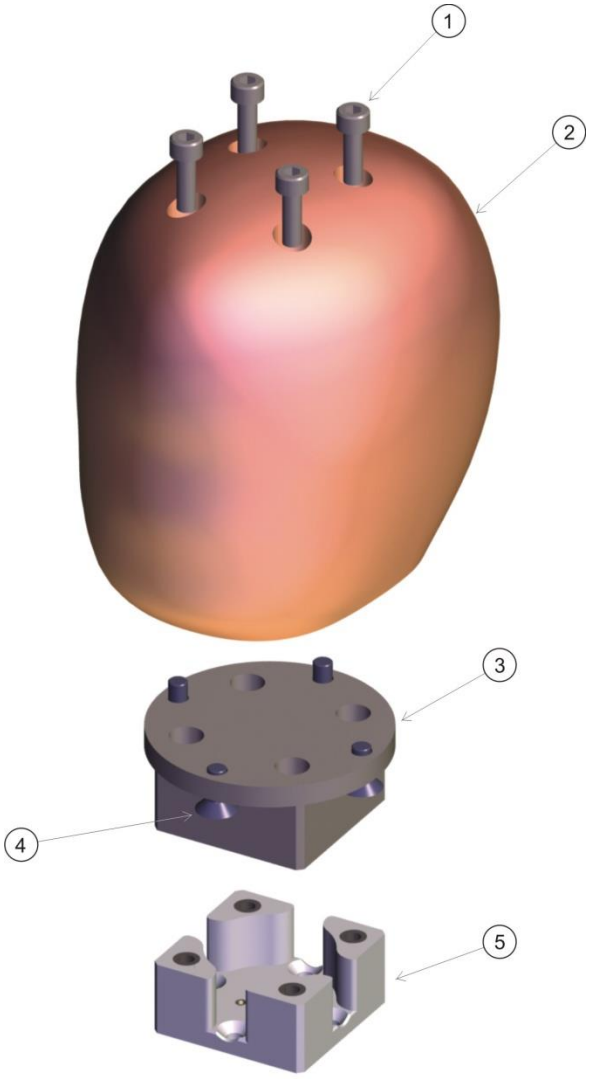


Figure 11: Q0 Head components

Table 2: Head parts list

ITEM	QTY	PART NO.	DESCRIPTION
1	4	5000020	SCREW, SHCS M5 X 0.8 X 16
2	1	047-1000	Q0 HEAD ASSEMBLY
3	1	020-2007	LOADCELL STRUCT. REPLACEMENT
4	4	5000374	SCREW, FHCS M5 X 0.8 X 12
5	1	047-2001	Q0 ACCEL MOUNT (REF)

3.3 Neck

The neck of the Q0 dummy comprises of two parts and two sets of bolts (Figure 12):

- Neck mold that includes two end plates and two intermediate disks
- Neck cable with washers and nut
- Four accelerometer mounting bracket to neck attachment screws (countersunk screws)
- Four neck to shoulder plate attachment screws (hexagon-socket screws)

The neck mold has two steel end plates with threaded holes to attach the neck to the head and the thorax and two aluminum intermediate disks. The three rubber sections in the neck are equipped with transverse holes and slits at the front side. These incisions are applied to decrease the bending stiffness of the neck in the extension (rearward) bending mode. The neck cable protects the rather fragile neck for tension loads that may be too sever in combination with extensive bending.

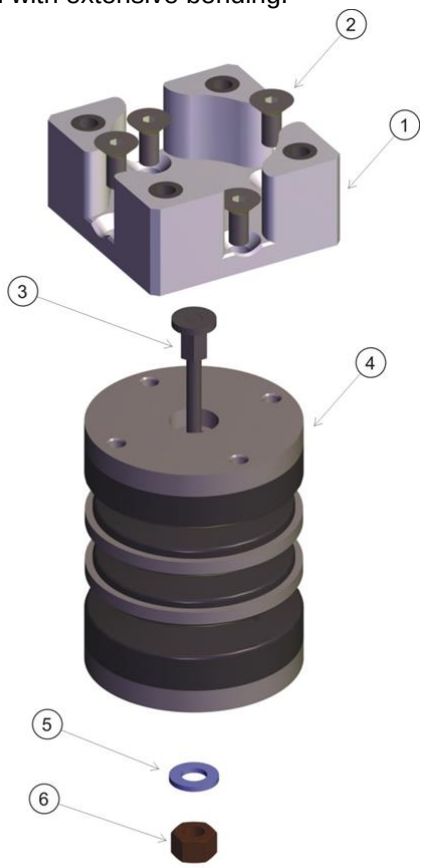


Figure 12: Q0 Neck

Table 3: Neck Parts list

ITEM	QTY	PART NO.	DESCRIPTION
1	1	047-2001	Q0 ACCEL MOUNT
2	4	5000023	SCREW, FHCS M4 X 0.8 X 10
3	1	047-2200	Q0 NECK CABLE
4	1	047-2100	Q0 NECK MOLDED
5	1	5000566	WASHER FLAT, M5
6	1	5000522	HEX NUT, NYLOK M5

3.4 Shoulder and Arms

The shoulder and arms of the Q0 dummy comprise of three parts and some bolts (Figure 13):

- shoulder bracket
- two arms (left hand and right hand one)
- two arm to shoulder attachment bolts (shoulder bolts modified)
- four shoulder to thoracic spine attachment screws (countersunk screws)

The shoulder bracket serves also as the top plate on the polyurethane thoracic spine.

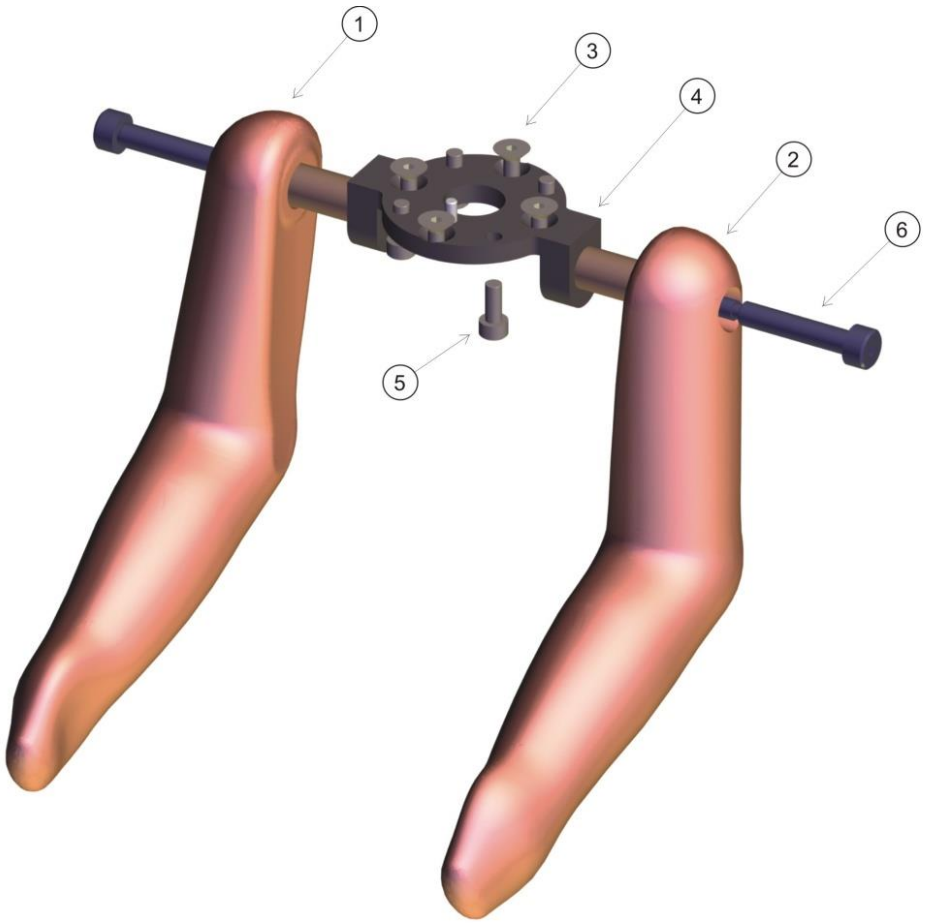


Figure 13: Q0 Shoulder and arms

Table 4: Shoulder and Arms Parts list

ITEM	QTY	PART NO.	DESCRIPTION
1	1	047-7000	Q0 RIGHT ARM
2	1	047-6000	Q0 LEFT ARM
3	4	5000023	SCREW, FHCS M4 X 10
4	1	047-3102	TORSO TOP PLATE
5	4	5000151	SCREW, SHCS M4 X 10
6	2	047-6002	SHOULDER SCREW, MODIFIED

3.5 Torso

The Q0 torso comprises of eight parts and several sets of interface attachment screws (Figure 14)

- Shoulder bracket
- Polyurethane thoracic spine (the color of this part may be black)
- Lower thoracic spine end plate
- Lumbar spine assembly (this assembly is identical to the neck, however positioned upside-down)
- Pelvis bone
- Integral torso vinyl skinned foam flesh part
- Eleven countersunk screws M4 x 10 for shoulder bracket and lower end plate to thoracic spine and for pelvis bone to lumbar spine attachment.
- Four socket head screws M4 x 10 for thoracic to lumbar spine attachment.

The polyurethane thoracic spine is equipped with recesses at the top and bottom end that allow the insertion of screws to attach the neck and lumbar spine. Recesses at the rear side of the thoracic spine and the pelvis bone allow the application of accelerometers.

The torso flesh has access at the rear side to allow the insertion of the complete spine-pelvis bone assembly.

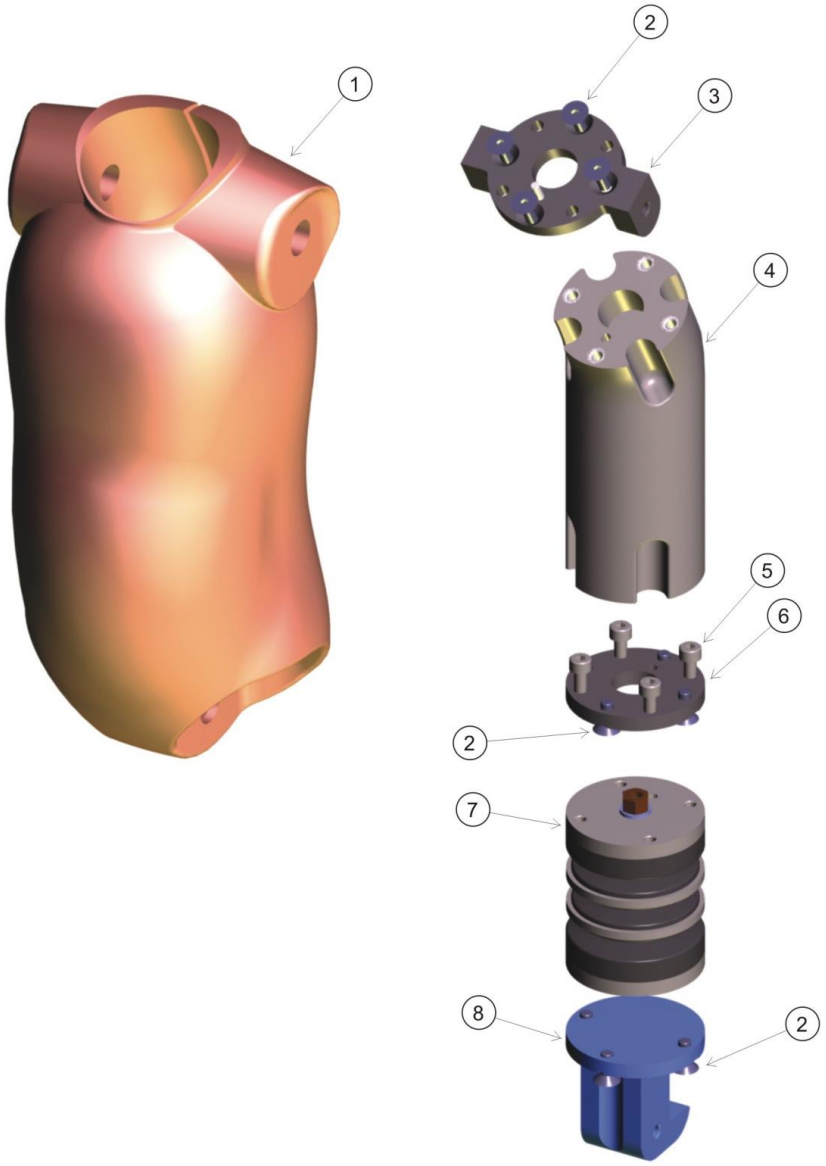


Figure 14: Q0 Torso

Table 5: Torso parts list

ITEM	QTY	PART NO.	DESCRIPTION
1	1	047-3001	Q0 TORSO FLESH
2	11	5000023	SCREW, FHCS M4 X 10
3	1	047-3102	TORSO TOP PLATE (REF)
4	1	047-3101	Q0 THORACIC SPINE
5	4	5000151	SCREW, SHCS M4 X 10
6	1	047-3103	THORACIC SPINE, BOTTOM PLATE
7	1	047-2104	Q0 NECK ASSEMBLY
8	1	047-3200	Q0 PELVIS BONE

3.6 Lumbar Spine

The lumbar spine of the Q0 dummy comprises of two parts and two sets of bolts (Figure 15):

- a lumbar spine mold that includes two end plates and two intermediate disks
- a lumbar spine cable with washers and nut
- four lower thoracic end plate to lumbar spine attachment screws (hexagon-socket screws)
- four lumbar spine to pelvis bracket attachment screws (countersunk screws)

The lumbar spine assembly is identical to the neck assembly. The lumbar spine mold has two stainless steel end plates with threaded holes to attach the lumbar spine to the thorax and the pelvis bracket and two aluminum intermediate disks. The three rubber sections in the lumbar spine are equipped with transverse holes and slits as required to decrease the bending stiffness of the neck in the extension (rearward) bending mode. The lumbar spine is mounted in the dummy with the slits at the rear side. The lumbar spine cable protects the rather fragile molded part for tension loads.

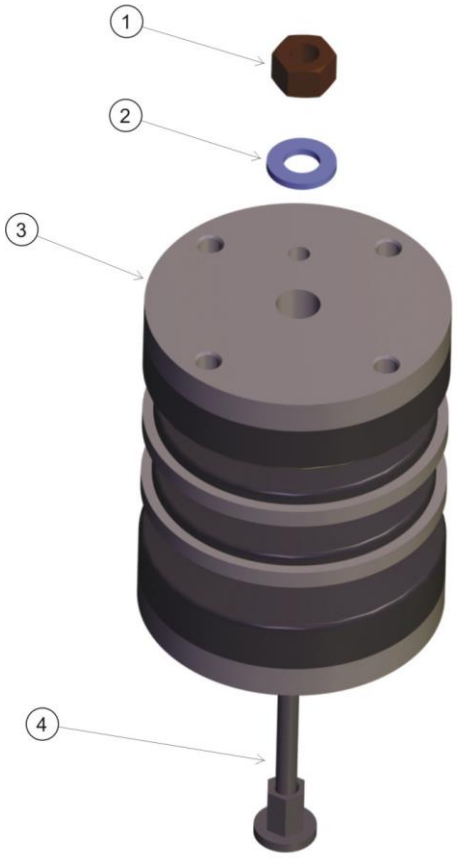


Figure 15: Q0 Lumbar Spine

Table 6: Lumbar Spine Parts list

ITEM	QTY	PART NO.	DESCRIPTION
1	1	5000522	HEX NUT, NYLOK M5
2	1	5000566	WASHER FLAT, M5
3	1	047-2100	Q0 NECK MOLDED
4	1	047-2200	Q0 NECK CABLE

3.7 Pelvis and Legs

The pelvis and legs of the Q0 dummy comprise of three parts and two bolts (Figure 16):

- Pelvis bracket
- Two legs (left hand and right hand one)
- Two pelvis to leg attachment bolts (shoulder bolts)

The pelvis bracket is equipped with a recess for pelvis accelerometers at the rear side.

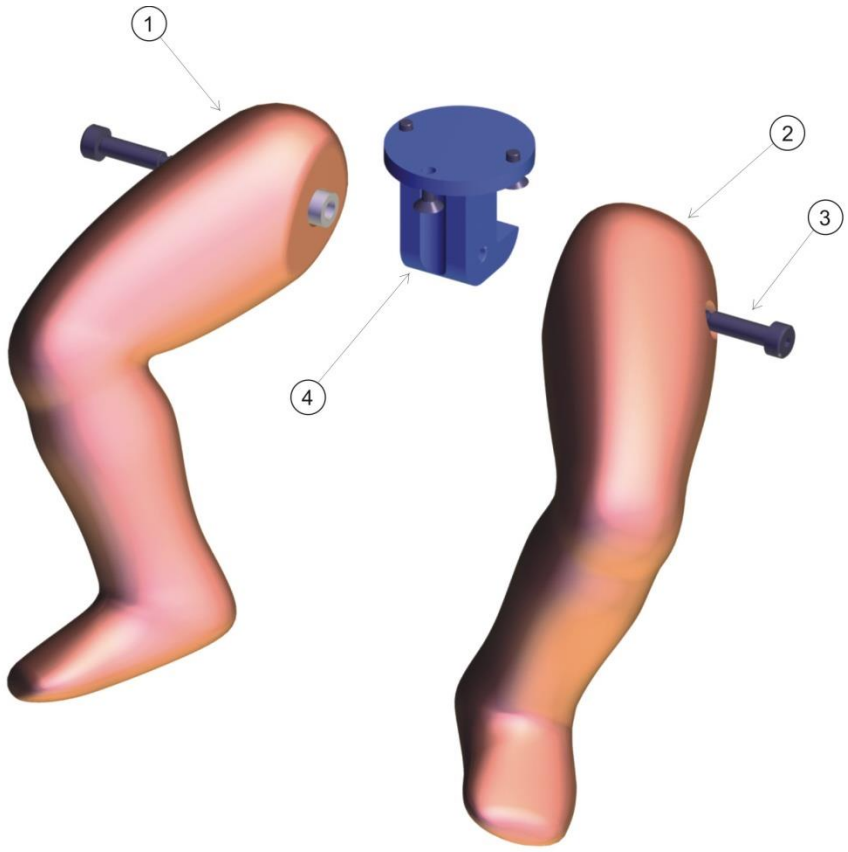


Figure 16: Q0 Pelvis and Legs

Table 7: Pelvis and Legs Parts list

ITEM	QTY	PART NO.	DESCRIPTION
1	1	047-5000	Q0 RIGHT LEG
2	1	047-4000	Q0 LEFT LEG
3	2	5000640	SCREW, SHSS M6 X 20 (REF.)
4	1	047-3200	Q0 PELVIS BONE (REF.)

3.8 Rubber Suit

The Q0 dummy is provided with a suit that covers the upper arms with short sleeves, the thorax, abdomen and pelvis and the upper legs with short sleeves (Figure 17). The suit can be opened at the back of the dummy with hook-and-loop-bands.

Figure 17: Q0 Suit

3.9 Main Dummy Characteristics

This section will describe the main Q0 dummy characteristics with regards the mass and principle dimensions. In Table 8 the masses of the main Q0 dummy components are given. A detailed description of the parts considered per component is presented and in Table 9 the principle dimensions Q0 dummy are given.

Table 8: Q0 Mass specification

Component	Mass in kg	Principle Content
Head and neck	1.130 ± 0.060	Head, upper neck load cell accelerometer mounting bracket, neck assembly and 3 sets of screws
Arms (together)	0.280 ± 0.020	Arm and shoulder screw
Torso	1.400 ± 0.080	Shoulder bracket, thoracic spine, thoracic spine end plate, lumbar spine, pelvis bracket, and 5 sets of bolts
Legs (together)	0.580 ± 0.030	Leg and shoulder screw
Suit	0.080 ± 0.020	Suit
Total	3.470 ± 0.210	(tolerance including instrumentation allowance)

Table 9: Q10 Main dimensions

Dimension	Distance in mm
Sitting height	355 ± 7
Shoulder height	255 ± 5
Shoulder width	145 ± 5
Shoulder top to elbow	100 ± 2
Elbow to hand	127 ± 2
Buttock to knee	130 ± 5
Knee to foot	112 ± 2

Section 4. Disassembly and Assembly

4.1 Introduction

The disassembly and assembly of the Q0 dummy is described in this chapter. Disassembly may be necessary in order to check, certify or repair the dummy or its parts. The parts are usually assembled in reversed order described for disassembly. Some remarks and instructions important for assembly are given.

4.2 Required Tools

The Q0 dummy is a metric design. No special tools are required for disassembly and assembly. The standard tools to be used for disassembled and assembled are:

- Allen-keys (2.5, 3.0 and 4.0 mm)
- Flat end screwdriver (width 3.5 mm)
- Box-wrench (8 mm across flats).

To reach the thoracic spine to neck and the thoracic spine to lumbar spine attachment screws an Allen-key with a reduced short end or ball-head Allen-keys can be helpful.

4.3 Fasteners List

In Table 10 the fasteners are listed. Indicated are the body part, fastener location, size and quantity.

Table 10: Fasteners List

Body Part	Location	Size	Quantity
Head	Head to upper neck load cell	M5x12 c'sunk head	4
	Upper neck load cell to accelerometer mounting bracket	M5x16 socket head	4
	Accelerometer mounting bracket to upper neck	M4x10 c'sunk head	4
Neck	Lower neck to shoulder bracket	M4x10 socket head	4
	Neck cable	M5 nut self-locking	1
Shoulder and arms	Arms to shoulder bracket	M6x30 shoulder screw	2
	Shoulder bracket to thoracic spine	M4x10 c'sunk head	4
Thorax	Thoracic spine to lower thoracic spine end plate	M4x10 c'sunk head	4
	Lower thoracic spine end plate to upper lumbar spine	M4x14 socket head	4
Lumbar spine	Lumbar spine cable	M5 nut self-locking	1
	Lower lumbar spine to pelvis bracket	M4x10 c'sunk head	3
Pelvis and legs	Legs to pelvis bracket	M6x20 shoulder screw	2

4.4 Suit

All disassembly tasks with the Q0 dummy, except the disassembly of the head, require stripping off the suit from the dummy.

1. Open the hook-and-loop-band splice in the Q0 Neoprene suit at the back.
2. Remove the suit by stripping off.

Assembly remark or instruction:
After assembly of the dummy up to and inclusive the neck to the shoulder bracket the suit can be put on. It is recommended to turn the suit inside out.

- Turn the suit inside out
- Put the trouser legs on the dummy legs with the edges up to just above the knees.
- Slip the suit trousers over the buttock of the dummy.
- Put the suit sleeves on the dummy arms with the edges up to just above the elbows.
- Slip the suit body over the shoulders.
- Rotate the arms and legs a few times 30 degrees up and down for a correct settlement of the suit on the arms and legs.

4.5 Head

To remove the head from the Q0 dummy the four M5x16 socket head screws accessible from the top of the head should be unscrewed. With these fasteners the head and upper neck load cell combination is separated from the accelerometer-mounting bracket that remains attached to the neck. To separate the upper neck load cell from the head, unscrew the four M5x16 countersunk screws that attach the load cell inside the blind recess in the head. The accelerometer-mounting bracket can be disassembled from the neck by unscrewing the four M4x10 countersunk screws.

1. Remove head and upper neck load cell from the accelerometer-mounting bracket by unscrewing the four M5x16 socket head screws accessible from the top of the head.
2. Remove the upper neck load cell from the blind cavity in the head by unscrewing the four M5x16 countersunk screws.
3. Remove the accelerometer-mounting bracket from the neck by unscrewing the four M4x10 countersunk screws.

Assembly remark or instruction:
The three interfaces described above can be mounted in four different directions each.
Caution:

- The direction of the head should be forward facing on the body.
- In case of accelerometer the accelerometer-mounting bracket should be positioned such the X- and Y-direction sensitive accelerometers are on the correct position.
- In case of load cell application the load cell direction should be such that the cable exits are at the rear side.

4.6 Neck

The neck can be separated from the dummy after the head and accelerometer-mounting bracket are removed (see section 4.5). To reach the lower neck to thoracic spine interface fasteners, the complete spine should be separated from the torso flesh foam part. This can be done when the arms and legs are removed. The neck cable can be removed from the neck molded part.

1. Remove the head from the accelerometer-mounting bracket and the accelerometer-mounting bracket from the neck as described in section 4.5.
2. Remove the arms from the torso by unscrewing the two M6x30 shoulder bolts.
3. Remove the legs from the torso by unscrewing the two M6x20 shoulder bolts.
4. Open the torso flesh part at shoulder level to release the shoulder bracket from the torso flesh foam part.
5. Remove the spine and pelvis bracket assembly from the torso flesh by carefully pulling it out of the opened torso flesh in rear-upward direction.
6. Remove the neck assembly from the shoulder bracket by unscrewing the four M4x10 socket head screws.
7. Remove the neck cable from the neck molded part by unscrewing the self-locking M5 nut at the neck lower side. (Use an 8 mm box-wrench for the nut and hold the threaded end of the spine cable with a flat end screwdriver (width 3.5 mm).

Assembly remark or instruction:
Caution:

- The neck cable should be assembled without any pretension, therefore nut is fitted with no play in the cable. If the cable is too long the use of extra washers underneath the nut is allowed to fill the gap.
- The neck assembly should be mounted with the slits in its rubber sections on the forward side. A locator pin in the shoulder bracket prevents faulty assembly of the neck on top of the shoulder bracket.

Note: The neck assembly is identical to the lumbar spine assembly the neck however is a part critical for the dummy performance, certification requirements are applicable for this part.

4.7 Shoulder and Arms

The arms can easily be removed by unscrewing the two M6x30 shoulder screws. The shoulder bracket can be separated from the dummy after the removal of the neck (see section 4.6).

1. Remove the neck (or the head neck assembly in case the head is not disassembled) from the dummy as described in section 4.6.
2. Remove the shoulder bracket from the thoracic spine by unscrewing the four M4x10 countersunk screws.

Assembly remark or instruction:
Caution:

- The shoulder bracket should be mounted with its locator pin at the forward side. The locator pin protrudes at both sides of the shoulder bracket. A hole in the thoracic spine topside prevents faulty assembly of the shoulder bracket.

Note: The topside of the thoracic spine is the bent cylindrical end.

4.8 Thorax

The thoracic spine assembly can be separated from the rest of the spine after removal of the shoulder bracket (see section 4.7) and removal of the lumbar spine. The lower thoracic spine end plate can be removed from the thoracic spine by unscrewing the four M4x10 countersunk screws.

1. Remove the shoulder bracket from the thoracic spine as described in section 4.7.
2. Remove the thoracic spine assembly from the lumbar spine by unscrewing the four M4x10 socket head screws.
3. Remove the lower thoracic spine end plate from the thoracic spine by unscrewing the four M4x10 countersunk screws.

Assembly remark or instruction:
Caution:

- The thoracic spine end plate should be mounted with its locator pin at the rear side. The locator pin protrudes at both sides of the thoracic spine end plate. A hole in the thoracic spine bottom side prevents faulty assembly of the thoracic spine end plate.

Note: The bottom side of the thoracic spine is the straight cylindrical end.

4.9 Lumbar Spine

The lumbar spine assembly can be separated from the dummy after the thoracic spine assembly is removed (see section 4.8). The lumbar spine cable can be removed from the lumbar spine molded part.

1. Remove the thoracic spine assembly as described in section 4.8.
2. Remove the lumbar spine assembly from the pelvis bracket by unscrewing the three M4x10 countersunk screws.
3. Remove the lumbar spine cable from the lumbar spine molded part by unscrewing the self-locking M5 nut at the neck lower side. (Use an 8 mm box -wrench for the nut and hold the threaded end of the spine cable with a flat end screwdriver (width 3.5 mm).

Assembly remark or instruction:

Caution:

- The lumbar spine cable should be assembled without any pretension, therefore nut is fitted with no play in the cable. If the cable is too long the use of extra washers underneath the nut is allowed to fill the gap.
- The lumbar spine should be mounted with the slits in its rubber sections on the rear side. A locator pin in the thoracic spine end plate prevents faulty assembly of the lumbar spine on the lower thoracic end plate.

Note: The lumbar spine assembly is identical to the neck assembly the lumbar spine however, is not a part critical for the dummy performance, no certification requirements are applicable for this part.

4.10 Pelvis and Legs

The legs can easily be removed by unscrewing the two M5x30 shoulder screws. The pelvis bracket can be separated from the dummy after the removal of the complete spine from the torso flesh foam part.

1. Remove the legs from the torso by unscrewing the two M6x20 shoulder bolts.
2. Remove the arms from the torso by unscrewing the two M6x30 shoulder bolts.
3. Open the torso flesh part at shoulder level to release the shoulder bracket from the torso flesh foam part.
4. Remove the neck, shoulder bracket, thoracic spine, lumbar spine and pelvis bracket assembly from the torso flesh foam part by carefully pulling it out of the opened torso flesh foam in rear-upward direction.
5. Remove the pelvis bracket from the lumbar spine assembly by unscrewing the three M4x10 countersunk screws.

Assembly remark or instruction:

Caution:

- The pelvis bracket should be mounted with its accelerometer cavity to the rear side.
- If the pelvis bracket is not correctly mounted the legs will not fit properly

Note: The slits in the rubber sections of the lumbar spine are at the rear side.

Section 5. Certification and Calibration

5.1 Introduction

The certification procedures to verify the performance of the Q0 dummy are based on the use of standard Part 572 equipment [iii].

Depending on the side to be impacted, dummy parts should be certified for frontal, rear or left hand or right hand side impact. It is recommended to verify the Q0 dummy performance for all direction each time a certification is desired or required.

The certification tests on the Q0 dummy deal only with head and neck.

- **Head:** a free-fall drop test with the front and sides of the head impacting a flat rigid surface. Equipment needed is a Part 572 subpart E drop table;

- **Neck:** tests with a Part 572 subpart E neck pendulum using the Q0 child head form and ES-2 interface, causing lateral flexion, as well as rotation and translation of the neck top interface;

Note: As the lumbar spine is identical to the neck. The performance of the part can be verified in the same way as the neck. However there are no performance requirements applicable for the lumbar spine.

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:

- Temperature of 20 ± 2 degrees Celsius.
- Relative humidity of 40 ± 30%.

5.2 Certification Equipment

The certification equipment required for the performance verification of the Q0 dummy is given below. A detailed description of the application of the equipment is given in the section that deals with the procedure.

Head Drop Test

For the free-fall head drop test a support and release mechanism, as well as a rigid, flat impact surface is necessary. The release mechanism and impact surface can be similar to that of the Standard Part 572 subpart E head drop test [iii]. The Q0 head is suspended to the release mechanism with a simple rope harness. No special dummy-dedicated equipment is required for the Q0 head certification.

Neck Bending Tests

For the neck and lumbar spine tests, a pendulum is required similar to the Standard Part 572 subpart E, neck-bending pendulum [iii]. The pendulum is decelerated by 6 inch aluminum honeycomb (density 28.8 kg/m^3 (1.8 lb/ft^3)).

List of special equipment:

- Q3 neck pendulum mounting base TE2650-1
- Q0 head form 047-9930

5.3 Head

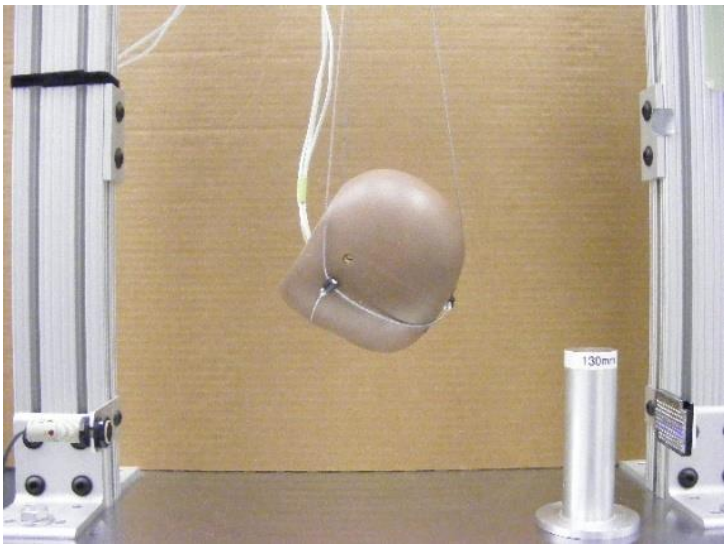
Introduction
The head should be visually inspected for damage to the skin or core. No tears or cracks in the skin and skull are allowed.

Test set-up
This test has to be conducted using the complete head assembly. The head consisting of the head, the upper neck load cell structural replacement and the accelerometer-mounting bracket (see Figure 11). The head has to be instrumented with three uni-axial accelerometers mounted on an accelerometer-mounting block located on the accelerometer-mounting bracket.

Accelerations are to be filtered using ISO 6487 or SAE J211 Channel Filter Class 1000.

The head must be positioned with a130 ± 1 mm spacing above a flat, rigid impact surface, as described in Part 572 subpart E (surface finish between 8 and 80 micro-inches). The impact surface must be horizontal.

A 'quick release' mechanism is required to drop the head on the impact surface. The Q0 head is suspended to the release mechanism with a simple harness. No special dummy-dedicated equipment is required for the Q0 head certification. In Figure 18 the head drop test set-up and the head suspension harness is shown.



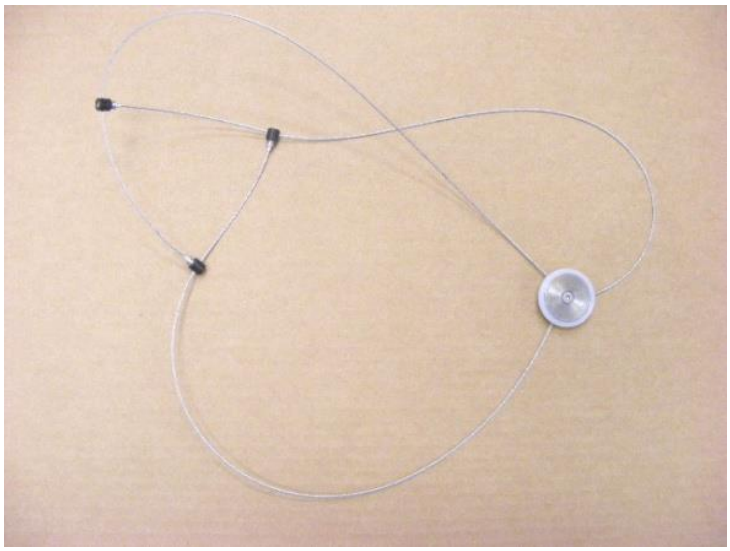


Figure 18: Left: Head drop test set-up
Right: Q0 head in harness oriented for frontal impact

Test performance

The following steps have to be made to certify the head:

1. Inspect the head on possible damage.
2. Attach the Upper neck load cell (replacement) in the head with four M4x10 countersunk screws.
3. Equip the Head accelerometer bracket with three uni-axial accelerometers Ax, Ay and Az mounted on an appropriate mounting block
4. Attach the Head accelerometer bracket to the lower side of the load cell with four M5x16 screws
5. Suspend the head in the harness so that the head is in desired impact test mode
    a. **Frontal impact:** The head has to be oriented such that the forehead is impacted. The angle between the head left to right plane (YZ-plane) and the impact surface shall be 28° ± 1°. The mid-sagittal plane of the head shall be vertical ± 1° (see Figure 18 left).
    b. **Lateral impact:** The head has to be oriented such that its mid-sagittal plane has an angle of 35° ± 1° with the impact surface. The head left to right plane (YZ-plane) shall be vertical ± 1° (see Figure 18 right).
6. Lift the head so that the drop height (gap between head and impact surface) is 130 ± 1 mm.
7. Release the head for impact.

Data Processing

1. Filter the acceleration signals at CFC1000.
2. Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.
3. Determine the resultant acceleration.

Requirements

Three tests are to be performed one frontal impact and two lateral impacts, one at each side.

1. The drop height (gap between the head and the impact surface) shall be 130 ± 1 mm

The head passes the tests when the test results are within the corridors specified below:

Frontal impact

1. Peak resultant head acceleration is between 101.7 g and 124.3 g
2. Peak lateral head acceleration (Ay) is between -10 and 10 g

Lateral impact (Left and Right)

1. Peak resultant head acceleration is between 109.8 g and 134.2 g
2. Peak frontal head acceleration (Ax) is between -20 and 20 g

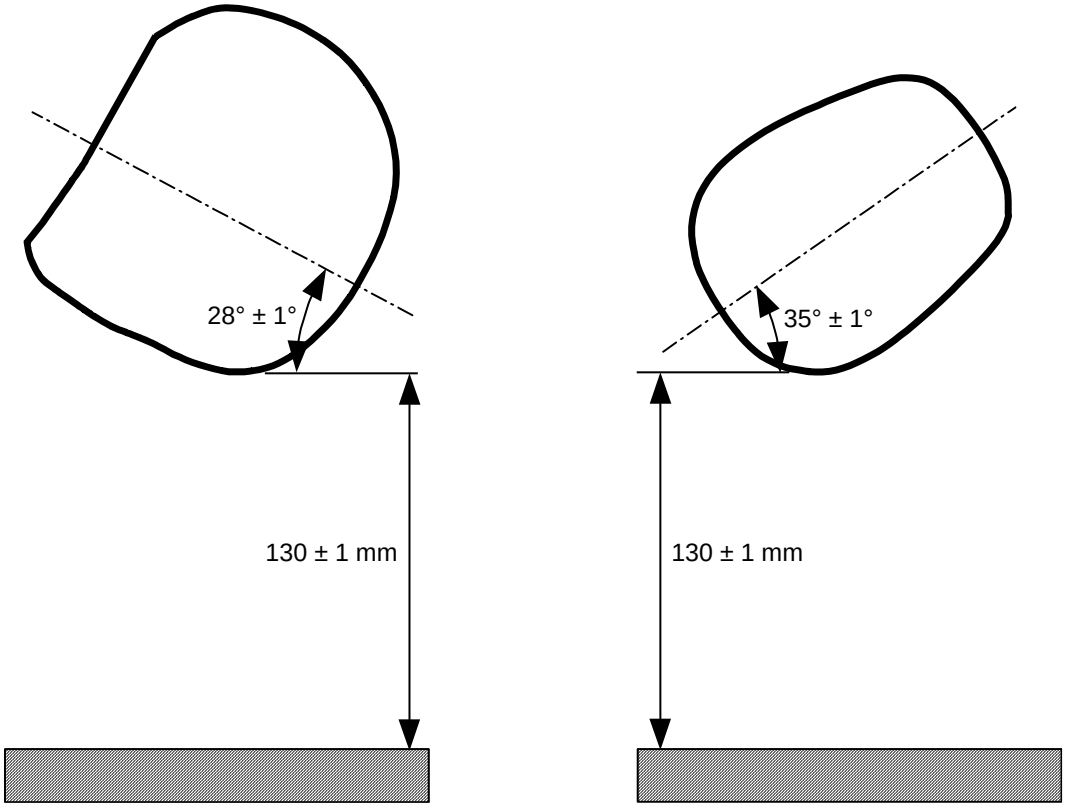


Figure 19: Q0 head drop tests Left: Frontal test Right: Lateral test

5.4 Neck

Introduction
The neck should be visually inspected for damage to the rubber. No tears or cracks in the rubber are allowed.

Test set-up
The Q0 head form is developed to replace the head in the test set up for neck certification. In Figure 20 the Q0 neck test set up mounted on the neck pendulum arm is shown.

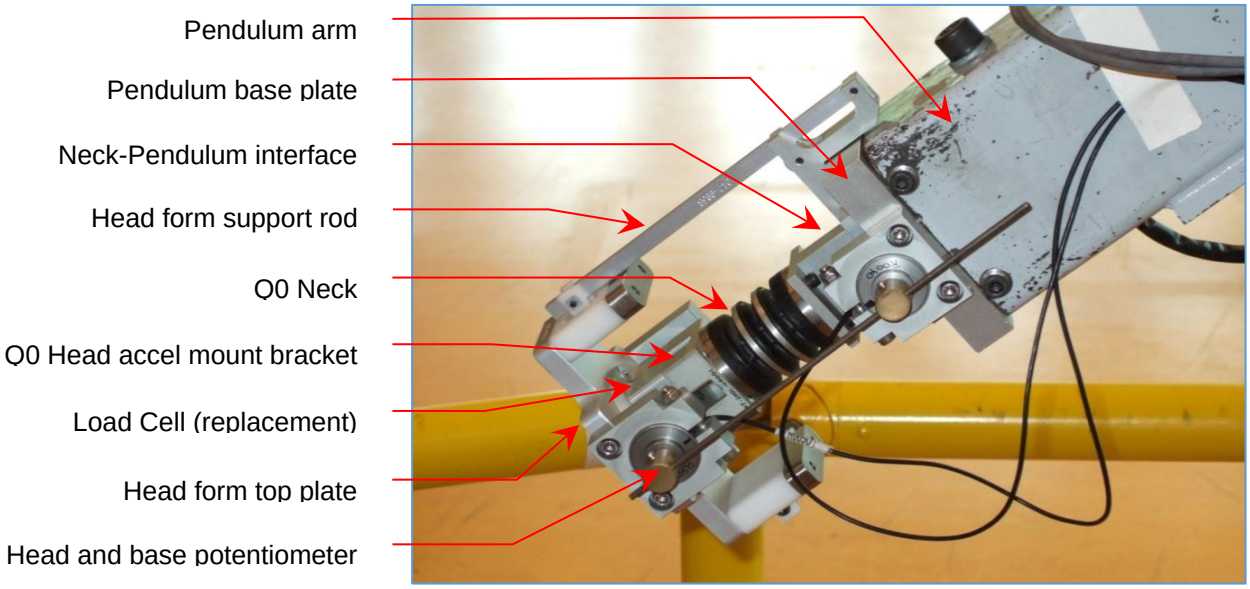


Figure 20: Q0 Neck certification set-up with Q0 head form (047-9930)

Four tests are to be performed in three test modes: flexion (forward bending), extension (rearward bending) and lateral flexion left and right (sideward bending). These tests have to be conducted using the complete neck assembly. The neck consisting of the neck molded rubber part with a neck cable mounted with a washer and a M5 self-locking nut (see Figure 12). The neck cable should not be torqued, but mounted with zero play. If necessary the use of extra washers under the nut, to fill the gap, is allowed.

Test Performance

The following steps have to be made to certify the neck:

1. Inspect the neck on possible damage and on zero play for the neck cable.
2. Attach the Neck-Pendulum interface to the standard Q3 pendulum base (TE2650-1) with four M5 x16 socket head screws.
3. Attach the base potentiometer to the pendulum base with two M5x16 socket head screws.
4. Mount the neck in the head form in the appropriate direction for the desired test mode
   Flexion : Neck slits at the front
   Extension : Neck slits at the back
   Lateral flexion : Neck slits at the side
   a. Attach the Q0 head accelerometer mounting bracket to the flat neck top plate with four M4x10 countersunk screws.
   b. Attach the neck-head accelerometer bracket combination with the neck bottom plate (with protruding M5 nut) to the Neck-Pendulum interface with four M4x10 socket head screws.
   c. Attach the head form (including load cell (replacement)) to the head accelerometer bracket with four M5x16 socket head screws
5. Install the shaft between the potentiometers
6. Engage the head form support rod with the plastic fork on the head form. Adjust the clamping of support rod in the fork with the M3x20 socket head screw through the fork so that the friction holds the head form during the lifting of the pendulum arm.
7. Adjust the support rod (engaged with the fork) with help of the eccentric wheel, so that the neck is in straight (un-deformed) position.

(The neck will remain in the straight condition during the after pendulum release, up to the moment that the head form becomes free from the support rod upon initiation of the pendulum deceleration.)

8. To stop the pendulum, attach honeycomb material to the pendulum anvil. Use 152.4 mm (6 inch) thick aluminum Hexcel density 28.8 Kg/m^3 (1.8 lb/ft^3) with a number of cells appropriate to meet the pulse requirement in Table 11.
9. Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.
10. Lift the pendulum up to its desired pre-test height
11. Double check if the head form support rod is still engaged with the plastic fork. Do not leave the head-neck system in this position for more than 1 minute, as the neck will start to deform due to the mass-gravity loading of the head form.
12. 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 test speed should be between 3.1 and 3.3 m/s for all three test modes
2. The pendulum velocity decrease should be as specified in the table below

Table 11: Q0 Neck pendulum deceleration specification in terms of velocity change corridor

Time (ms)	Lower Limit (m/s)	Upper Limit (m/s)
10	1.1	1.4
20	2.3	2.8
30	3.3	3.7

The neck passes the tests when the test results are within the corridors specified below:

Flexion

1. Maximum D-plane rotation should be between 62.65 and 76.50 degrees
2. Time of Max. D-plane rotation should be between 46.75 and 57.15 ms

Extension

1. Maximum D-plane rotation should be between 64.80 and 79.20 degrees
2. Time of Max. D-plane rotation should be between 46.90 and 57.30 ms

Lateral Flexion (Left and Right)

1. Maximum D-plane rotation should be between 59.90 and 73.20 degrees
2. Time of Max. D-plane rotation should be between 45.45 and 55.55 ms

5.5 Lumbar Spine

The Q0 dummy lumbar spine is identical to the neck. The performance of the part can be verified in the same way as the neck (see section 5.4). However there are no performance requirements applicable for the lumbar spine.

It is recommended to certify the lumbar spine in according to the same procedure as used for the neck. In case the lumbar spine certification is skipped it is recommended to clearly label the lumbar spine with: "NOT CERTIFIED".

Section 6. Handling Procedures and Application

6.1 Introduction

The handling procedure for the Q0 dummy and its endorsed application are presented in this chapter.

6.2 Handling Procedures

The Q0 dummy design is robust and does not require special handling procedures. It is recommended to avoid impact contact with rigid sharp edges that may result in damage to the skin and the underlying structure. Prior to a test the Q0 dummy should be kept in the test room for a period of at least four hours prior to a test at a temperature between 18°C and 22°C and humidity of 10 to 70%.

6.3 Storage of Q0 Dummy

When storing the Q0 dummy between tests, or between a test and certification or vice versa it is recommended to lay the dummy on its back.

To avoid accelerated aging of dummy materials the dummy should be kept out of direct sunlight when storing. Storage temperature should be between 10˚ and 30˚ C. Further it is advisable to make sure that the humidity of the storage environment does not exceed 70%. To reduce the risk of corrosion, avoid direct contact of the dummy parts with water.

6.4 Application in Impact Tests

The Q0 dummy is designed as a tool to evaluate the protection offered to new-born children and babies by an appropriate child restraints used in cars as specified in the restraint manual in frontal, rear and side impact and rollover crash conditions. The dummy design is suitable for use in the standard EuroNCAP and ECE R44 child restraint evaluation test procedures. In the current evaluation test procedures the P0 dummy is specified. The P0 dummy allows only a qualitative assessment of the protection in terms of remaining of the dummy in the child restraint as well as not exceeding certain specified space envelops. The Q0 dummy enables besides the qualitative aspect also a quantitative assessment of the safety through the data obtained by the built in instrumentation. The measurement capabilities of the Q0 dummy make it suitable for application in accident scenario and forensic research.

6.5 Disclaimer

The decision to expose the dummy to certain crash scenarios will be the user’s responsibility. Humanetics does not accept any responsibility for damage due to application of the Q0 dummy beyond its design limits.

References

[i] Q-dummies Report - Advanced Child Dummies and Injury Criteria for Frontal Impact, EEVC WG12 and 18 report, EEVC Document Number 514, dated February 12, 2008 (published April 2008).

[ii] ASSESSING NEW CHILD DUMMIES AND CRITERIA FOR CHILD OCCUPANT PROTECTION IN FRONTAL IMPACT, Kate de Jager, Michiel van Ratingen, TNO Science and Industry, Philippe Lesire, Hervé Guillemot, LAB (France), Claus Pastor, Britta Schnottale, BASt (Germany), Gonçal Tejera, Applus+IDIADA (Spain) Jean-Philippe Lepretre, UTAC (France). Paper no. 05-0157.

[iii] American Code of Federal Regulation 49 CFR Chapter V Part 572 (10-1-00 Edition)

Manual Update Record

Rev. A, June 2006	Draft manual for application of prototype in CHILD project
Rev. B, June 2011	Draft manual changed from FTSS to Humanetics
Rev. C, Oct. 2013	Complete update
Rev. D, Jul. 2015	Page 2: Added lead material statement
Rev. E, Feb. 2016	Section 3.9, Table 8: Head and neck Mass: ± 0.060 was ± 0.056; Arm Mass ± 0.020 was 0.014; Torso Mass: 1.400 ± 0.80 was 1.480 ± 0.075, removed 'suit' from Principle Component; Added row, Suit, Mass 0.080 ± 0.020; Total Mass 3.470 ± 0.210 was 3.470 ± 0.175
Rev. F, Jul. 2017	Section 5.4, Neck, Flexion, #1, 76.50 was 72.50; In 2.1, SBL A level added; In 2.2, the use of Q0 in R44 added along with link to R44 regulation change document. Wording is 2.2, also updated for use in R129; In 5.3 head drop wording was corrected to ±1 was ±0.5.