Procedures for Assembly, Disassembly, and Inspection (PADI) of the Q3s Child Side Impact Crash Test Dummy

JANUARY 2021

Vehicle Research and Test Center
National Highway Traffic Safety Administration

Table of Contents

List of Tables

List of Figures

1 INTRODUCTION

The National Highway Traffic Safety Administration (NHTSA) has prepared this document under the title "Procedures for Assembly, Disassembly and Inspection of the Q3s Child Side Impact Crash Test Dummy," otherwise known as "PADI for the Q3s". The Q3s dummy is designed for use in side impacts. Photographs of the Q3s are shown in Figure 1.

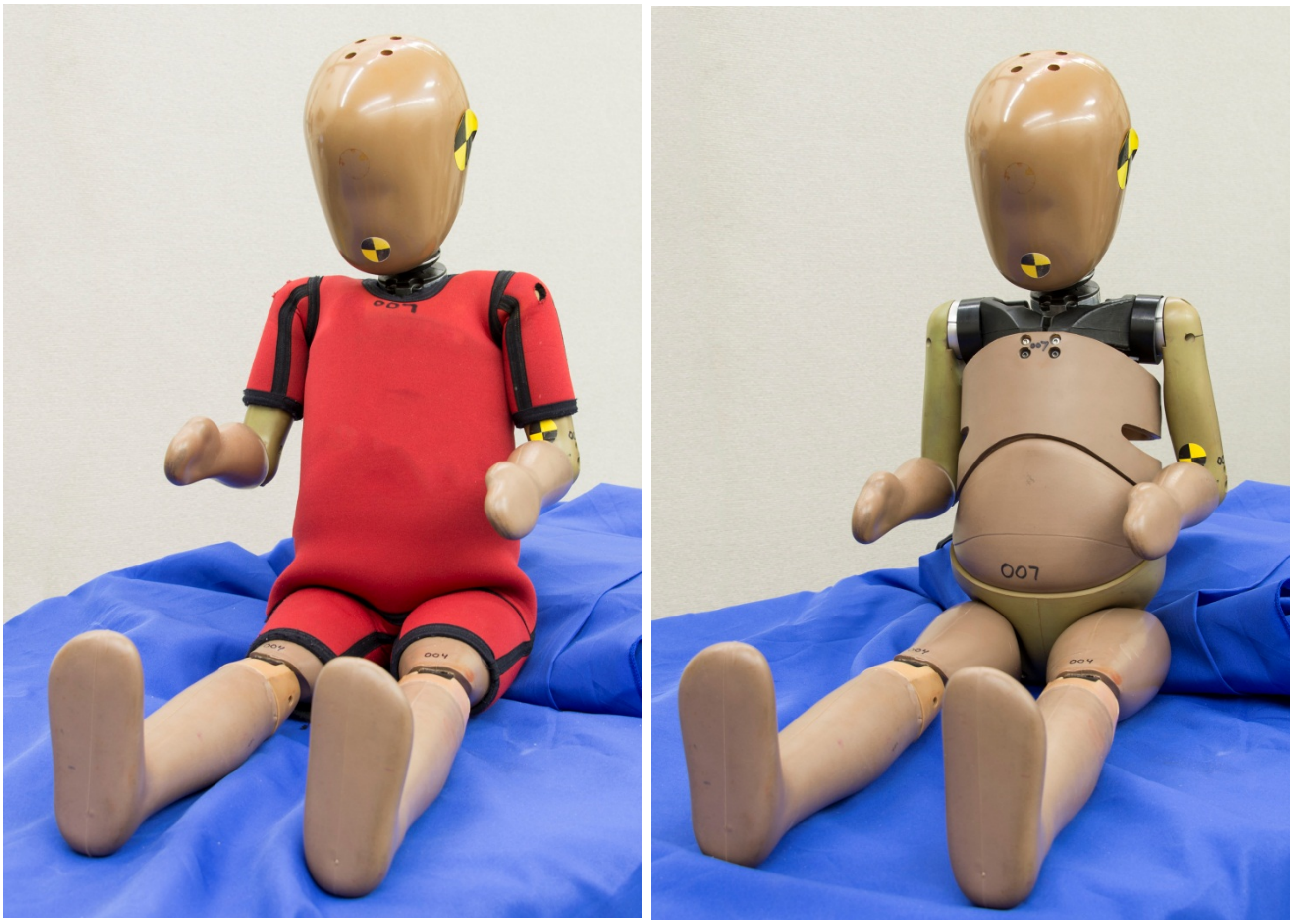


Figure 1. Q3s child side impact dummy with and without suit

1.1 Purpose

This document contains the procedures for disassembly, assembly, and adjustment of the Q3s dummy for the purpose of inspecting and preparing it for testing. Qualification tests are specified in 49 CFR, Part 572 Subpart W Final Rule to validate dummy responses that could affect dummy measurements used to assess occupant injury potential. The dummy manufacturers perform qualification tests to assure that a new component or assembly meets the specified response requirements. The crash dummy user will periodically perform the qualification tests to assure the dummy is maintained at the specified performance levels. This manual aids the user in preparing the dummy for testing

1.2 Part Numbers

All part numbers in this document refer to the drawing package specified in 49 CFR, Part 572 Subpart W. Electronic files of the drawings for this dummy may be downloaded from docket at http://www.regulations.gov.

1.3 Abbreviations

The abbreviations for screw fasteners used throughout the PADI are listed in Table 1.

Table 1. Threaded Fastener Abbreviations

Abbreviation	Description
SHCS	Socket Head Cap Screw
BHCS	Button Head Cap Screw
FHCS	Flat Head Cap Screw
SSNP	Set Screw, Nylon Point
Shoulder Screw	Shoulder Screw

1.4 Screw Fastener Torque Specifications

Table 2 provides general torque guidelines for screw fasteners used in the Q3s dummy. These torque specifications should be used on fasteners throughout the dummy when torque values are not otherwise specified in the assembly procedures described herein or in the Q3s engineering drawing package incorporated by reference by Part 572.

Table 2. Screw Torque Specifications

Screw Type	Size	Torque (in-lb)	Torque (N-m)
FHCS	M5-0.8	20	2.3
	M4-0.7	10	1.1
	M3-0.5	10	1.1
BHCS	M2.5-0.45	5	0.6
	M5-0.8	10	1.1
	M4-0.7	10	1.1
	M3-0.5	6	0.7
SHCS	M2.5-0.45	5	0.6
	M3-0.5	10	1.1
	M4-0.7	10	1.1
	M5-0.8	20	2.3

2 CONSTRUCTION

The general construction of the Q3s follows a design philosophy that is fundamentally different from what was used to design most other ATDs in Part 572. The Q3s uses more plastics and high density foams. With the exception of fasteners, instrument mounting plates, and stiffeners for the femurs, the Q3s is almost completely devoid of steel. This philosophy is most evident in the design of the shoulders, thorax, and pelvis. Each shoulder is molded from rubber into a hollowed, rectangular structure that allows controlled buckling when it is struck on the lateral aspect. Aluminum mounting plates are embedded into the shoulder mold to securely affix the subassembly to other dummy components. The thorax consists of a one-piece solid ribcage molded of polyurethane with a thin layer of PVC “skin” bonded to the outer aspect. The pelvis is made out of two parts: a pelvic bone casting made of a zinc alloy encased snuggly within a molded polyurethane flesh. This design provided the flexibility to place the Q3s in either a sitting or a standing posture. Also, the Q3s is designed with the intent to ease its assembly and disassembly so that qualification procedures may be carried out with less intermediate dummy adjustments. As such, the Q3s has many fewer parts than other Part 572 dummies.

3 CLOTHING

No additional clothing or shoes are required for testing this dummy.

4 AVAILABLE INSTRUMENTATION

The Q3s has provisions for installing the instrumentation listed in Table 3. Typically, only a subset of this instrumentation is required for dummy qualification and standardized testing. Refer to Part 572 and the applicable Federal Motor Vehicle Safety Standard (FMVSS) or test protocol to determine which instruments are required.

Table 3. Instrumentation Available for Q3s

Sensor Type	Location in Dummy	Part Number	Measurements	Total # Channels
Accelerometers	Head C.G.	SA572-S4	Ax, Ay, Az	3
	Thorax (T1, top and side of the spine box near neck base)	SA572-S4	Ay	1
	Thorax (upper spine box)	SA572-S4	Ax, Ay, Az	3
	Pelvis	SA572-S4	Ax, Ay, Az	3
IR-TRACC	Thorax	SA572-S37	Dy	1
Potentiometers	Shoulder	SA572-S38 (Left) SA572-S39 (Right)	Dy	1
Load Cells	Upper Neck	SA572-S8	Fx, Fy, Fz, Mx, My, Mz	6
	Lower Neck	SA572-S8	Fx, Fy, Fz, Mx, My, Mz	6
	Lumbar	SA572-S8	Fx, Fy, Fz, Mx, My, Mz	6
	Pubic	SA572-S7	Fy	1
Angular Rate Sensors (ARS)	Head	SA572-S58	ω_x, ω_y, ω_z,	3
Tilt Sensors	Thorax	SA572-S44	X°, Y°	2
			TOTAL AVAILABLE CHANNELS	**36**

5 PROCEDURES FOR ASSEMBLY, DISASSEMBLY, AND INSPECTION

The complete Q3s dummy consists of six major assembly groups as shown in Figure 2. Table 4 shows the breakdown of the assembly groups as they are described in the Procedures for Assembly, Disassembly and Inspection.

Table 4. Q3s Assembly Groups

Assembly Group	Part Number
Head	020-1200
Neck	020-2400
Upper Torso	020-4500
Lower Torso	020-4000
Leg, Left & Right	020-9500, 020-9600
Arm, Left & Right	020-9700, 020-9800

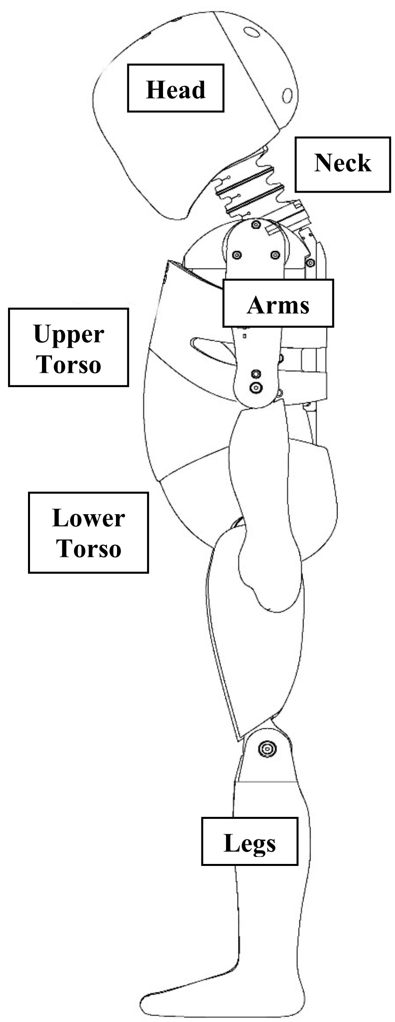


Figure 2. Assembly groups for the Q3s

5.1 Suit Removal

1. In preparation for the Q3s disassembly, remove the dummy's suit[1] by opening the hook and loop closure system on the back of the dummy (Figure 3). This will allow access to the neck and torso components.

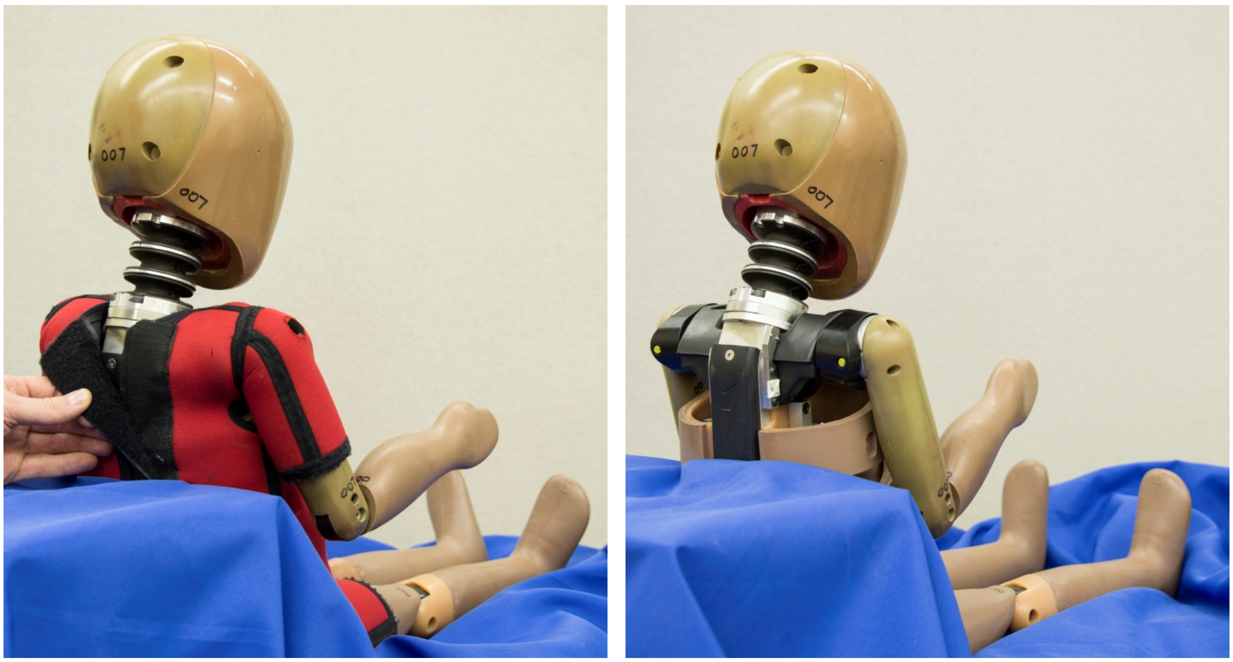


Figure 3. Remove suit to begin disassembly

[1] Part number 020-8001

5.2 Head

The components in Table 5 list the parts that are included in the Head Assembly. Figure 4 and Figure 5 show drawings of the head assembly components with parts labeled as shown in Table 5.

Table 5. Head Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Front Skull Assembly, Q3s	1	020-1220	4	1
Rear Skull Cap Assembly	1	020-1025	4	2
Screw, BHCS M5-0.8 x12mm	4	5000654-FT	4	3
Instrumentation Bracket Assembly	1	020-1013A	4, 5	4, 1
Load Cell Structural Replacement, Upper Neck	1	020-2007	4	5
Screw, FHCS M5-0.8 x 12mm	4	5000096-FT	4	6
Screw, SHCS M3-0.5 x 10mm	2	5000119	5	2
Screw, SHCS M3-0.5 x 40mm	1	5000649	5	3
Accelerometer Mounting Block	1	SA-572-S86	-	-
6 Axis Accelerometer ARS Mounting Bracket	1	SA-572-S87	-	-
Screw, SHCS M2.5-0.45 x 16mm	2	5000283	-	-

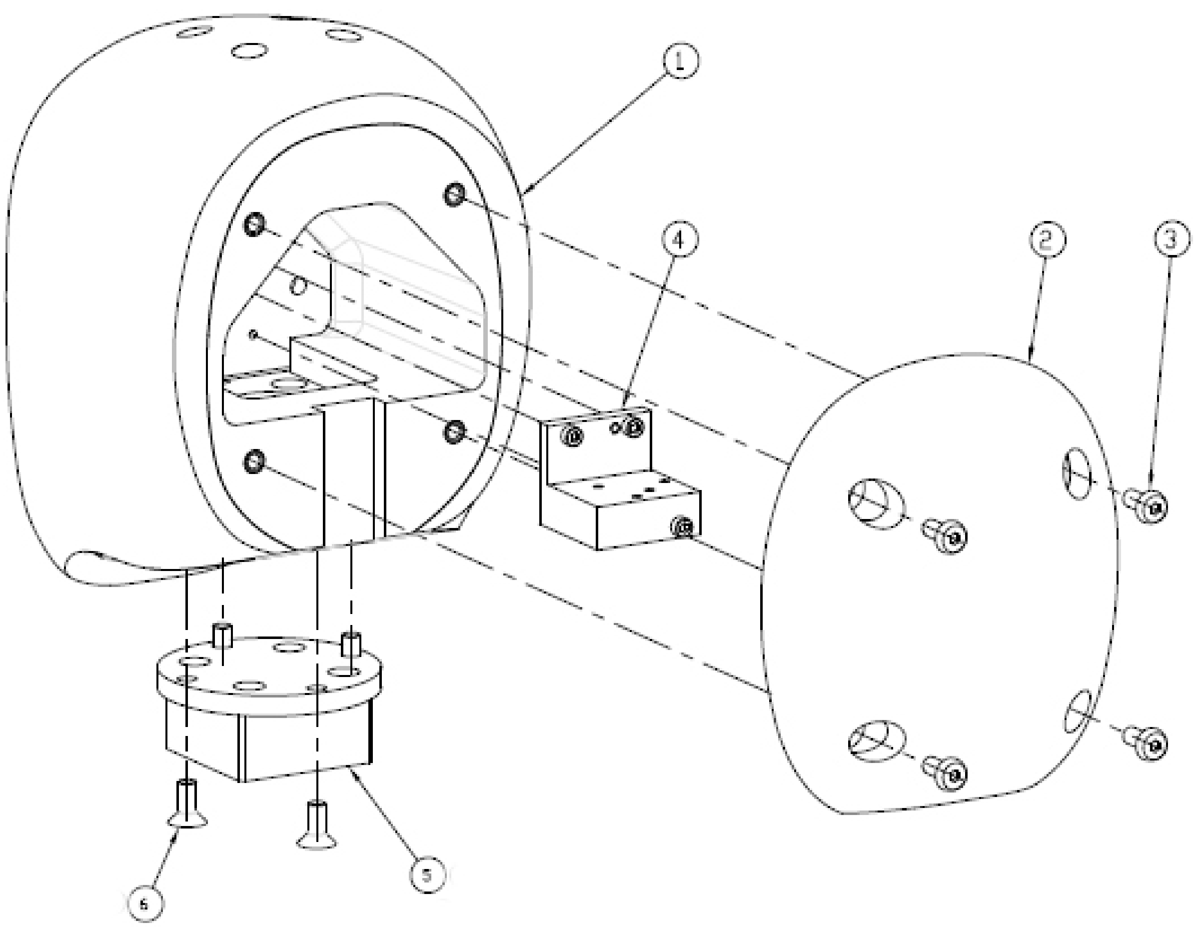


Figure 4. Head assembly – exploded view

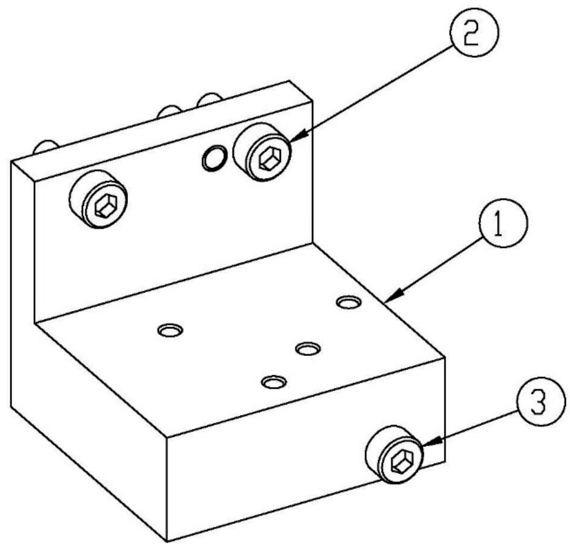


Figure 5. Instrumentation bracket assembly

5.2.1 Head Disassembly

1. The Q3s requires some disassembly of the head in order to remove the head from the neck. First, remove the skull cap by removing the four M5-0.8 x 12mm BHCS on the back of the head (Figure 6). Separate the skull cap from the head (Figure 7).

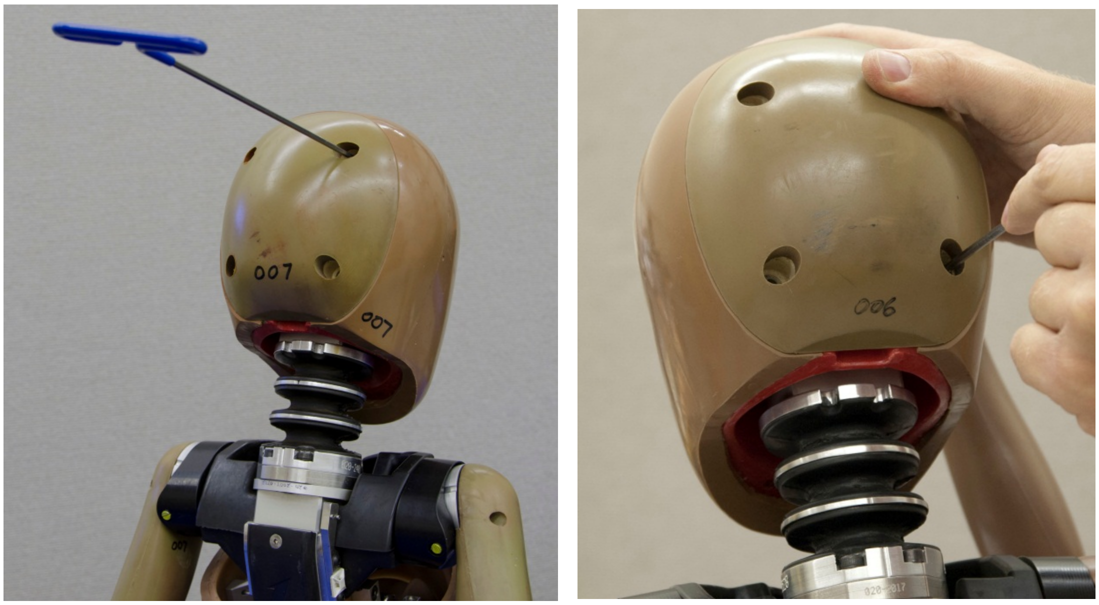


Figure 6. Remove skull cap

Figure 7. Q3s with skull cap removed

5.2.1.1 Instrumentation Bracket Removal

The Q3s dummy has provisions for either an accelerometer array or an angular rate sensor (ARS) array. The following Sections describe removal of both types of brackets from the head.

5.2.1.1.1 Accelerometer Instrumentation Bracket Disassembly

1. Uninstall the instrumentation bracket assembly by removing the two M3-0.5 x 10mm SHCS (top of bracket) and one M3-0.5 x 40mm SHCS (bottom of bracket) (Figure 8 and Figure 9).

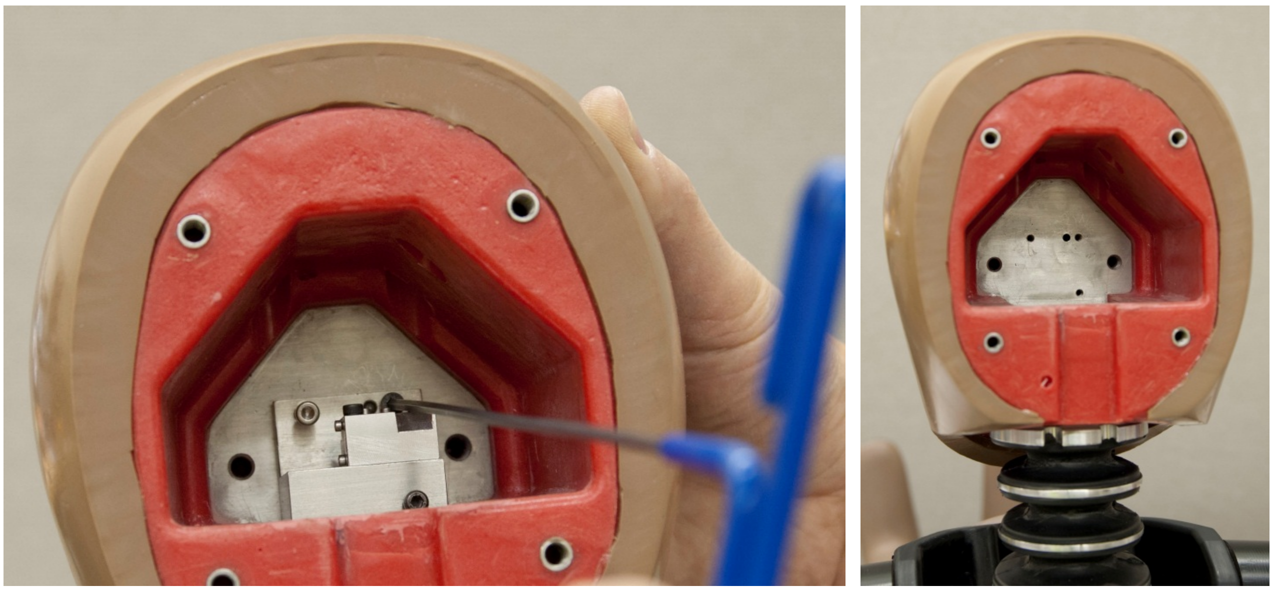


Figure 8. Uninstall instrumentation bracket from the head

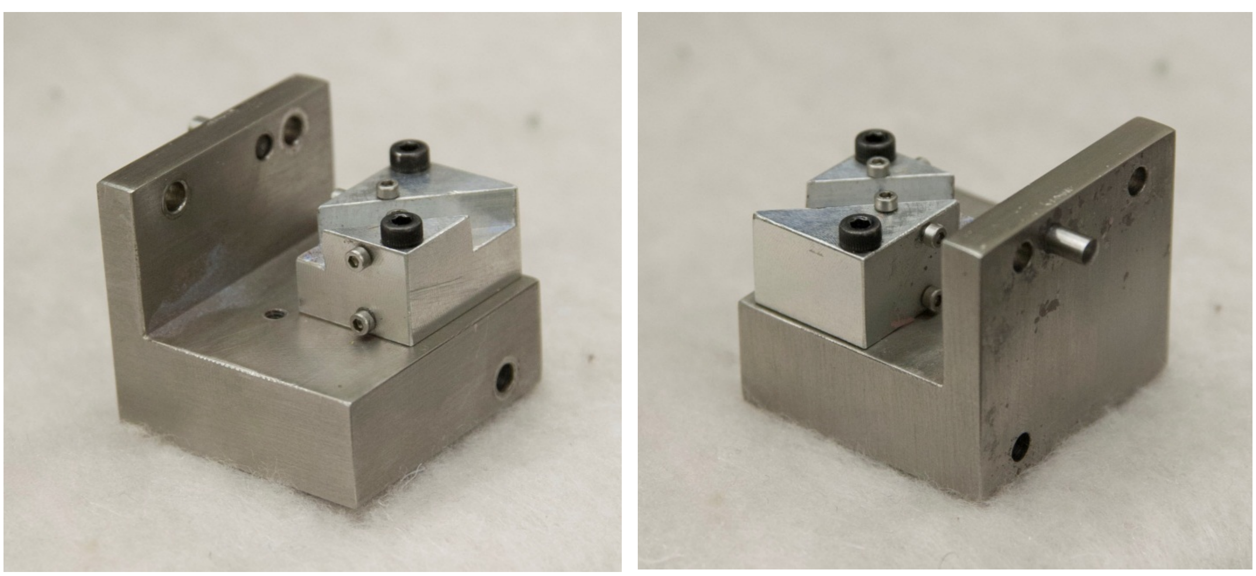


Figure 9. Instrumentation bracket with accelerometer mounting block uninstalled from head

2. Take out the two M2.5-0.45 x 16mm SHCS on the corners of the accelerometer mounting block in order to remove it from the instrumentation bracket assembly (Figure 10).

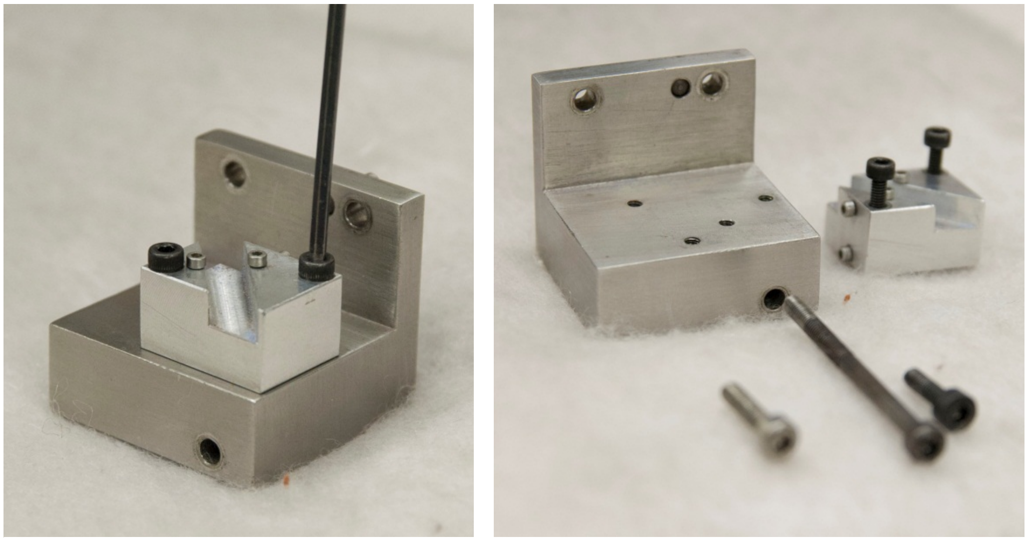


Figure 10. Removing accelerometer block from instrumentation bracket assembly

5.2.1.1.2 Angular Rate Sensor (ARS) Instrumentation Bracket Disassembly

1. If the ARS devices are utilized, remove two M3-0.5 x 10mm SHCS and one M3-0.5 x 40mm SHCS which secure the instrumentation bracket (Figure 5) to the skull (Figure 11 and Figure 12).

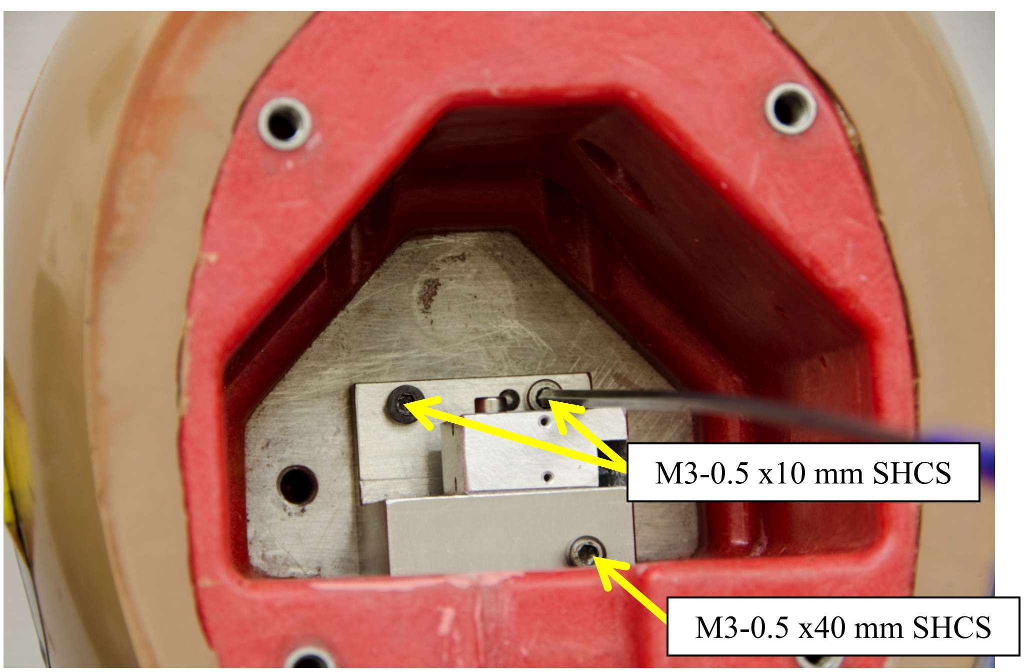


Figure 11. Remove angular rate sensor bracket assembly

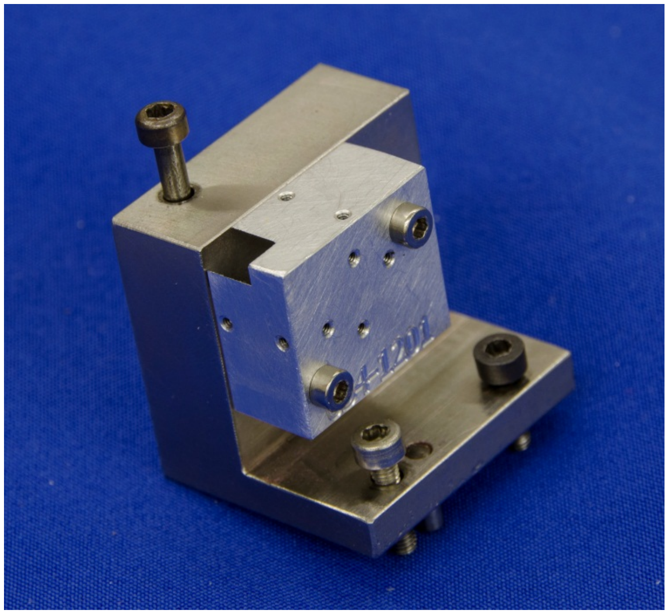


Figure 12. ARS assembly removed from head

2. Disassemble the ARS/accelerometer mounting block from the instrumentation bracket by removing the two M2.5-0.45 x 16mm SHCS which secure the mounting block to the instrumentation bracket (Figure 13).

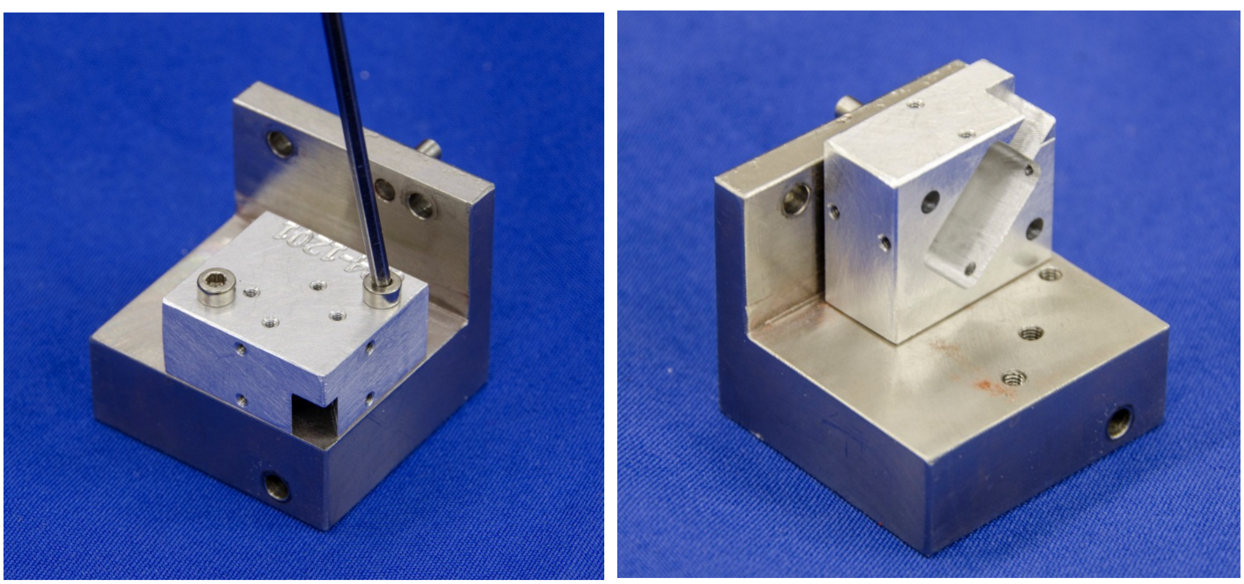


Figure 13. Remove the accelerometer/ARS mounting block from the instrumentation bracket

5.2.2 Head Removal

1. Insert the SHCS wrench through the access hole on top of the head to remove the four M5-0.8 x 10mm SHCS[1] which secure the head to the neck (Figure 14 and Figure 15).

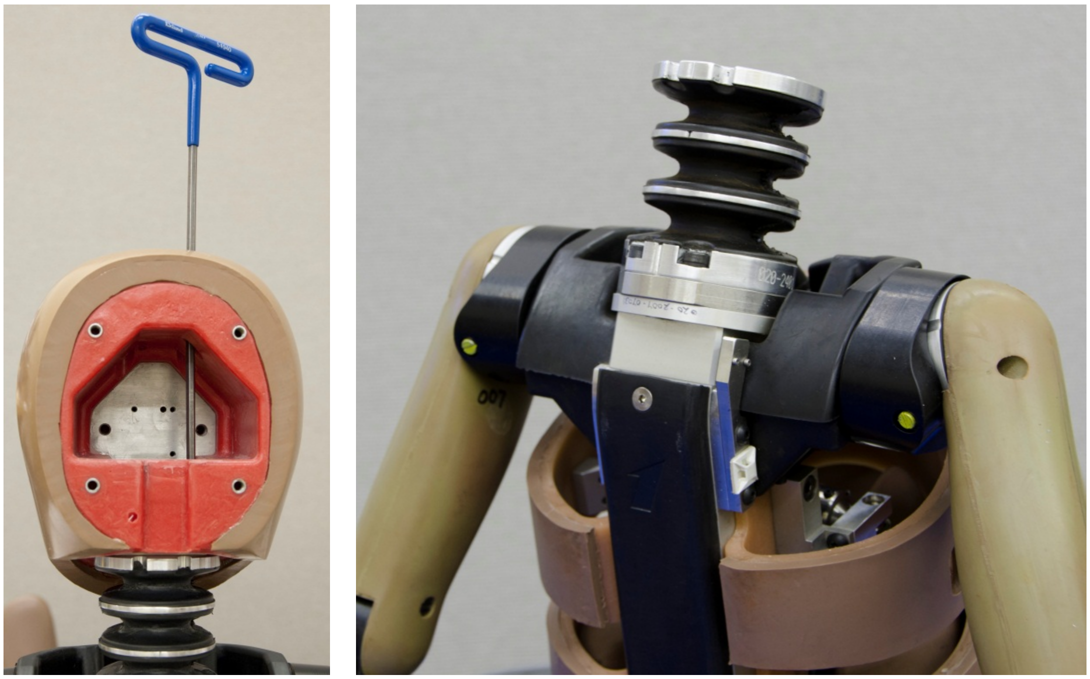


Figure 14. Remove head from neck

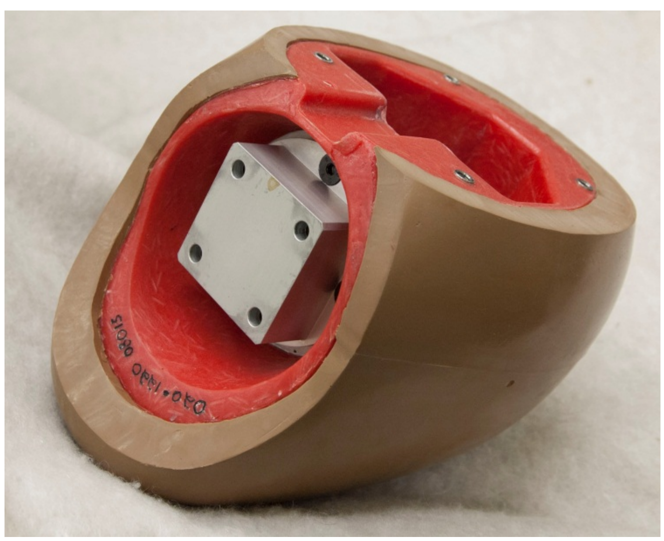


Figure 15. Head removed from neck

[1] It is ***imperative*** to use 10mm long screws to attach the head to the neck or interference will result. These screws are Part Number 5000291-FT.

2. Separate the upper neck load cell structural replacement from the bottom of the head by removing the four M5-0.8 x 12mm FHCS[2] which secure the load cell replacement to the head (Figure 16).

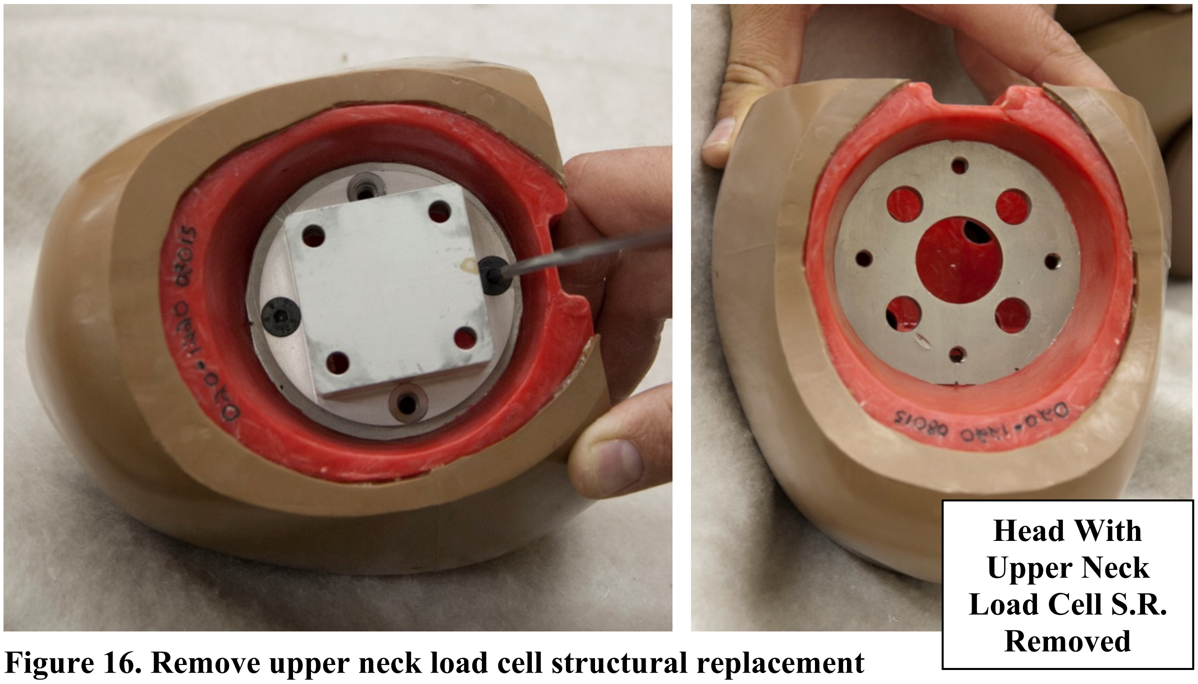


Figure 16. Remove upper neck load cell structural replacement

5.2.3 Head Inspection

- Inspect the head skin and skull cap skin for damage, such as tears or cracks. Replace if damaged[3].
- The skull integrity should be checked before each use. Inspect the skull and skull cap for damage, such as cracks or thread damage. Repair or replace if damaged.
- Verify that the accelerometers are securely attached prior to test and after each use.

5.2.4 Head Assembly and Installation

To assemble the head without instrumentation, reverse the process described in Section 5.2.1.

[2] Part number 5000096

[3] It should be noted that the Q3s head skin and skull cap skin are not removable from the skull as they are in many other ATD's.

5.3 Neck

The components in Table 6 list the parts that are included in the Neck Assembly. Figure 17 shows a drawing of the neck assembly components with parts labeled as shown in Table 6. Table 7, along with Figure 18 and Figure 19 illustrate the tools for assembling and disassembling the neck cable.

Table 6. Neck Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Molded Neck	1	020-2401	17	1
Thrust Bearing Washer (0.032" thick)	2	9003280	17	2
Thrust Bearing ½" ID – 15/16" OD	1	9003279	17	3
Tension Cable Assembly	1	020-2415	17	4
M5 x 0.8 x 10 LG SHCS	1	5000291	17	5
Cable Adjust Nut	1	020-2421	17	6
Cable Lock Nut	1	020-2426	17	7
Protective Snap Cap	4	020-2423	17	8

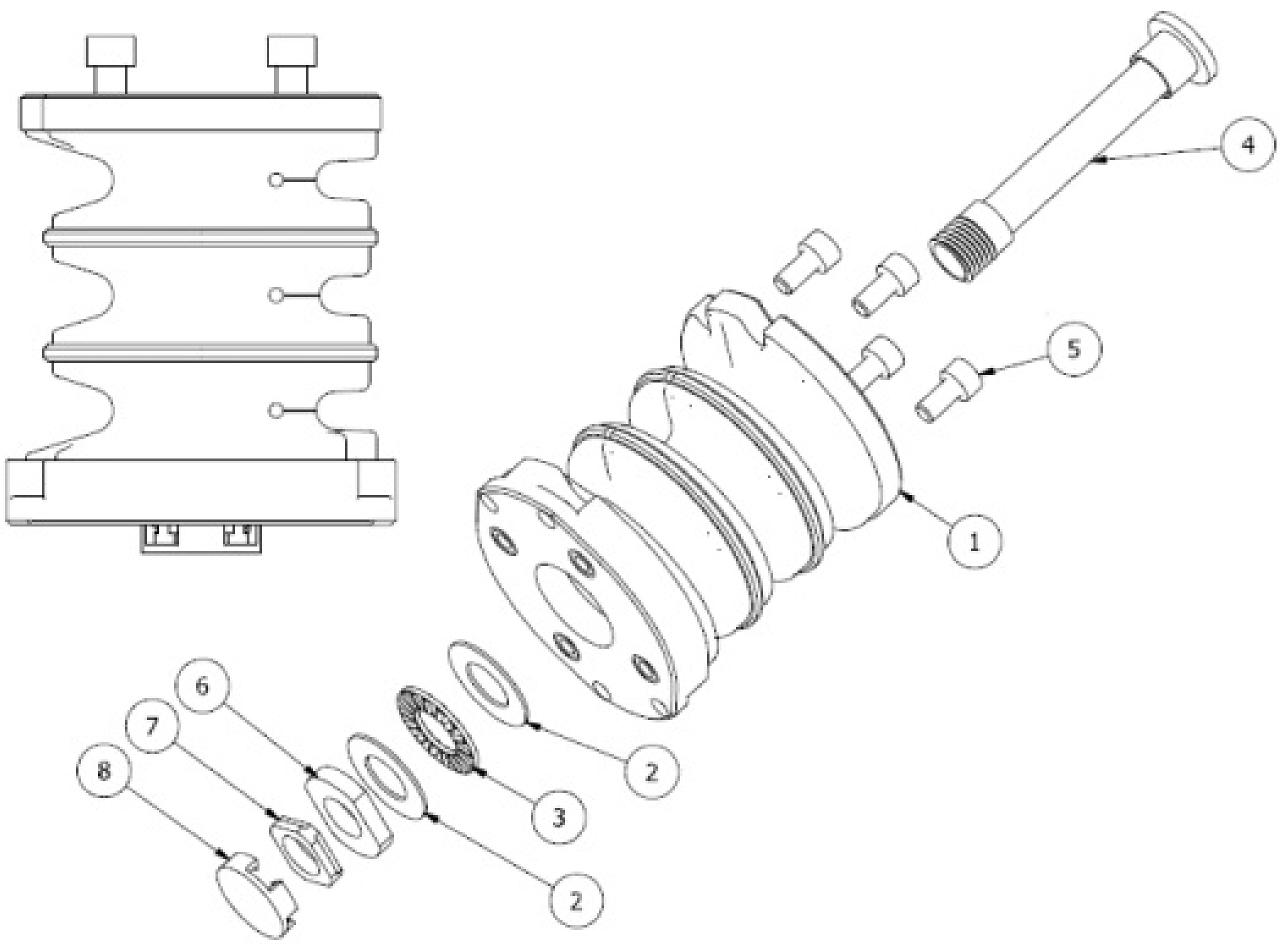


Figure 17. Neck assembly – exploded view

Table 7. Neck Assembly Toolkit (020-2400_Toolkit)

Part Description	Quantity	Part Number	Figure #
Protective Cap Remover	1	6004492	18
Neck Adjust Nut Wrench	1	020-2410	19
Neck Lock Nut Wrench	1	020-2420	19

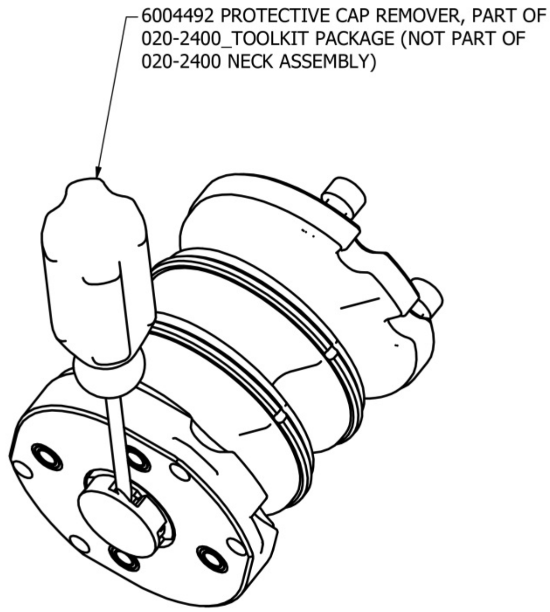


Figure 18. Protective cap remover from neck assembly toolkit

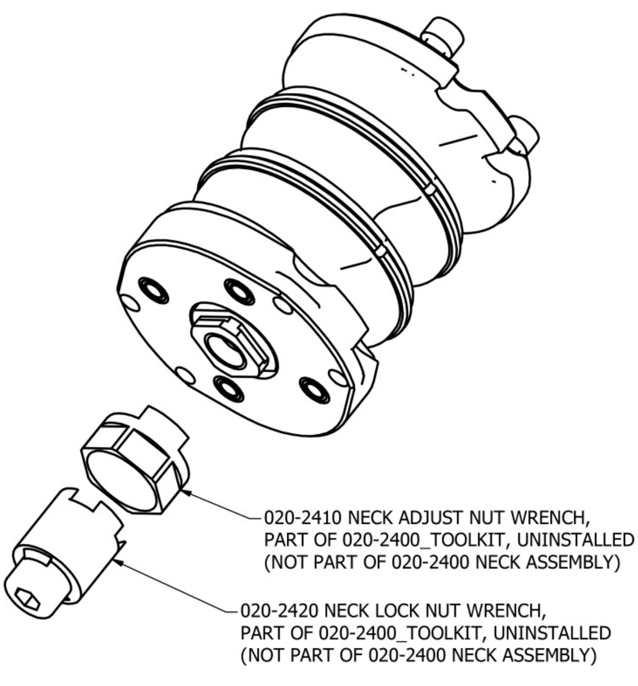


Figure 19. Neck adjust wrench and lock nut wrench from neck assembly toolkit

5.3.1 Neck Removal

1. Remove the two rear M5-0.8 x10mm SHCS at the base of the neck (Figure 20).

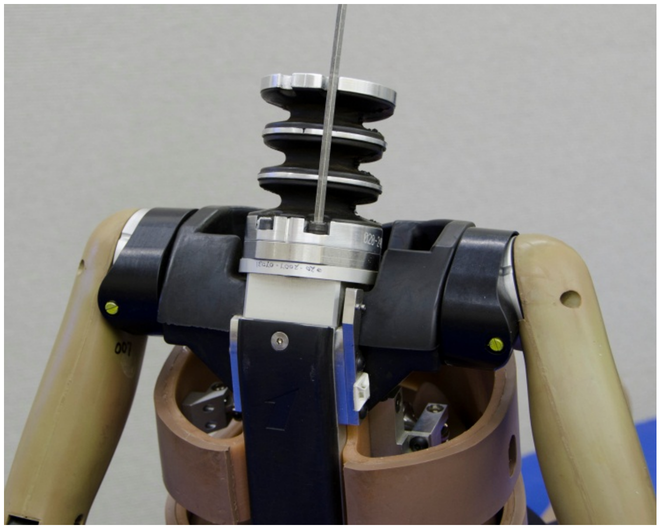


Figure 20. Remove screws from rear base of neck

2. Remove the two front M5-0.8 x10mm SHCS at the base of the neck. Using a ball tip hex wrench is advantageous to minimize interference with the neck during removal (Figure 21). This will separate the neck from the torso (Figure 22).

Figure 21. Remove screws from front base of neck using ball tip hex wrench

Figure 22. Neck separated from torso

5.3.2 Neck Disassembly

1. Remove the protective snap cap from the bottom of the neck using the protective snap cap remover (Part #6004492[4]) (Figure 23).

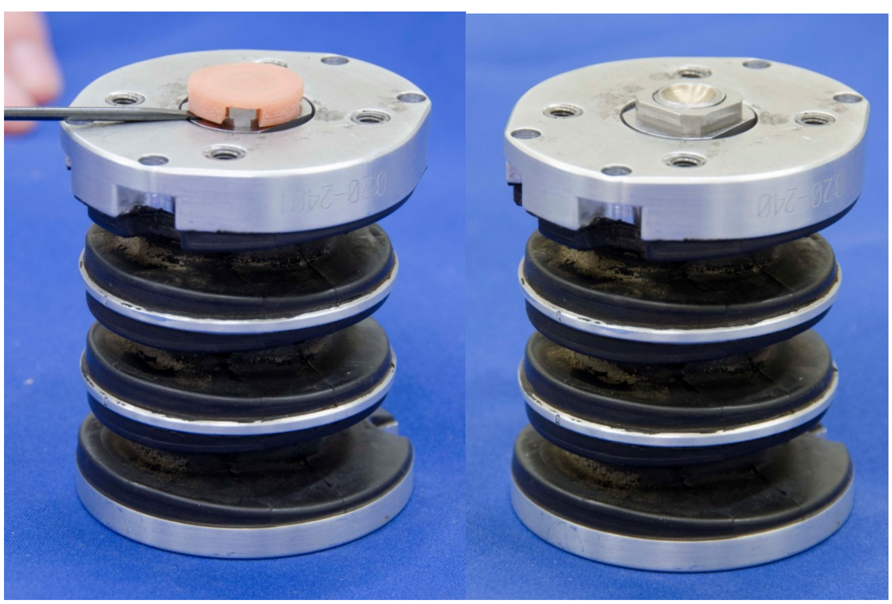


Figure 23. Remove protective snap cap

[4] This is part of the 020-2400_ToolKit package

2. Align and install the neck adjust nut wrench (020-2410[5]) over the cable lock nut and cable adjust nut (Figure 24). Insert the neck lock nut wrench (020-2420[5]) into the neck adjust nut wrench.

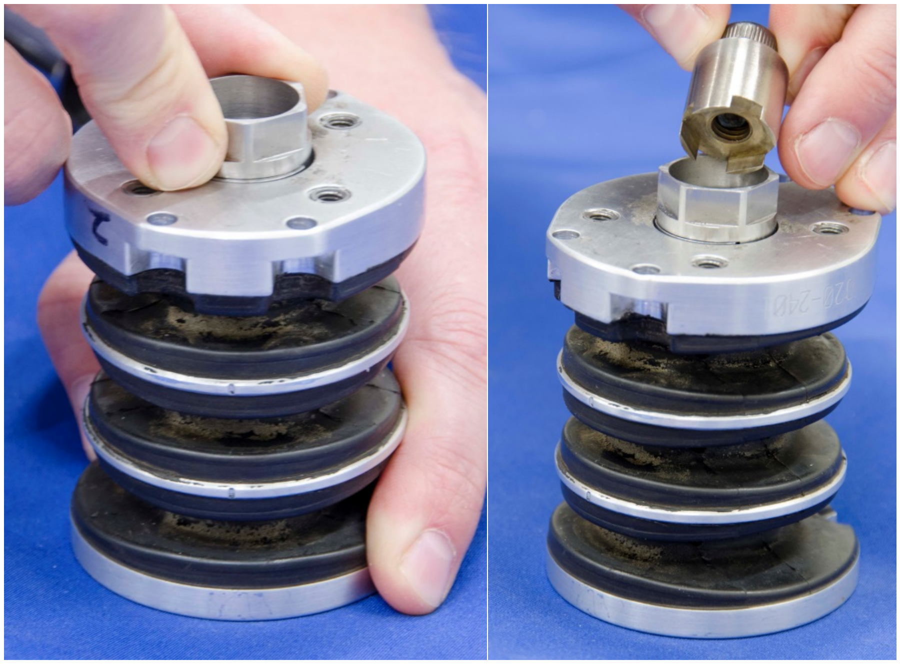


Figure 24. Install neck adjust nut wrench and neck lock nut wrench

3. While holding the neck adjust nut wrench stationary, insert an allen wrench into the neck lock nut wrench (Figure 25). Uninstall the cable lock nut by turning only the allen wrench (Figure 26).

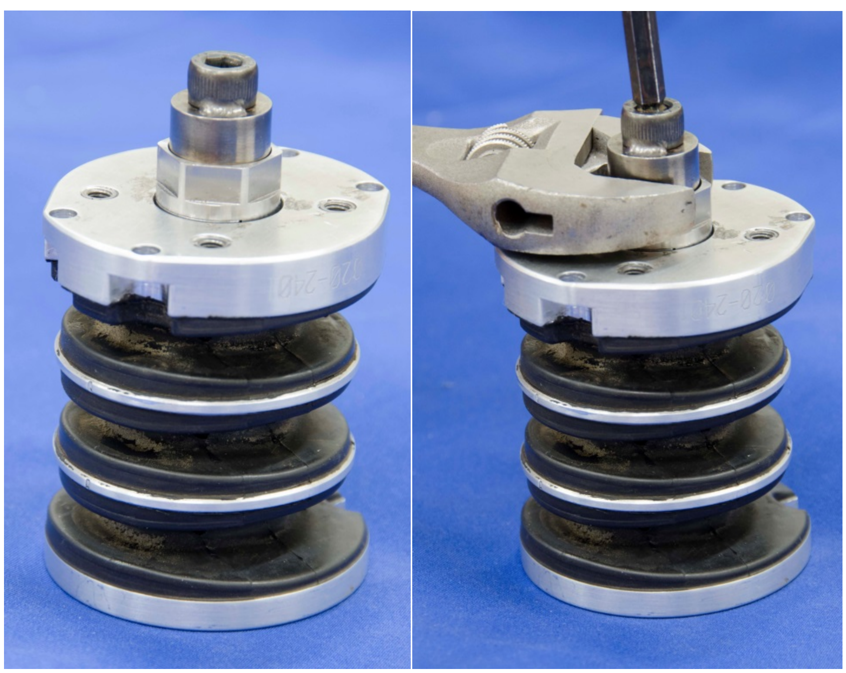


Figure 25. Uninstall cable lock nut

[5] This is part of the 020-2400_ToolKit package.

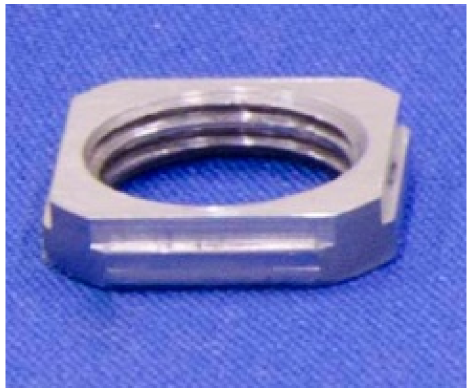


Figure 26. Cable lock nut

4. Reinstall the neck adjust nut wrench to remove the cable adjust nut (Figure 27 and Figure 28). This can be easily accomplished by hand since the torque setting on this nut is only 2 in-lb.

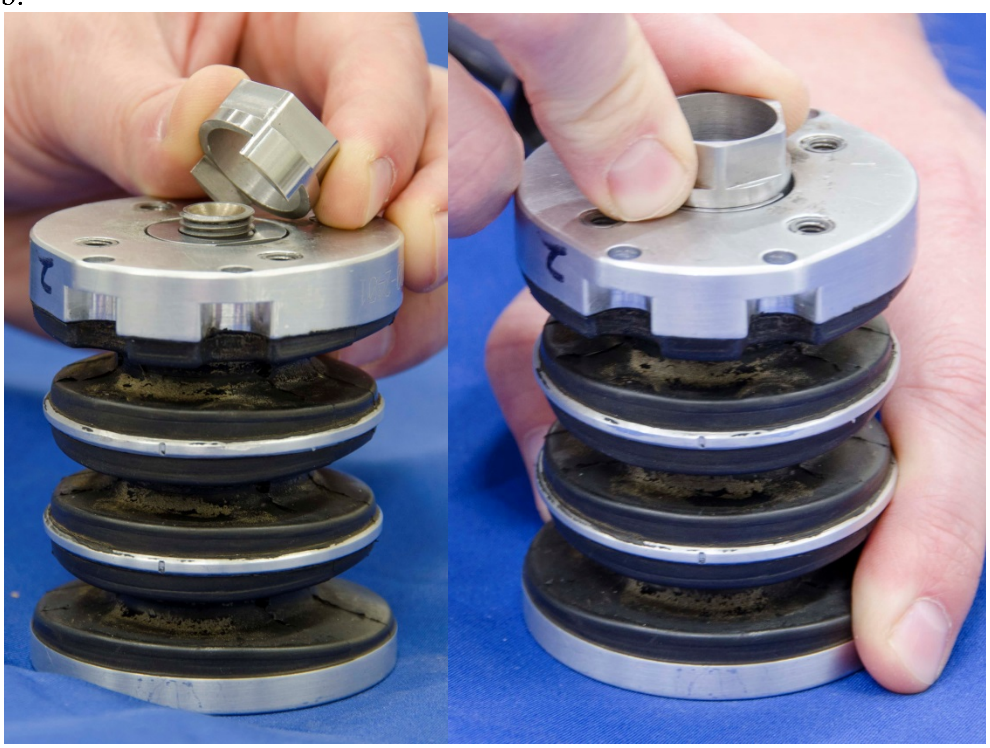


Figure 27. Use neck adjust nut wrench to remove cable adjust nut

Figure 28. Cable adjust nut

5. Push the Q3s tension cable assembly from the bottom to top to remove the neck cable from the neck (Figure 29).

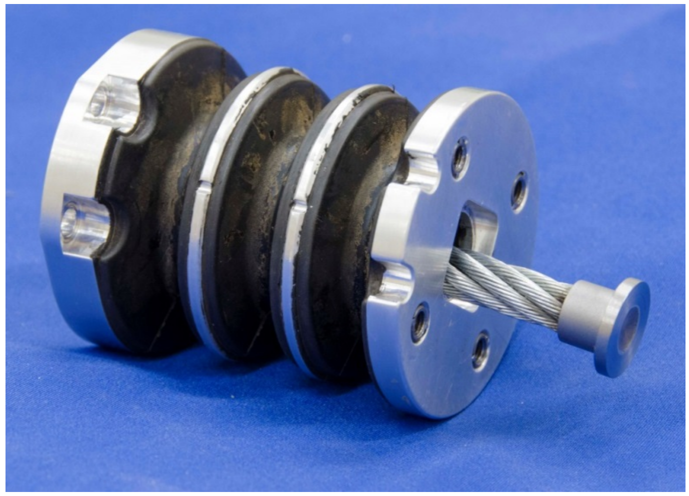


Figure 29. Remove neck cable

6. Remove the two 0.032" thick bearing washers and thrust bearing (1/2" ID- 15/16 OD) from the bottom of the neck (Figure 30). Figure 31 shows details of the neck thrust bearing. The orientations of washers, nuts, and the bearing are indicated in Figure 32.

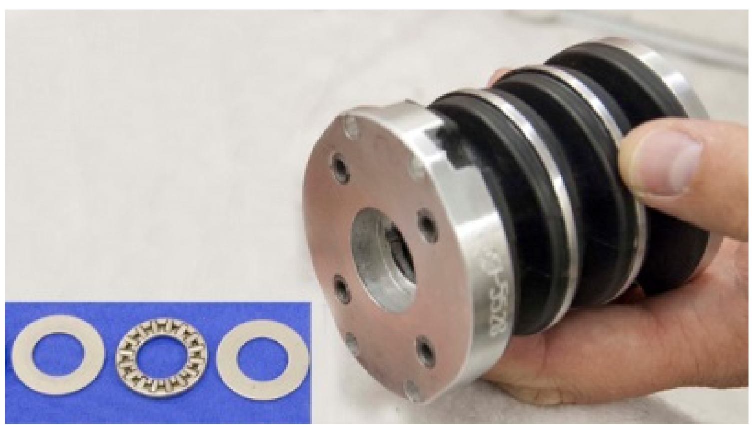


Figure 30. Remove thrust bearing washers and thrust bearing

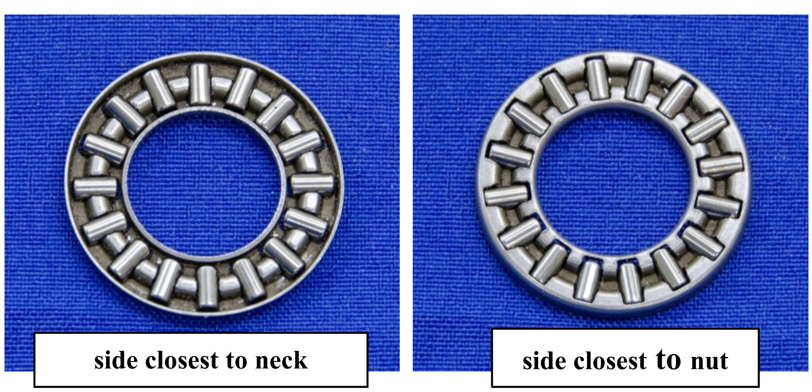


Figure 31. Details of neck thrust bearing

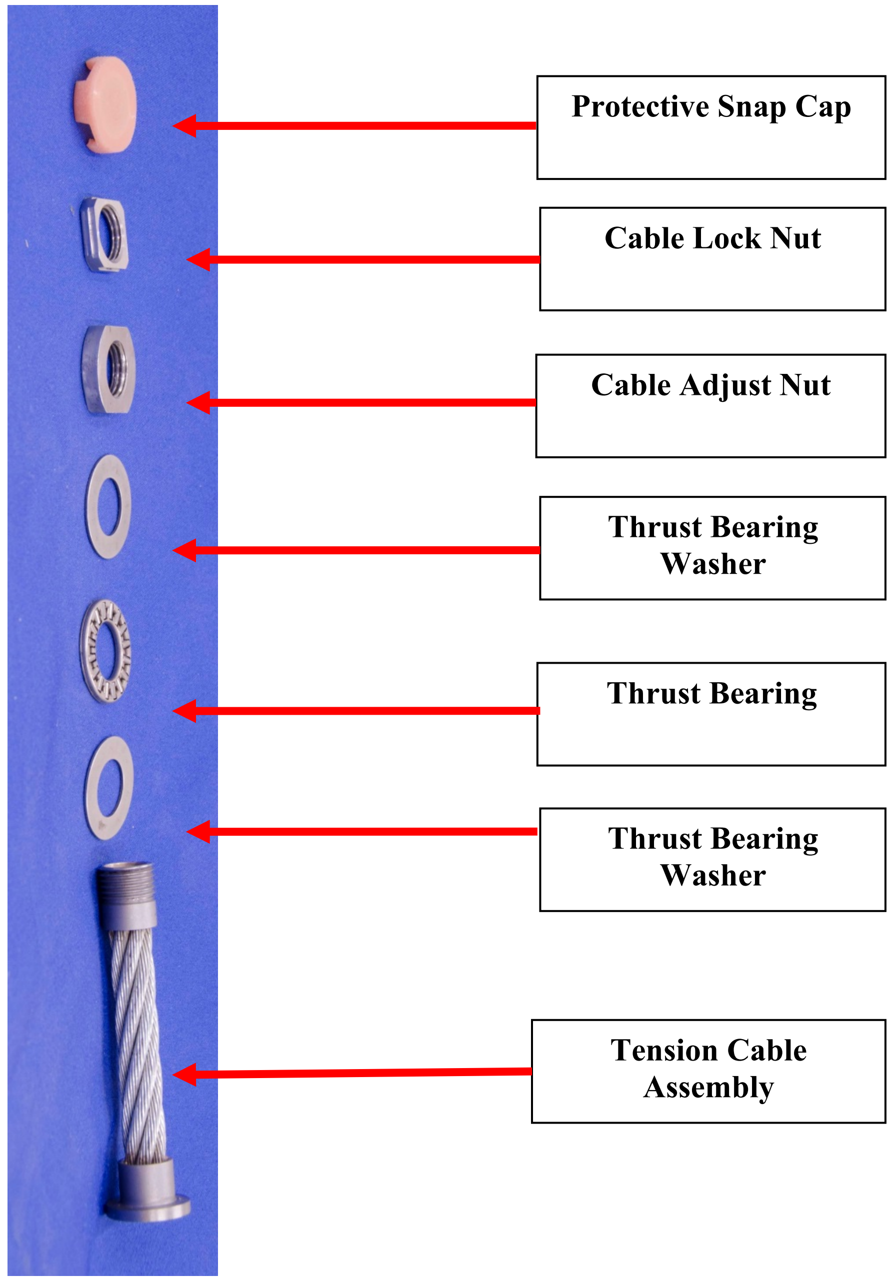


Figure 32. Neck cable showing location of nuts, washers, and bearing

5.3.3 Neck Inspection

- Inspect the molded neck for damage. Check the neck for deformation, tears, or breaks in the rubber. Replace if damaged.
- Check the neck cable by observing the condition of the strands. If they are not tightly wound, if frays are visible, or the cable appears larger in diameter on one end, replace the cable. If the cable is permanently bent or if the proper torque cannot be achieved, replace the cable.
- Inspect the head and torso interface plates for thread damage. Repair or replace if damaged.

- Be certain that all nuts, washers, and retainer ring are properly installed on the neck cable.
- Check that the torque on the cable lock nut is 30 in-lb (see Section 5.3.4).
- Check that the torque on the cable adjust nut is 2 in-lb (see Section 5.3.4).

5.3.4 Neck Assembly and Installation

To assemble the neck and install it to the torso, reverse the process described in Sections 5.3.1 and 5.3.2 observing the following reassembly points:

- Take care that the proper placement of washers, bearing and nuts are used on reassembly of the neck.
- The thrust bearing should be installed with the proper orientation (Figure 31).
- Set the torque on the cable adjust nut to 2 in-lb by installing the neck cable adjust nut wrench and using a torque wrench on this tool (Figure 33).

Figure 33. Set torque on neck adjust nut to 2 in-lb

- Set the torque on the cable lock nut to 30 in-lb by installing the neck cable lock wrench into the neck cable adjust wrench. Hold the neck cable adjust wrench stationary to maintain the 2 in-lb torque on the adjust nut while setting the lock nut to 30 in-lb using an allen torque wrench (Figure 34).

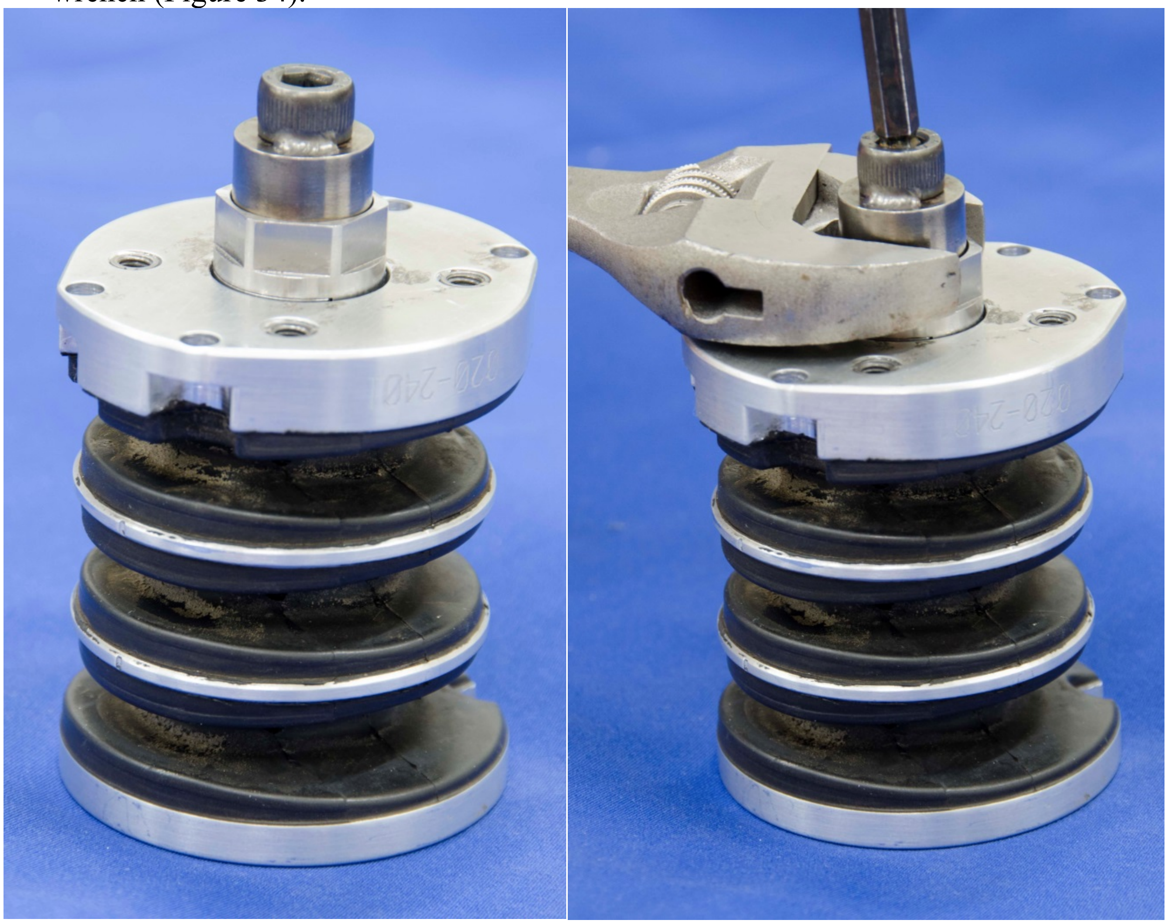


Figure 34. Set 30 in-lb torque on the cable lock nut

5.4 Arms

The components in Table 8 list the parts that are included in the arm assembly. Figure 35 shows a drawing of the arm assembly components with parts labeled as shown in Table 8.

Table 8. Arm Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Q3s Upper Arm Molded (left is shown)	1	020-9750[6]	28	1
Q3s Lower Arm Assembly (left is shown)	1	020-9730[7]	28	2
Stop Screw	1	020-9901	28	3
Screw, SSNP M8 x 12mm	1	5000725	28	4
Q3s Elbow Modified Shoulder Screw	1	020-9913	28	5

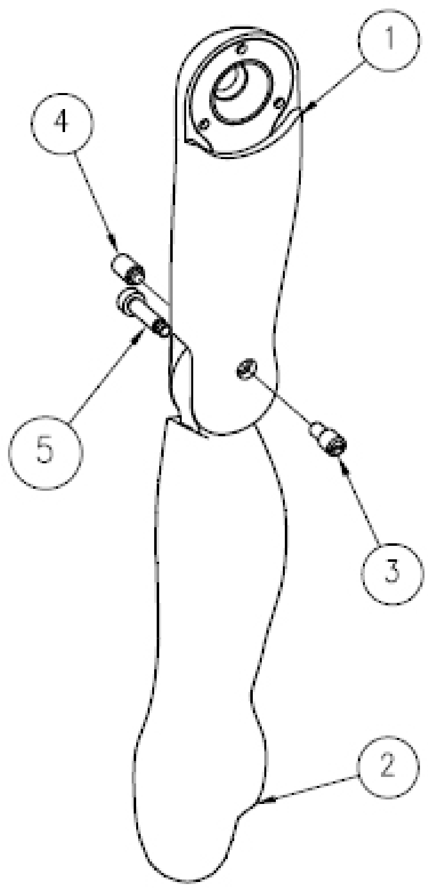


Figure 35. Arm assembly – exploded view

[6] Right upper Arm Molded is Part #020-9850
[7] Right Lower Arm Assembly is Part #020-9830

5.4.1 Arm Removal

1. Remove the three M4-0.7 x 10mm BHCS that secure the molded upper arm to the shoulder. (Figure 36). Be certain to retain the 0.15 ID x 0.31 x 0.062 Viton® washers that reside between the upper arm and the shoulder (Figure 37).

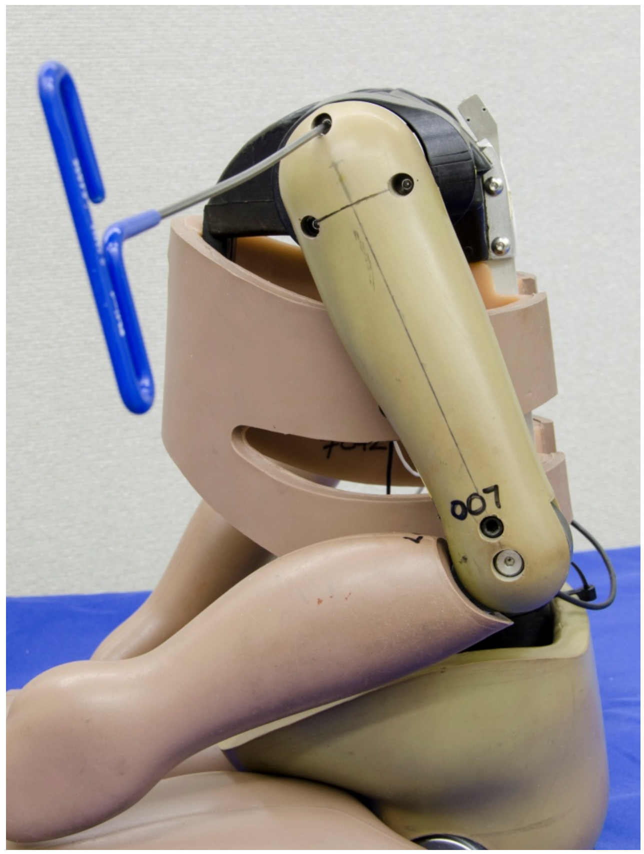


Figure 36. Remove arm from shoulder

Figure 37. Arm removed from Q3s showing Viton® washers at shoulder

5.4.2 Arm Disassembly

2. Remove the stop screw on the inside of the arm at the elbow joint (Figure 38).

Figure 38. Remove stop screw at elbow

3. Remove the M8 x 12mm SSNP Set Screw from the outside of the arm at the elbow (Figure 39).

Figure 39. Remove set screw on outer side of arm

4. Disassemble the lower arm assembly from the molded upper arm by removing the modified shoulder screw at the elbow (Figure 40 and Figure 41).

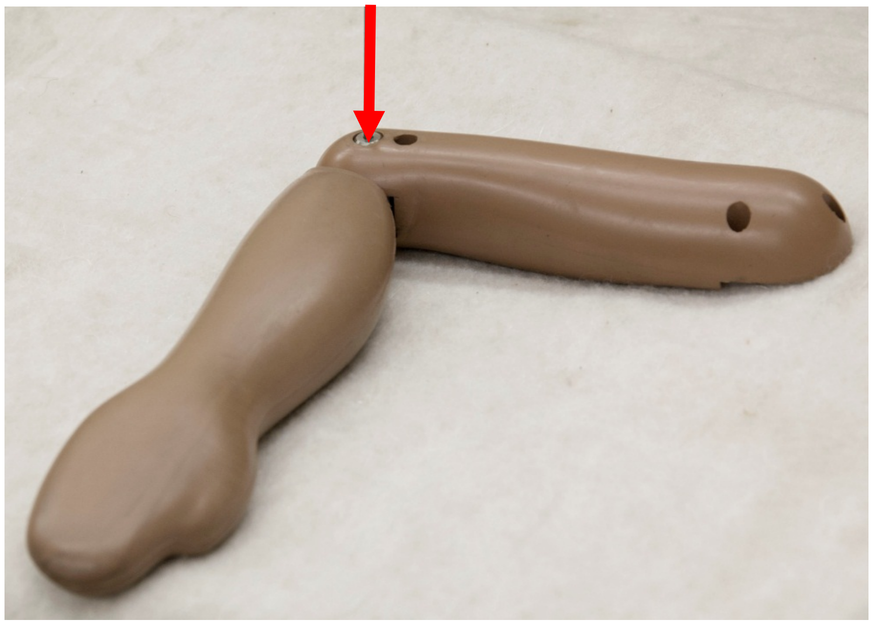


Figure 40. Remove shoulder screw at elbow

Figure 41. Upper and lower arm separated

5.4.3 Arm Inspection

- Inspect the arm for tears or damage. Repair or replace if necessary.
- Inspect for the presence and condition of the Viton® washers between the shoulder and upper arm. Replace if missing or damaged.

5.4.4 Arm Assembly and Installation

To assemble the arm, reverse the process described in Sections 5.4.1 and 5.4.2 observing the following reassembly points:

- Be certain that the Viton® washers (Figure 37) are installed between the shoulder and upper arm prior to installing the arm to the shoulder.
- Set the torque on the Q3s elbow modified shoulder screw to 15 in-lb (1.7 N-m).
- Use the M8 x 12mm SSNP to set the elbow joint to 1G (see Appendix).
- Use the three M4-0.7 x 10mm BHCS to set the shoulder joint to 1G (see Appendix).

5.5 Legs

Table 9 lists the parts that are included in the Leg Assembly. Figure 42 shows drawing of the leg assembly components.

Table 9. Leg Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Q3s upper leg, molded (left)[8]	1	020-9516	35	1
Lower (left) leg assembly[9]	1	020-9102	35	2
Stop screw	1	020-9901	35	3
Knee shoulder screw	1	020-9908	35	4

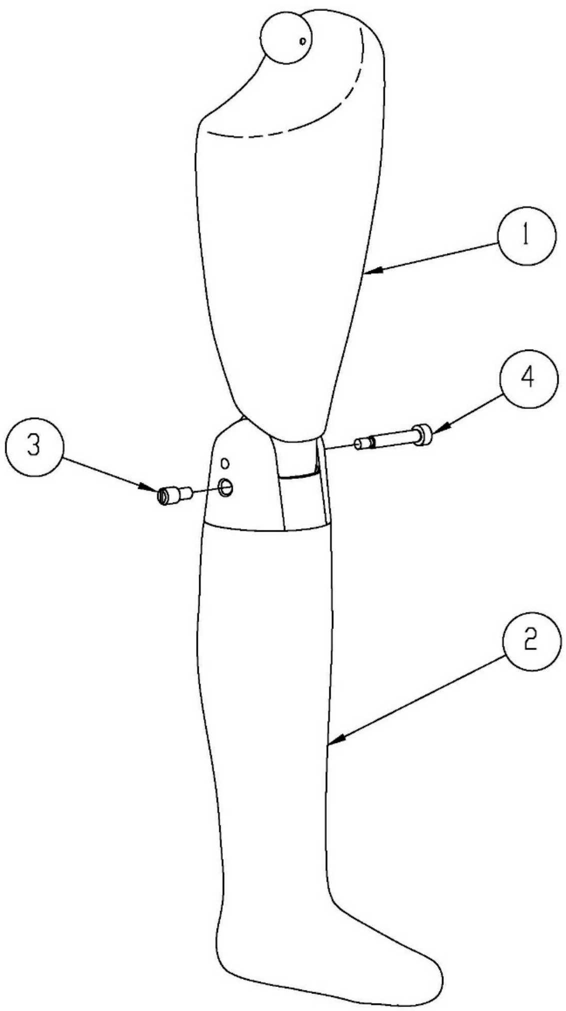


Figure 42. Leg components – exploded view

[8] Upper right leg molded is Part number 020-9616
[9] Lower right leg assembly is part number 020-9202

5.5.1 Leg Removal

1. Remove the two M5-0.8 x 10mm SHCS from the underside of the pelvis to separate the legs from the pelvis (Figure 43 and Figure 44).

Figure 43. Remove SHCS from pelvis

Figure 44. Separate leg from pelvis

5.5.2 Leg Disassembly

1. Remove the hip joint assembly[10] from the leg by removing the two M3-0.5 x 8mm BHCS (Figure 45 and Figure 46).

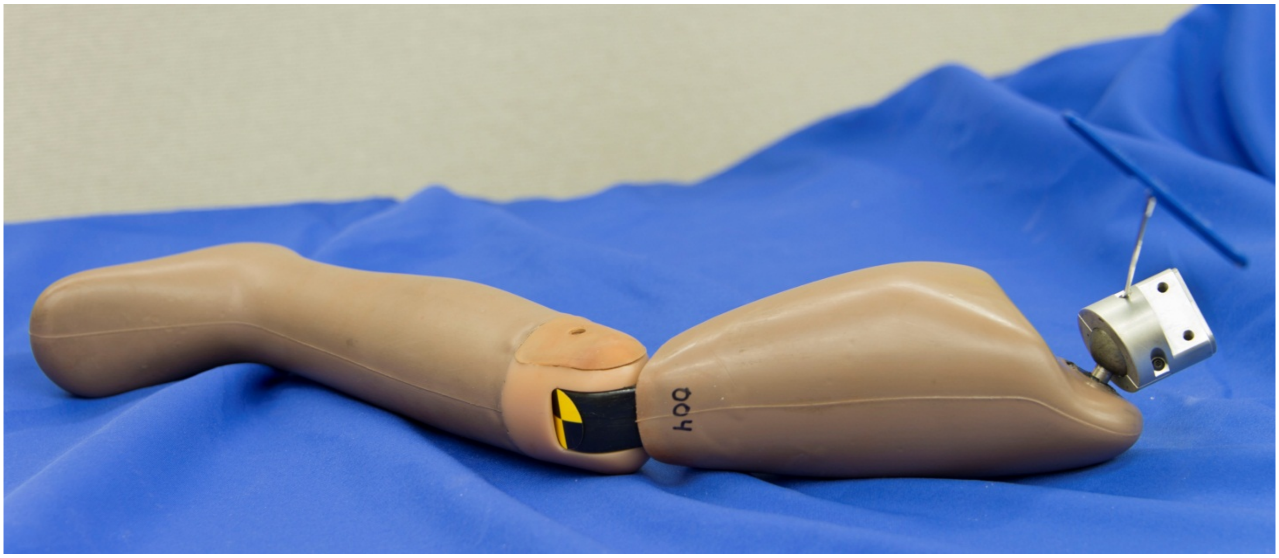


Figure 45. Remove hip joint assembly from leg

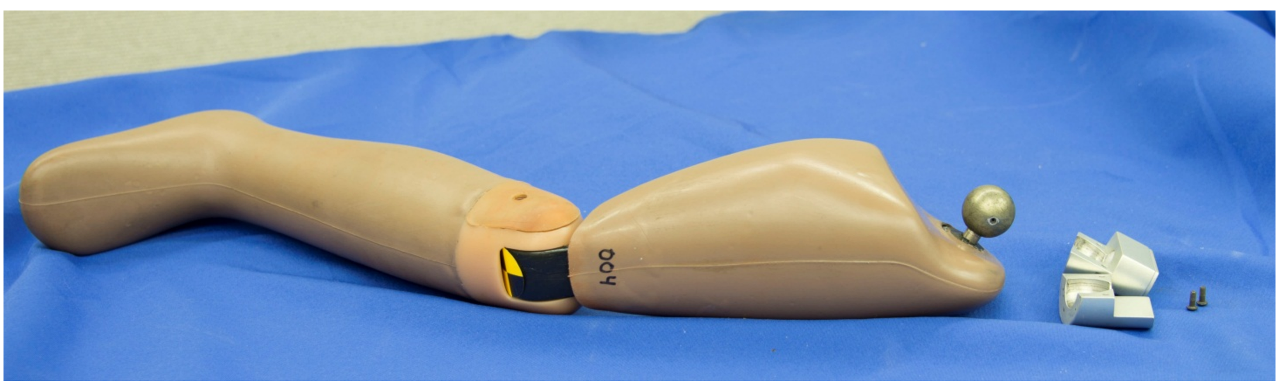


Figure 46. Hip joint assembly removed from leg

[10] The hip joint assembly (020-7113 (left) and 020-7116 (right)) is part of the lower torso assembly.

2. To finish disassembly of the hip joint, see Section 5.7.
3. Remove the stop screw on the inside of the knee (Figure 47).

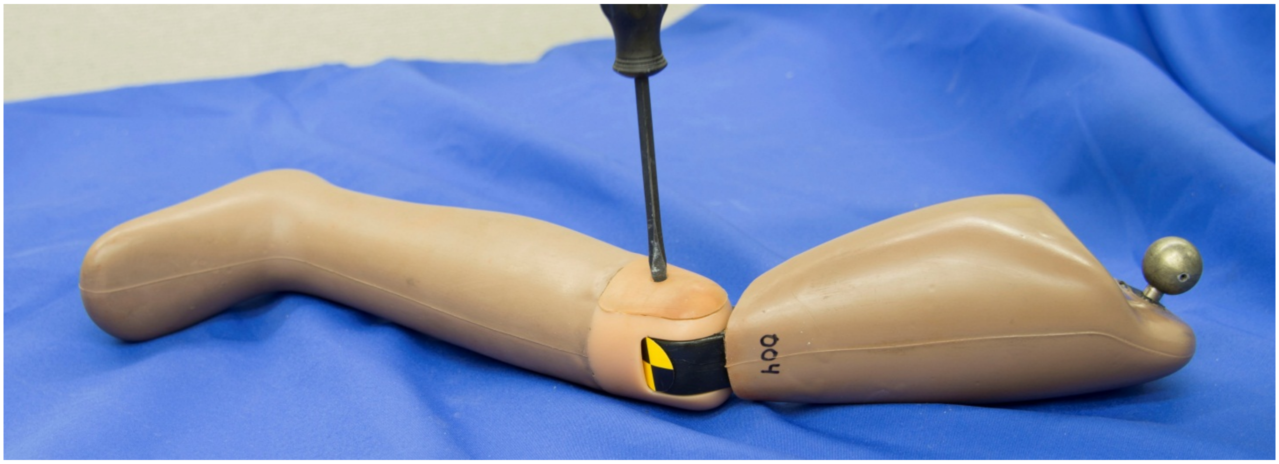


Figure 47. Remove stop screw at knee

4. Disassemble the lower leg assembly from the upper molded leg by removing the knee shoulder screw from the outer side of the knee (Figure 48).

Figure 48. Remove knee shoulder screw

5.5.3 Leg Inspection

- Inspect the legs for tears and wear. Repair or replace if needed.
- Remove and inspect the joint adjustment screw at the knee. Replace if worn.

5.5.4 Leg Assembly and Installation

To assemble the leg, reverse the process described in Sections 5.5.1 and 5.5.2 observing the following reassembly points:

- When reinstalling the leg to the pelvis, be sure that the hip joint is oriented properly with the “flat” on the hip joint oriented downwards.
- Set the torque on the knee shoulder screw (020-9908) to 20 in-lb (2.3 N-m).
- Set the knee joint to a 1G setting using the (stop screw 020-9901) joint adjustment screw located on the inner knee (see Appendix).

5.6 Upper Torso

The components in Table 10 list the parts that are included in the Upper Torso Assembly. Figure 49 through Figure 51 show drawings of the torso assembly components.

Table 10. Torso Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Thoracic spine	1	020-4001	42	1
Lower Neck Load Cell Structural Replacement	1	020-2007	42	2
Q3s Neck/Torso Interface Plate	1	020-2017	42	3
Q3s Rib Cage Assembly	1	020-4018	42	4
Screw, BHCS M5-0.8 x 10mm[11]	4	5000003-FT	42	5
Screw, FHCS M5-0.8 x 12mm	4	5000096-FT	42	6
Screw, SHCS M5-0.8 x 12mm	6	5000002-FT	42	7
IR-TRACC Bracket 1	1	020-4505	42	8
Screw, SHCS M5-0.8 x 20mm	2	5000371-FT	42	9
IR-TRACC Bracket 2	1	020-4502	42	10
Cone Spacer	4	020-4507	42	11
Rod End Mount, Base End	1	020-4508	42	12
Shoulder Screw (#4-40 1/8 x ½”), Modified	2	020-4506	42	13
Screw, SHCS M2-0.4 x 6mm	1	5000082-FT	42	14
Molded Shoulder Assembly, Left	1	020-3510	42	15
Molded Shoulder Assembly, Right	1	020-3520	42	16
Screw, BHCS M4-0.7 x 10mm[12]	14	5000010-FT	42	17
Accelerometer Adapter Assembly	1	020-4515	42	18
Screw, BHCS M4-0.7 x 16mm	2	5000153-FT	42	19
Screw, BHCS M5-0.8 x 12mm[13]	4	5000654-FT	42	20
Q3s Shoulder Cup, Right	1	020-3535	42	21
Q3s Shoulder Cup, Left	1	020-3534	42	22
Screw, FHCS M5-0.8 x 10mm	6	5000084-FT	42	23
Shoulder Shaft	2	020-3536	42	24
Screw, SHCS M5-0.8 x 16mm[14]	2	5000020-FT	42	25
Shoulder Ball	2	020-3537	42	26
Roll Pin, M3 x 20mm	2	5000188-FT	42	27
Shoulder Ball Retainer Ring	2	020-3533	42	28
Cable Guide	1	020-4412	42	29
Screw, FHCS M4-0.7 x 16mm	2	5000447-FT	42	30
IR-TRACC Bracket	1	020-4503	42	31
Screw, FHCS M4-0.7 x 8mm	2	5000646-FT	42	32

[11] Non-standard torque setting of 6 in-lb (0.7 N-m)
[12] Non-standard torque setting of 13 in-lb (1.5 N-m)
[13] Non-standard torque setting of 8 in-lb (0.9 N-m)
[14] Torque setting in the range of 30 in-lb (3.4 N-m) but will vary slightly from arm to arm; tighten so that ball will not turn

Part Description	Quantity	Part Number	Figure #	Item #
Clamp, Nylon Loop	1	9005135-DN	42	33
Screw, SHCS M4-0.7 x 16mm	1	5000025-FT	42	34
Retainer, String Pot	1	020-3549	42	35
Screw, BHCS M3-0.5 x 8mm	1	5000410-FT	42	36
Shoulder String Pot Bracket Assembly	1	020-3539	42	37
Washer, 0.15 I.D. x 0.31 O.D. x 0.062, Viton	6	9003058-FT	42	38
Screw, SHCS M5-0.8 x 10mm	4	5000291-FT	42	39
Stringpot Assembly (left side)[15]	1	SA572-S38	43	1
Screw, BHCS M4-0.7 x 10mm	8	50000010	43	2
Shoulder Stringpot Bracket Assembly	1	020-3539	43	3
Stringpot Retainer	1	020-3549	43	4
Screw, BHCS M3-0.5 x 8mm	1	5000410-FT	43	5
Screw, BHCS M4-0.7 x 10mm	6	5000010-FT	44	1
Ball Plunger, M8-1.25 x 16mm	2	9003792-FT	45	1
Transducer Mounting Block (Upper Spine Accel)	1	SA572-S88	53	-
Screw, BHCS M3-0.5 x 10mm	2	5000436-FT	53	-

[15] Stringpot assembly (right side) is part number SA572-S39

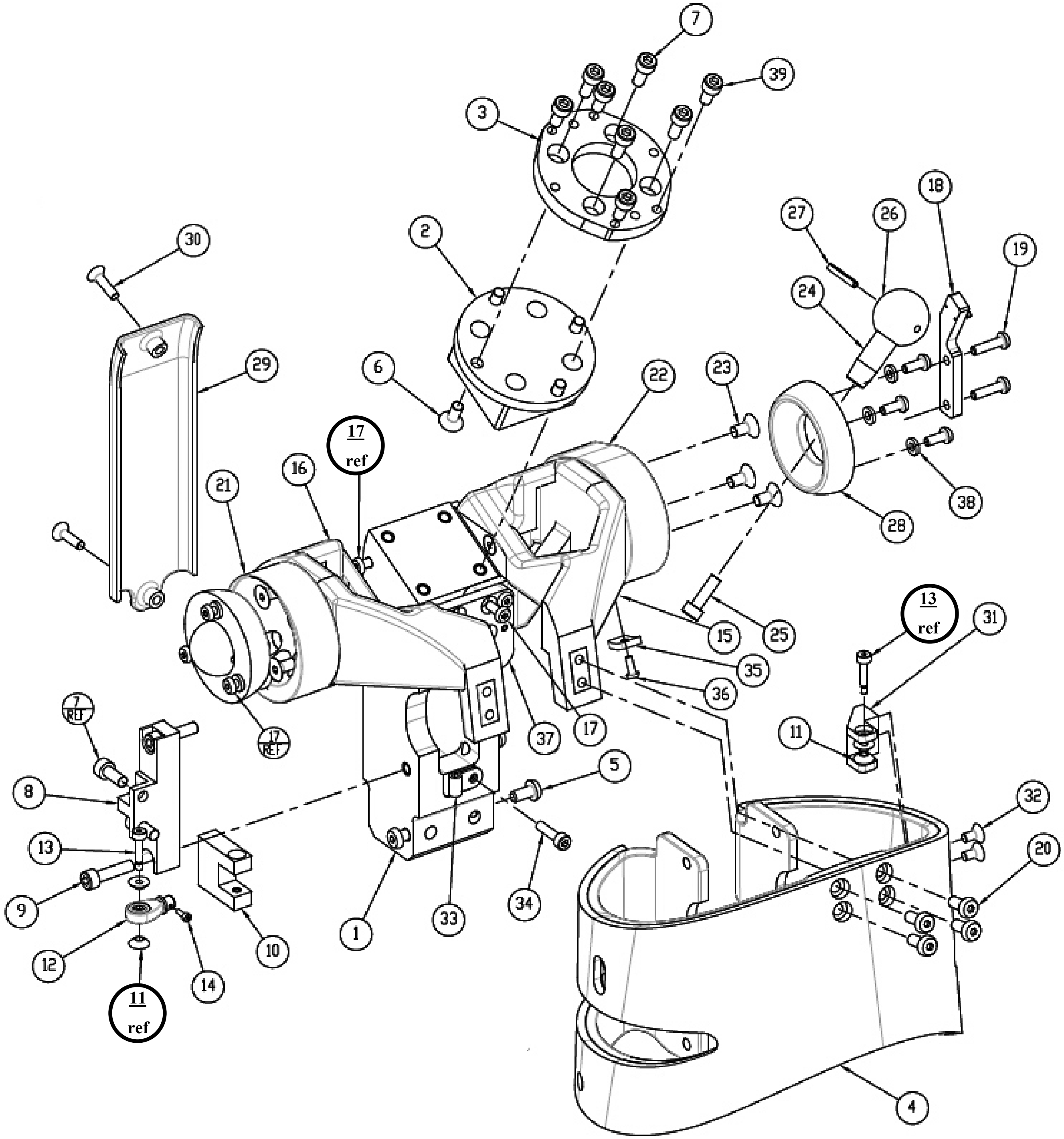


Figure 49. Upper torso assembly – exploded view

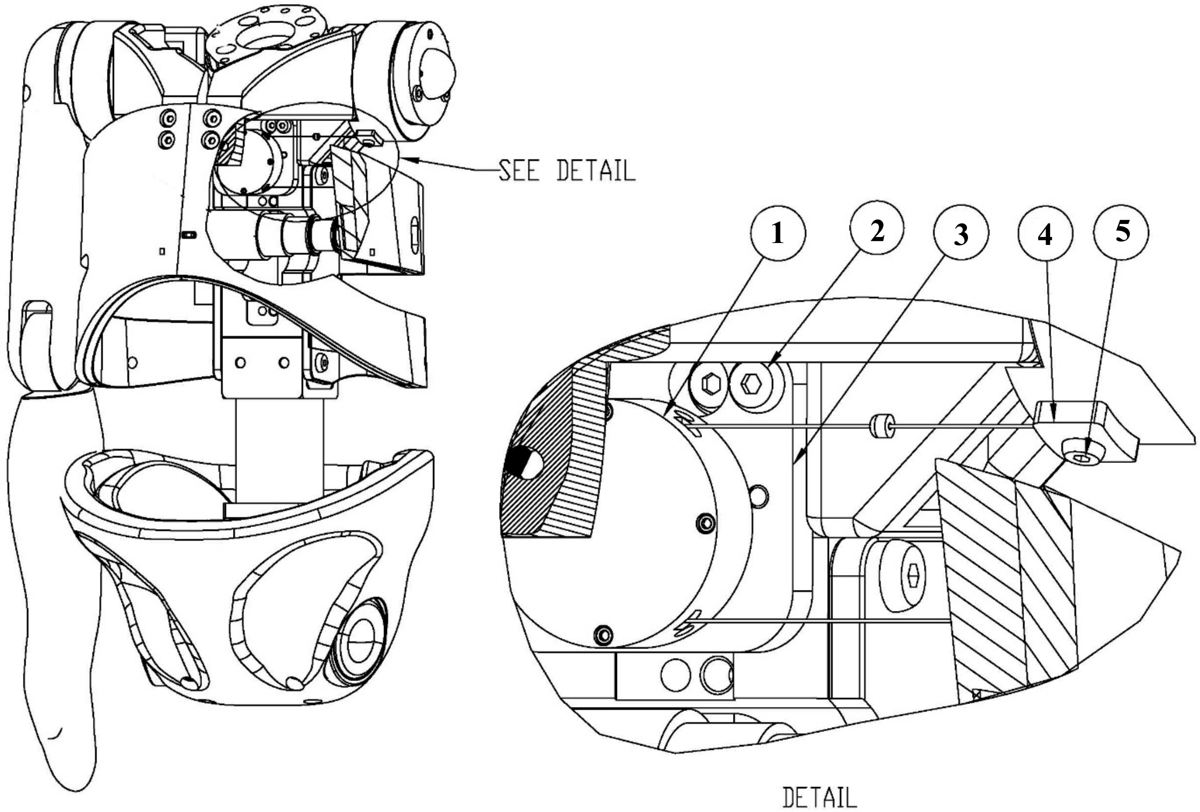


Figure 50. Details of upper torso assembly

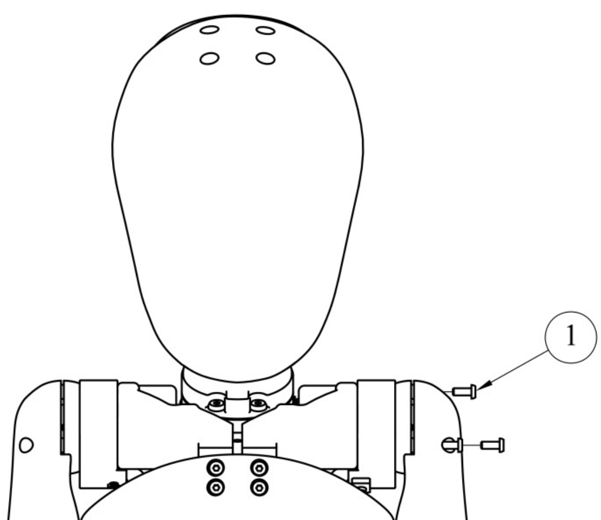


Figure 51. Attachment bolts for arms

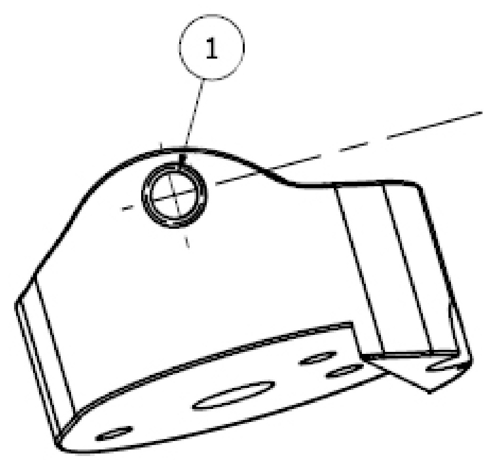


Figure 52. Q3s shoulder cup showing location of ball plunger

5.6.1 Upper Torso Disassembly

1. Remove the suit as described in Section 5.1.
2. Remove the Q3s neck/torso interface plate by removing the four M5-0.8 x 12mm SHCS (Figure 53).

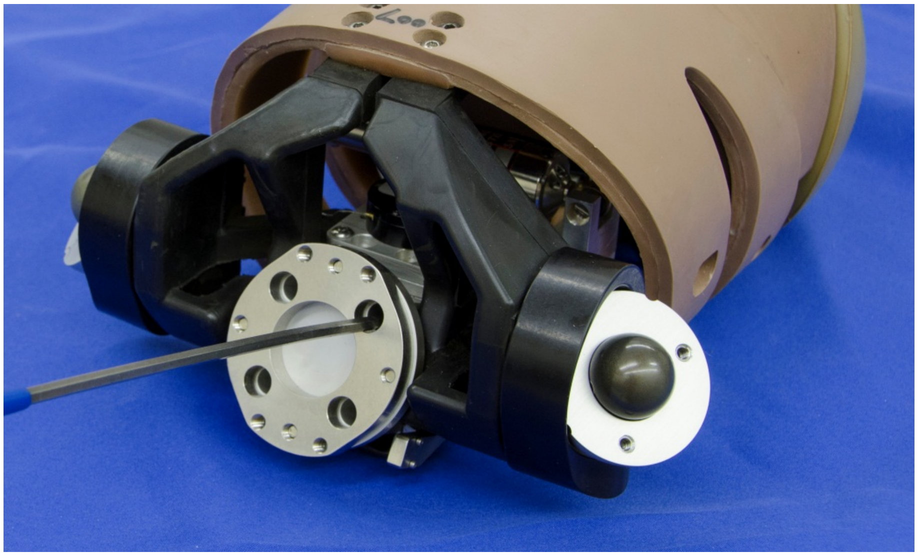


Figure 53. Remove neck/torso interface plate

3. Separate the lower neck load cell structural replacement from the neck/torso interface plate by removing the four M5-0.8 x 12mm FHCS (Figure 54).

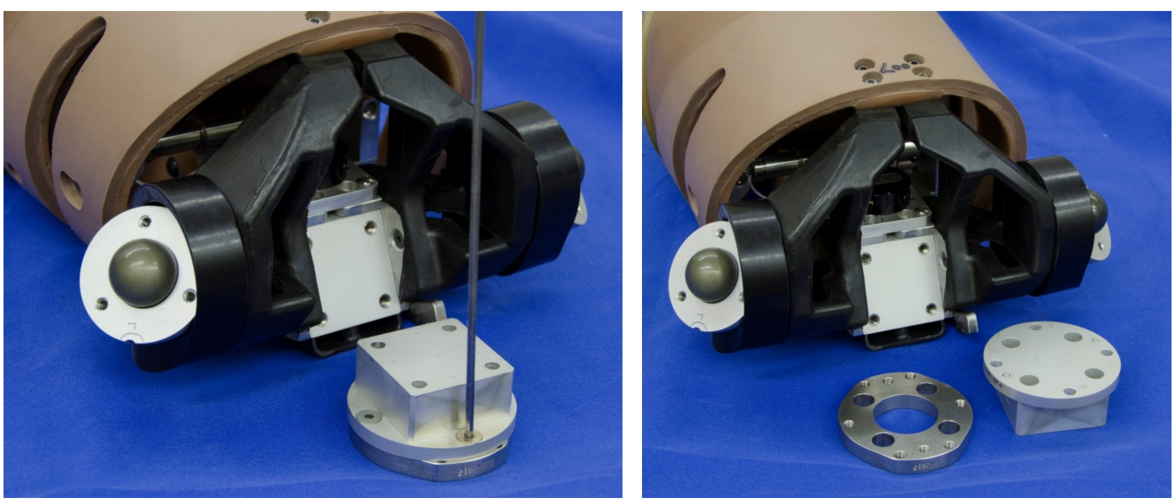


Figure 54. Separating lower neck load cell structural replacement from neck/torso interface plate

4. Back out (but do not remove) the M8-1.25 x 16mm ball plunger[1] screw on the back of the shoulder until the plunger recesses back into the shoulder cup (Figure 55).

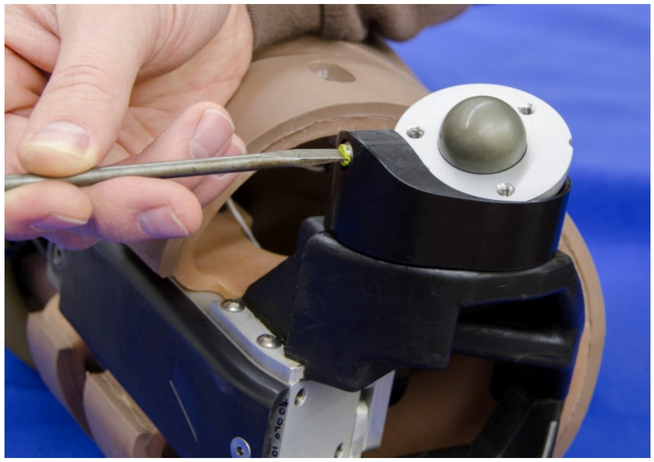
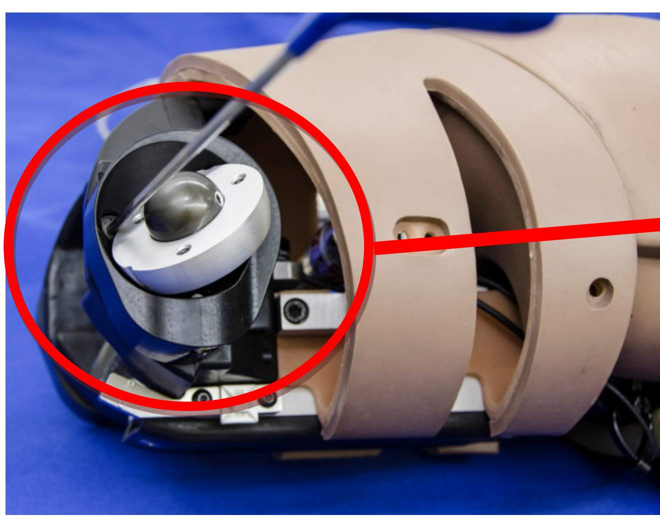


Figure 55. Back out spring-loaded set screw

5. To uninstall the shoulder cup from the torso, move the shoulder ball retainer ring to access the screws. Remove the three M5-0.8 x 10mm FHCS that hold the shoulder cup to the molded shoulder assembly (Figure 56).



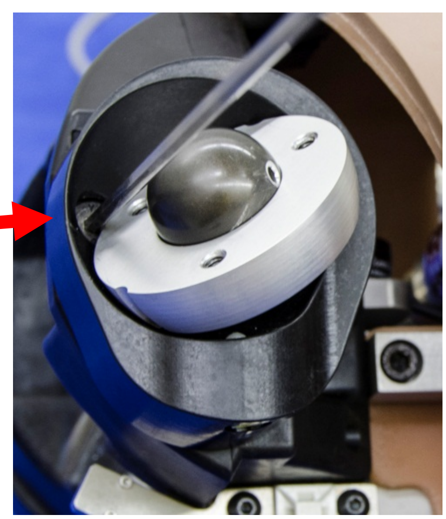


Figure 56. Uninstall shoulder cup from torso

[1] Part #9003792-FT

6. Remove the shoulder ball from the shoulder cup by unscrewing the M5-0.8 x 16mm SHCS about ¾ of the way out (do not remove the SHCS yet) (Figure 57).

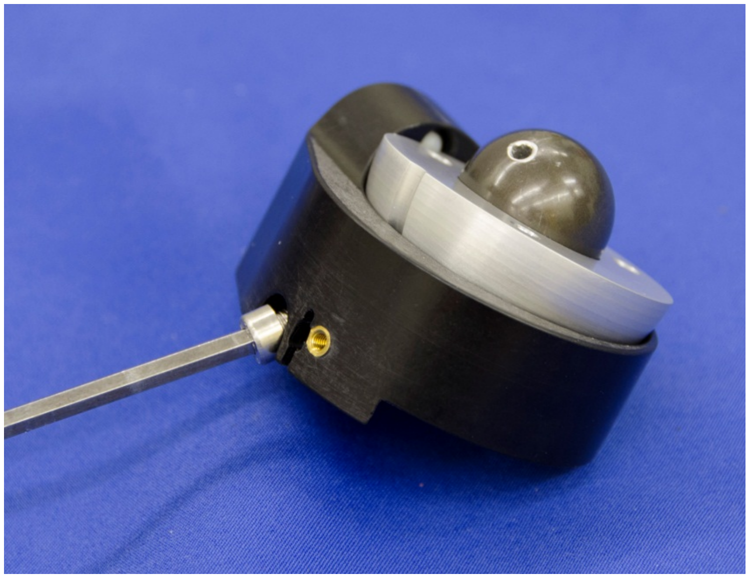


Figure 57. Remove shoulder ball from shoulder cup

7. Push on the screw head to remove the ball from the shoulder assembly. If necessary, use a hammer to tap the SHCS *carefully* so as not to damage the shoulder cup (Figure 58).

Figure 58. Using a hammer to remove shoulder ball

8. Remove the cable guide over the spine area by taking out the two M4-0.7 x 16mm FHCS (Figure 59).

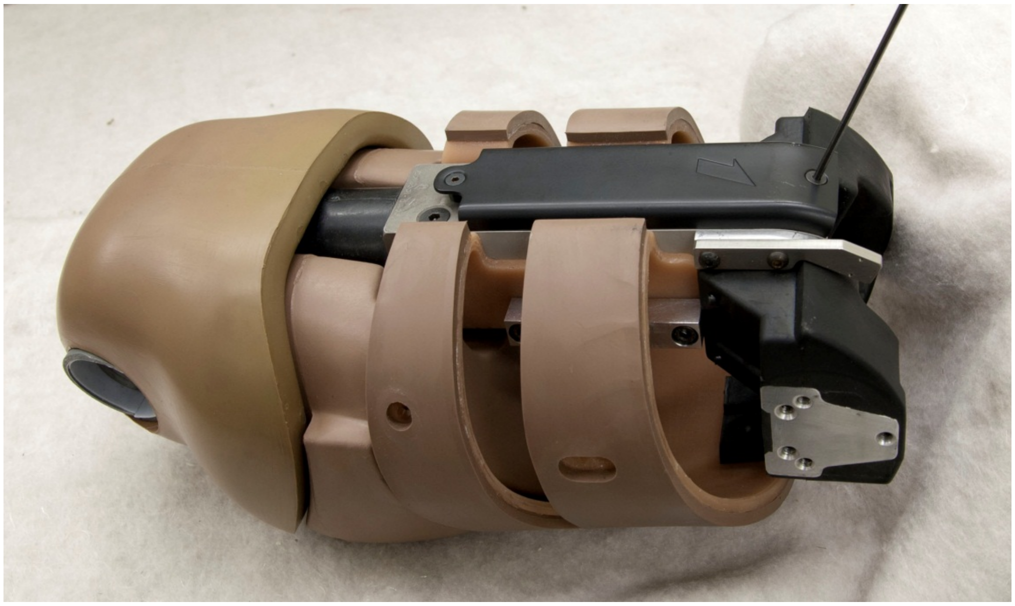


Figure 59. Remove cable guide over spine

9. Remove the two M3-0.5 x 10mm BHCS that secure the upper spine accelerometer mounting bracket to the thoracic spine (Figure 60).

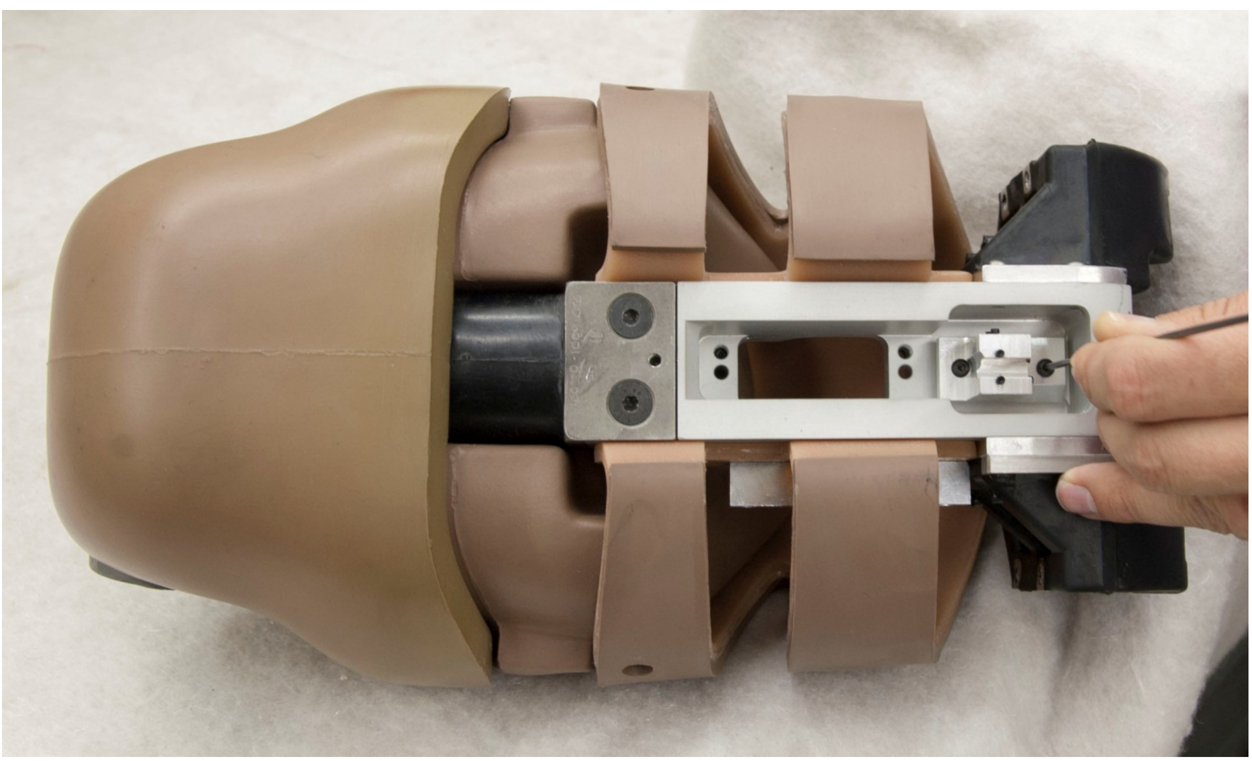


Figure 60. Remove upper spine accelerometer mounting bracket

10. Separate the lumbar from the thorax by removing two FHCS lumbar spine mounting screws (Figure 61 and Figure 62).

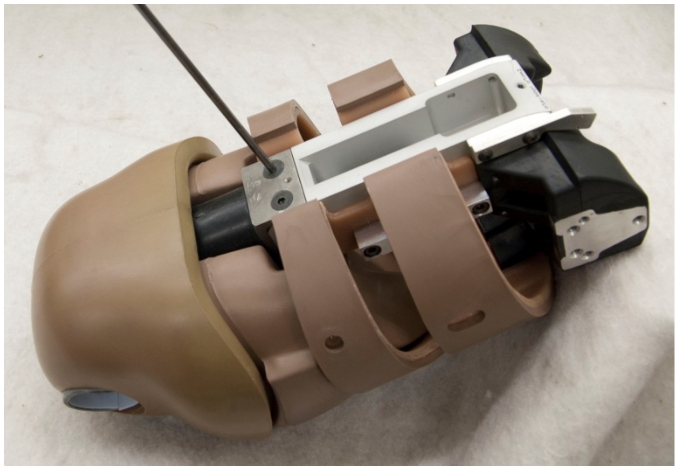


Figure 61. Remove the lumbar spine mounting screws to separate thorax from lumbar/pelvis

Figure 62. Separate thorax from pelvis

11. Take out the two M5-0.8 x 20mm SHCS to remove IR-TRACC bracket 1 (Figure 63 and Figure 64).

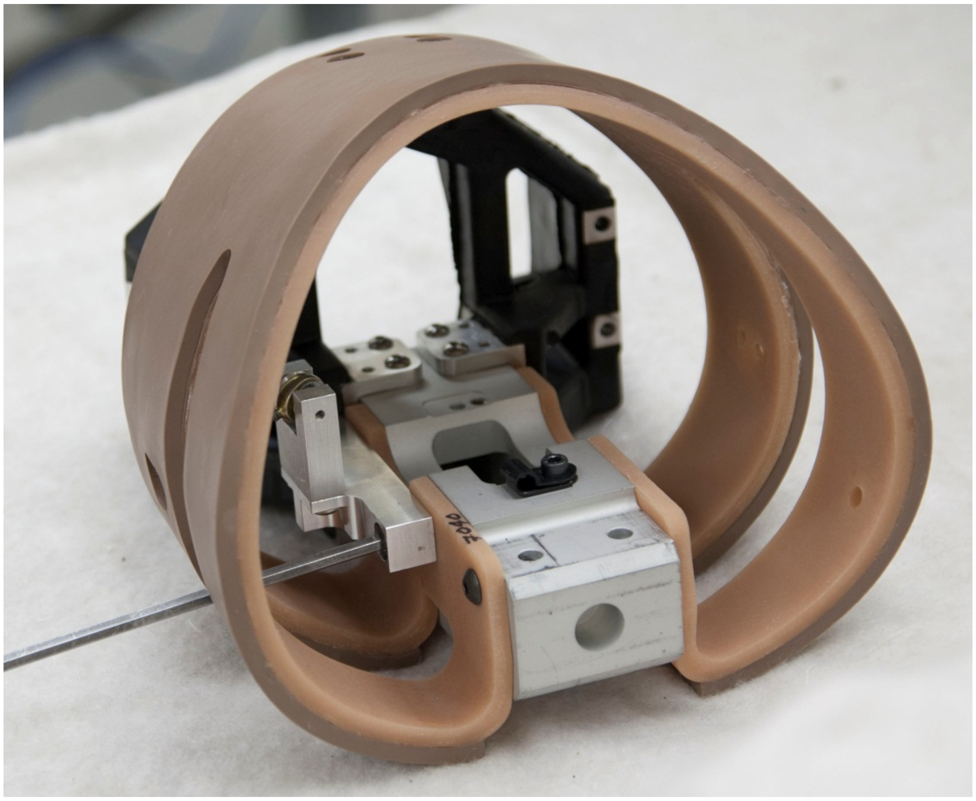


Figure 63. Remove IR-TRACC bracket 1 from thorax

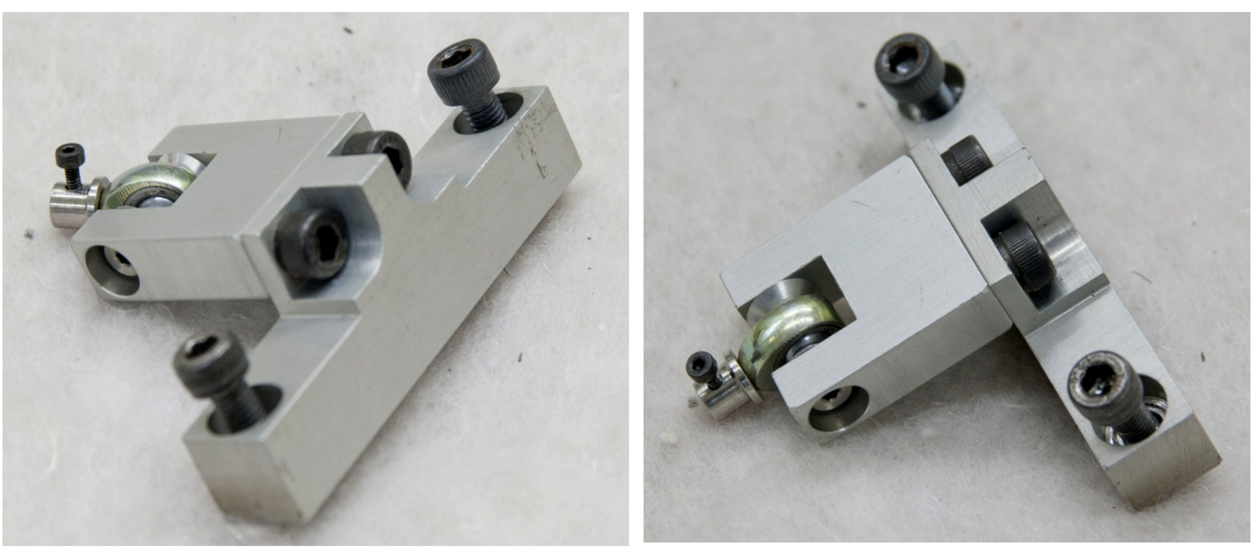


Figure 64. IR-TRACC bracket 1 removed from thorax

12. If necessary, disassemble IR-TRACC bracket 2 from IR-TRACC bracket 1 by removing two M5-0.8 x 12mm SHCS (Figure 65).

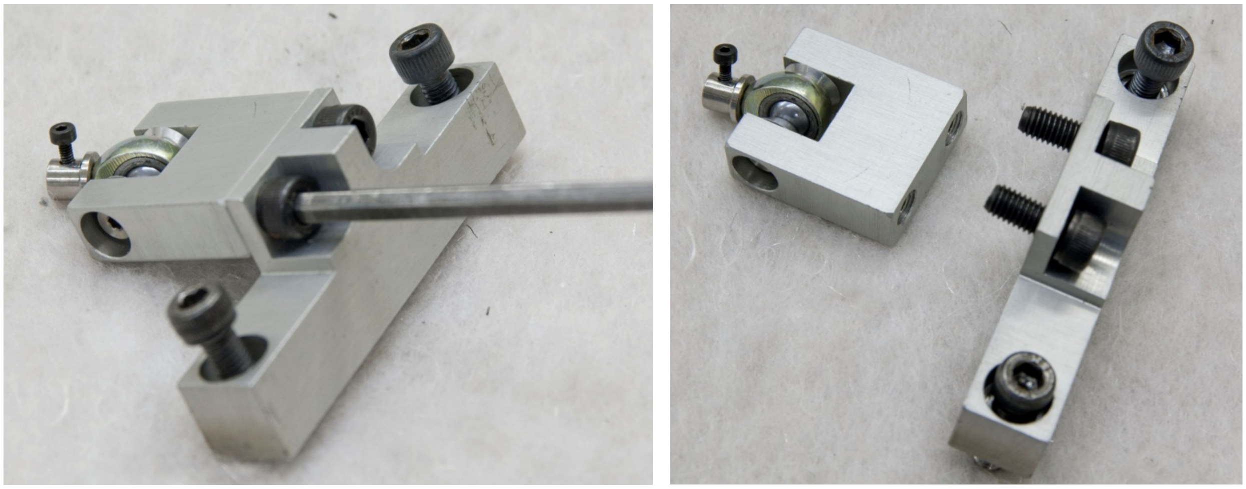


Figure 65. Disassemble IR-TRACC bracket 2 from IR-TRACC bracket 1

13. Remove the rod end mount from IR-TRACC bracket 2 by taking out the #4-40 1/8 x ½" modified shoulder screw and removing the two cone spacers (Figure 66).

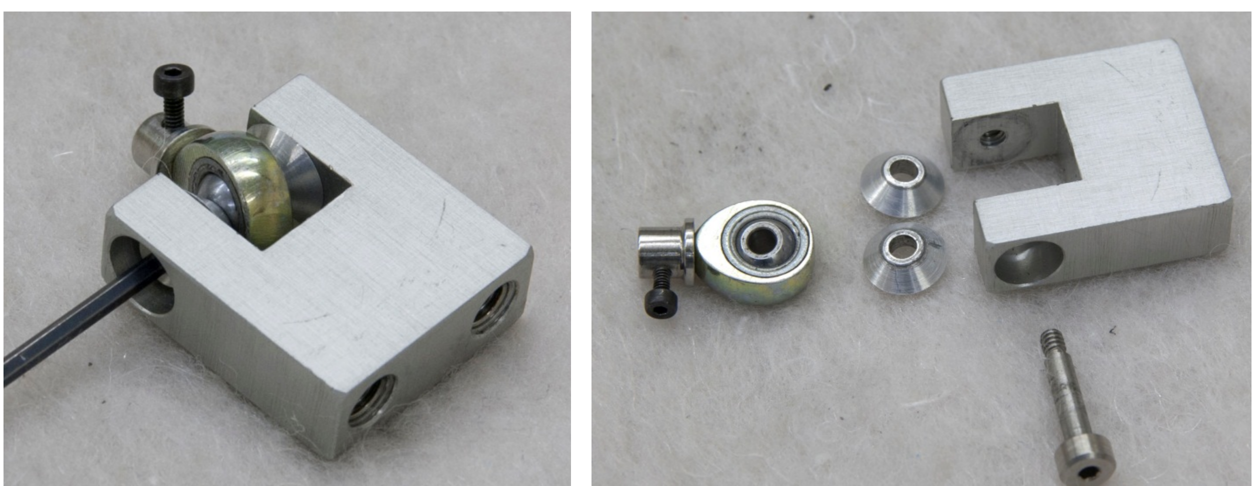


Figure 66. Remove the rod end mount from IR-TRACC bracket 2

14. To remove the ribcage from the spine, insert the wrench through the ribcage assembly to remove one M5-0.8 x 10mm BHCS from each side (left and right) of the lower thoracic spine (Figure 67).

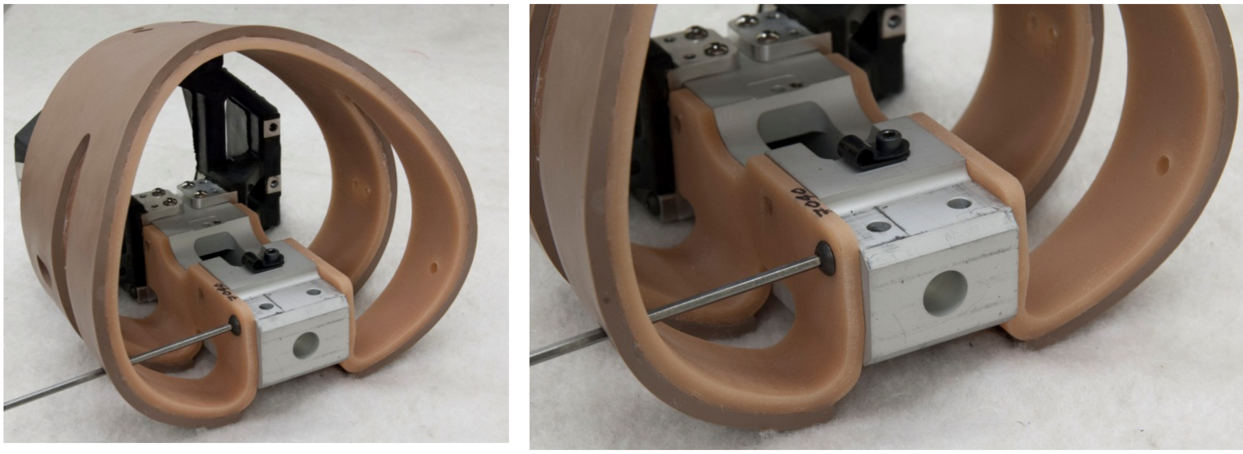


Figure 67. Remove screws which attach ribcage assembly to thoracic spine

15. Remove four M5-0.8 x 12mm BHCS from the ribcage assembly to separate it from the molded shoulder assembly (Figure 68 and Figure 69).

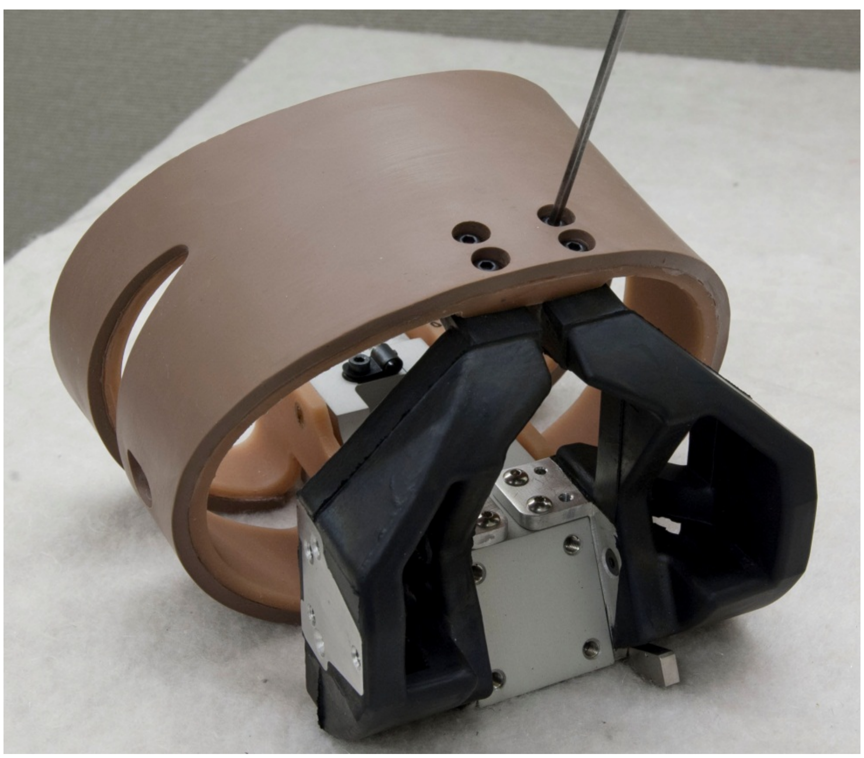


Figure 68. Remove molded shoulder assembly from ribcage assembly

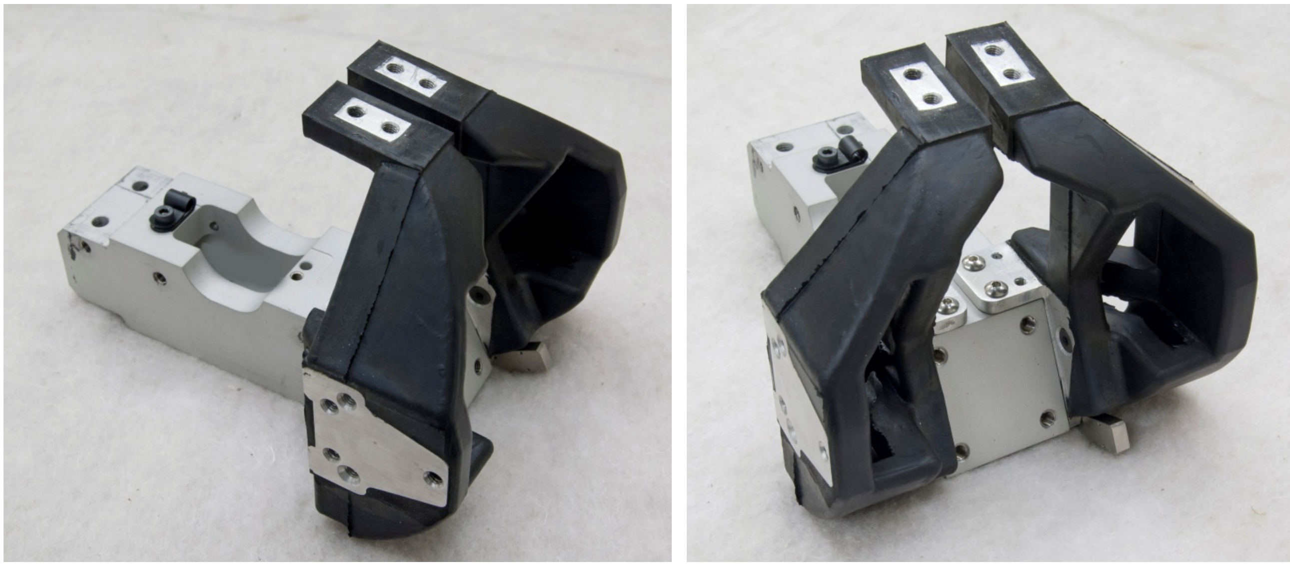


Figure 69. Molded shoulder assembly separated from ribcage assembly

16. Separate the accelerometer adaptor assembly[2] from the thoracic spine by removing two M4-0.7 x 16mm BHCS (Figure 70).

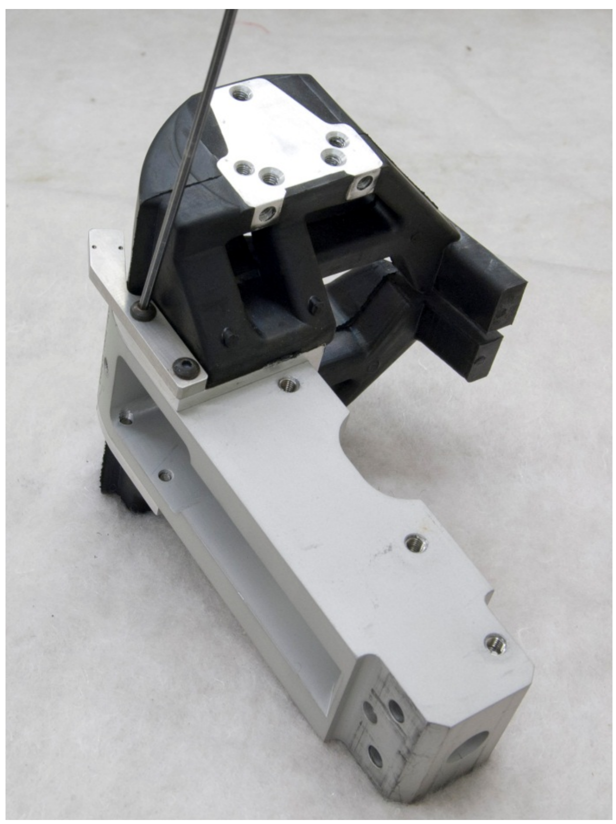


Figure 70. Remove accelerometer adaptor assembly from thoracic spine

[2] The accelerometer adaptor, when in use, is installed on the non-struck side of the dummy.

17. Remove the two M4-0.7 x 10mm BHCS from the side opposite of the accelerometer adaptor (Figure 71).

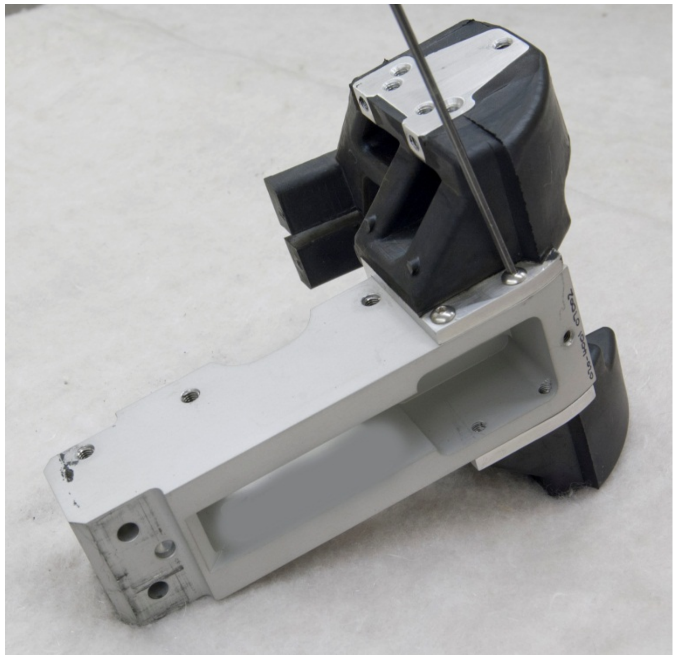


Figure 71. Remove screws on opposite side of accelerometer adaptor

18. Remove the four (two from each right and left shoulder assembly) M4-0.7 x10mm BHCS from the front of the thoracic spine (Figure 72 and Figure 73).

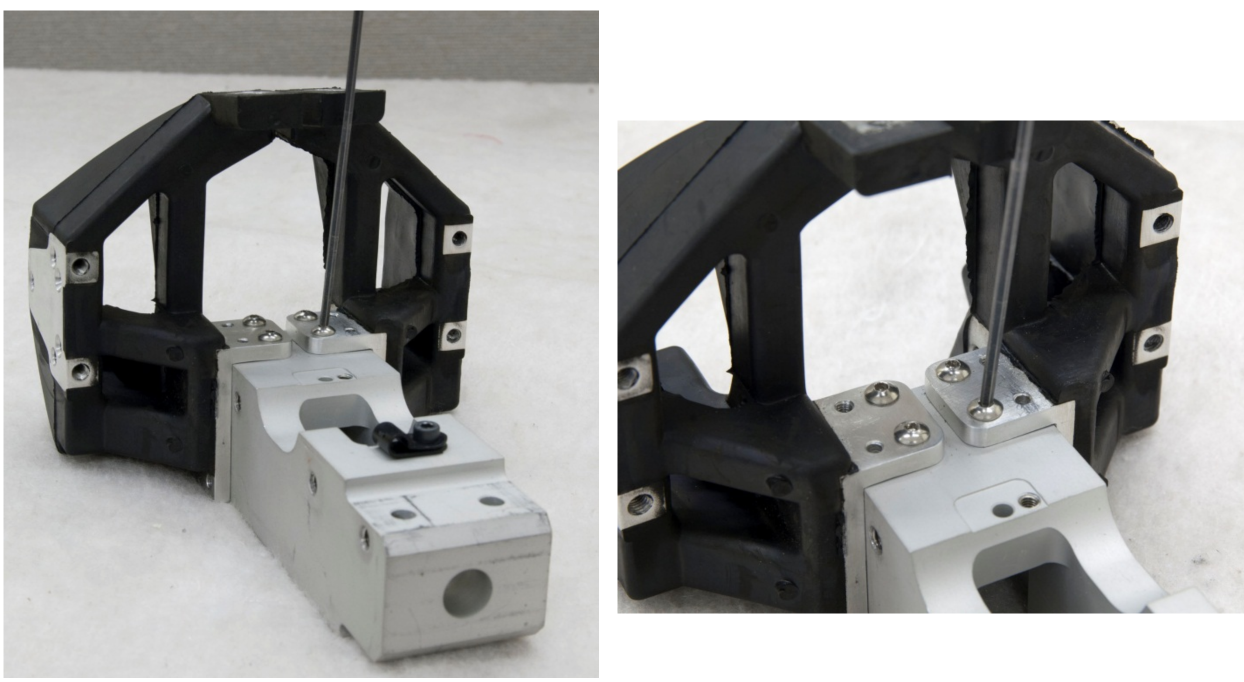


Figure 72. Remove the molded shoulder assembly from the thoracic spine

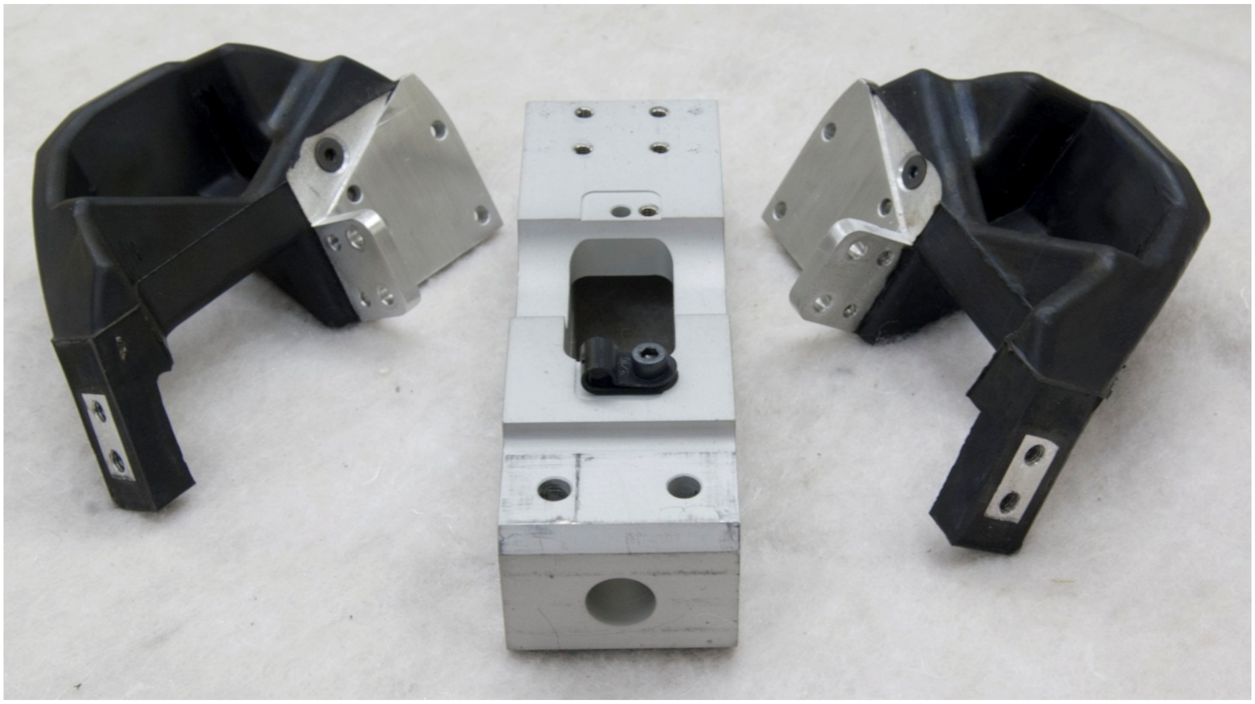


Figure 73. Left and right molded shoulder assemblies separated from thoracic spine

19. Remove the nylon loop clamp cable holder which secures the IR-TRACC and shoulder stringpot instrumentation cables by taking out the M4-0.7 x 16mm SHCS (Figure 74).

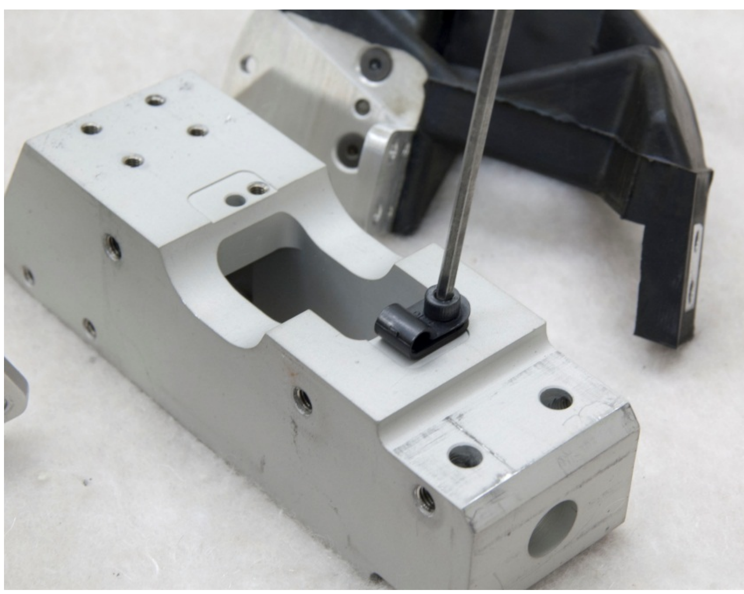


Figure 74. Remove optional cable holder from thoracic spine

5.6.2 Upper Torso Inspection

- Carefully inspect the ribcage for cracks. Replace if cracks are evident.
- Be certain that the T1 accelerometer (if utilized) is located on the non-struck side of the dummy.

5.6.3 Upper Torso Assembly and Installation

To assemble the torso, reverse the process described in Sections 5.6.1 observing the following reassembly points:

- The torque setting for the M5-0.8 x 10mm BHCS (Item 5 on Figure 49) should be set to 6 in-lb (0.7 N-m). This differs from the "standard" torque setting of 20 in-lb for this size of screw.
- The torque setting for the M4-0.7 x 10mm BHCS (Item 17 on Figure 49) should be set to 13 in-lb (1.5 N-m). This differs from the "standard" torque setting of 10 in-lb for this size of screw.
- The torque setting for the M5-0.8 x 12mm BHCS (Item 20 on Figure 49) should be set to 8 in-lb (0.9 N-m). This differs from the "standard" torque setting of 20 in-lb for this size of screw.
- The torque setting for the M5-0.8 x 16mm SHCS (Item 25 on Figure 49) is in the range of 30 in-lb (3.4 N-m). This setting will vary from arm to arm. The screw should be tightened so that the ball does not turn.
- The tension on the detent on the shoulder joint *must* be set *prior* to adjusting the shoulder joint torque (Appendix B).
- To set the tension on the shoulder detent:

    1. Align the shoulder ball retainer ring so that the portion of the retainer ring *with only one* threaded screw hole between the detent tracks is at the top of the shoulder cup (Figure 75).
    2. Insert the M8-1.25 x 16mm ball plunger screw into the shoulder cup (Figure 75).

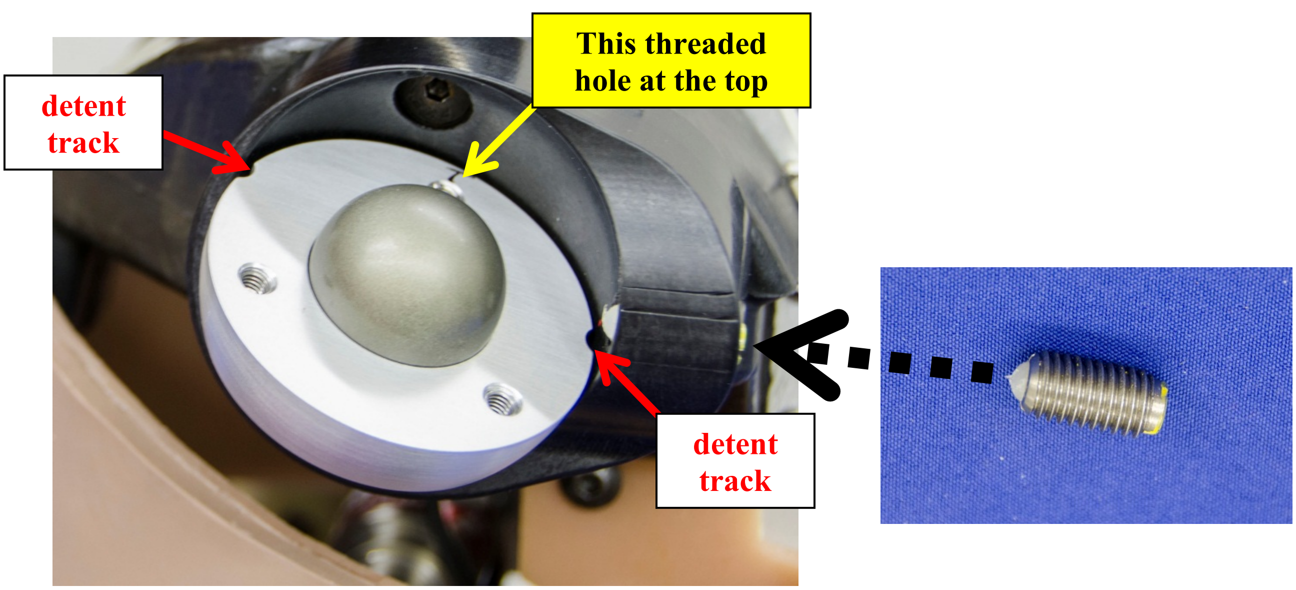


Figure 75. Aligning the shoulder ball retaining ring for proper installation of the shoulder

3. Thread the M8-1.25 x 16mm ball plunger screw until it protrudes into the detent (Figure 76). Stop threading the screw when the metal portion of the screw just becomes visible in the detent. Back the screw out slightly so that the metal portion of the screw is no longer visible. This placement technique will provide sufficient resistance to hold the shoulder in place within the detent.

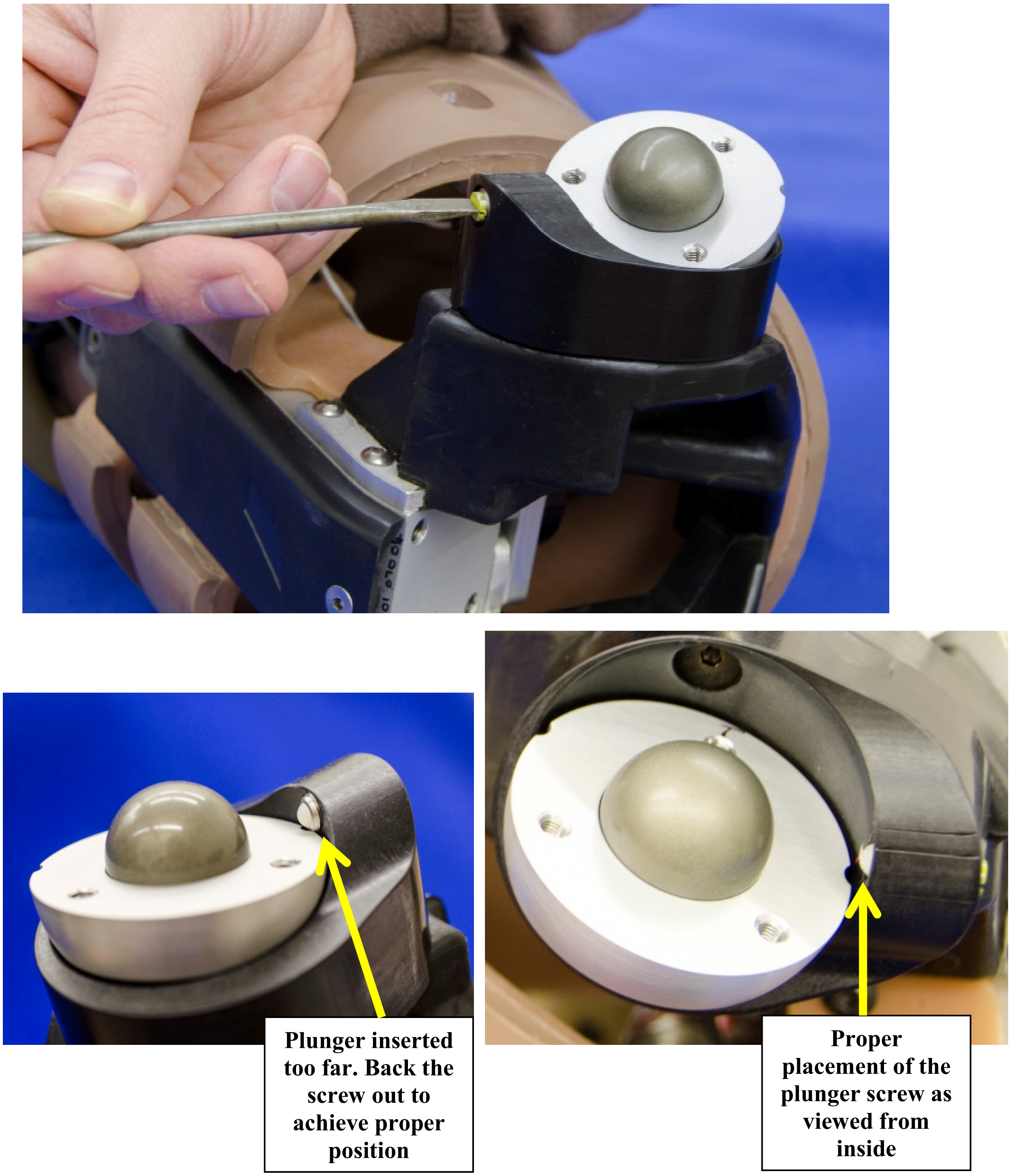


Figure 76. Screwing the spring-loaded screw into the shoulder detent

5.7 Lower Torso

Table 11. Lower Torso Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Lumbar Spine Assembly	1	020-6000	70	1
Lumbar Spine Mounting Screw	2	020-9902	70	2
Load Cell Structural Replacement	1	020-2007	70	3
Screw, SHCS M5-0.8 x 12mm	4	5000002-FT	70	4
Screw, FHCS M5-0.8 x 12mm	4	5000096-FT	70	5
Q3s Pelvis Assembly	1	020-7500	70	6
Abdomen	1	020-5000	70	7

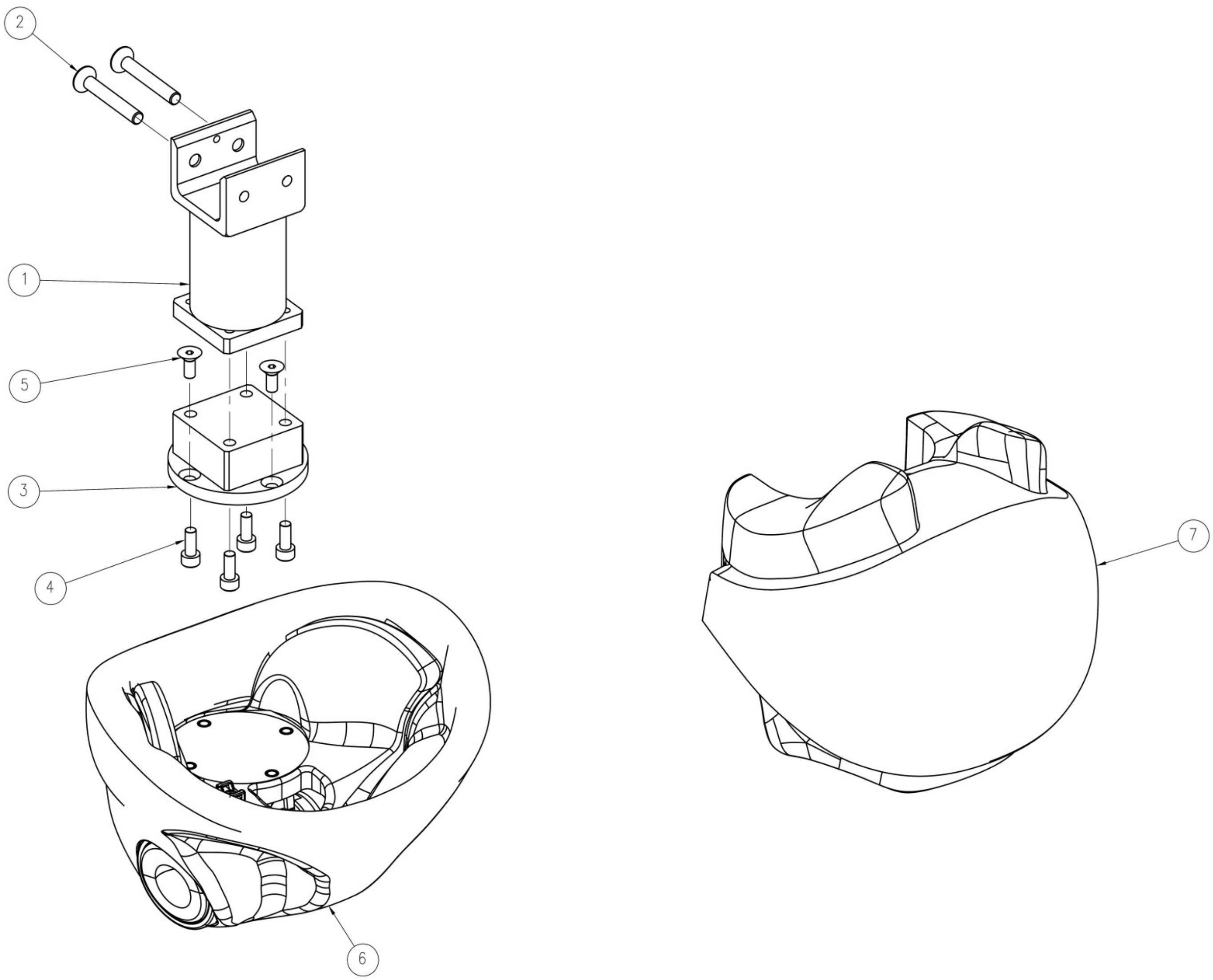


Figure 77. Lower torso assembly – exploded view

Table 12. Pelvis Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Q3s Machined Pelvis	1	020-7503	71	1
Pelvis Skin	1	020-7502	71	2
Pubic Load Cell Assembly	1	034-4110	71	3
Hip Joint Assembly, Left	1	020-7113	71	4
Hip Joint Assembly, Right	1	020-7116	71	5
Hip Joint Slide Cover	2	020-7135	71	6
Screw, SHCS M5-0.8 x 10mm[3]	8	5000291-FT	71	7
Cable Tie Mount, #4 Screw, Nylon	2	6002036	71	8
Screw, BHCS M2.5-0.45 x 6mm	2	5000244	71	9

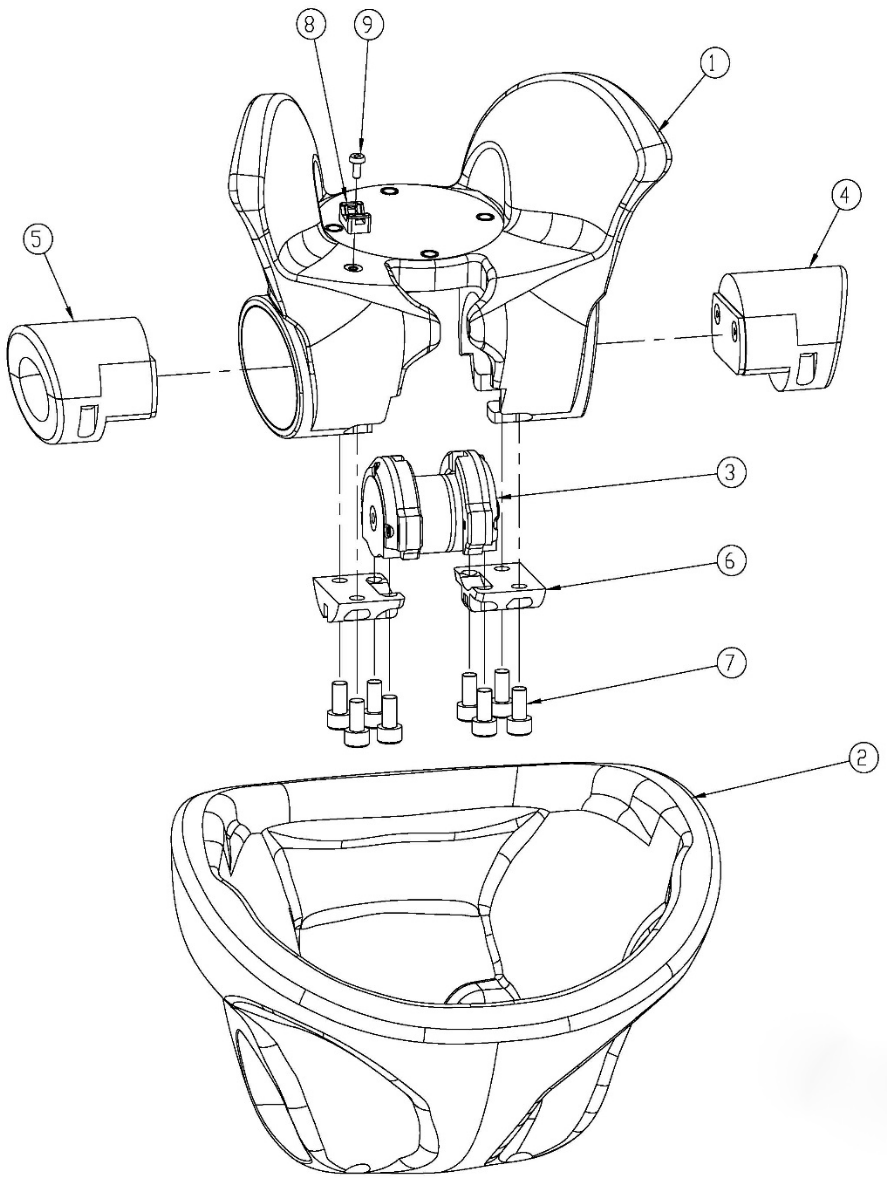


Figure 78. Pelvis assembly – exploded view

[3] Non-standard torque setting of 25 in-lb (2.8 N-m)

Table 13. Hip Joint Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Hip Joint Pair, (Left)[4]	1	020-7114	72	1
Lower Metal, Hip Joint	1	020-7117	72	1a
Upper Metal, Hip Joint	1	020-7118	72	1b
Detent Peg	1	020-7103	72	2
Spring LCM090F01M	1	5000650	72	3
Spring Retainer Plate	1	020-7104	72	4
Screw, FHCS M3-0.5 x 6mm	2	5000098	72	5
Screw, BHCS M3-0.5 x 8mm	2	5000410-FT	72	6

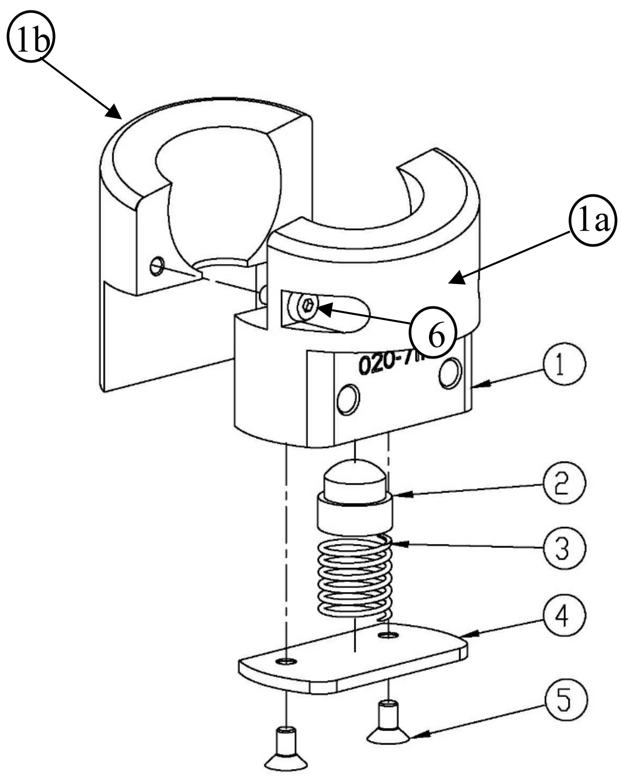


Figure 79. Hip joint assembly – exploded view

[4] Hip Joint Pair, Right is Part Number 020-7115

Table 14. Pubic Load Cell Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Hip Joint Slide Assembly	1	020-7136	73	1
Pubic Load Cell Structural Replacement	1	020-7150	73	2
Molded Pubic Buffer	1	020-7128	73	3
Hip Joint Slide Assembly (Spacer Side)	1	020-7137	73	4
Screw, SHCS M4-0.7 x 40mm	1	5000666	73	5

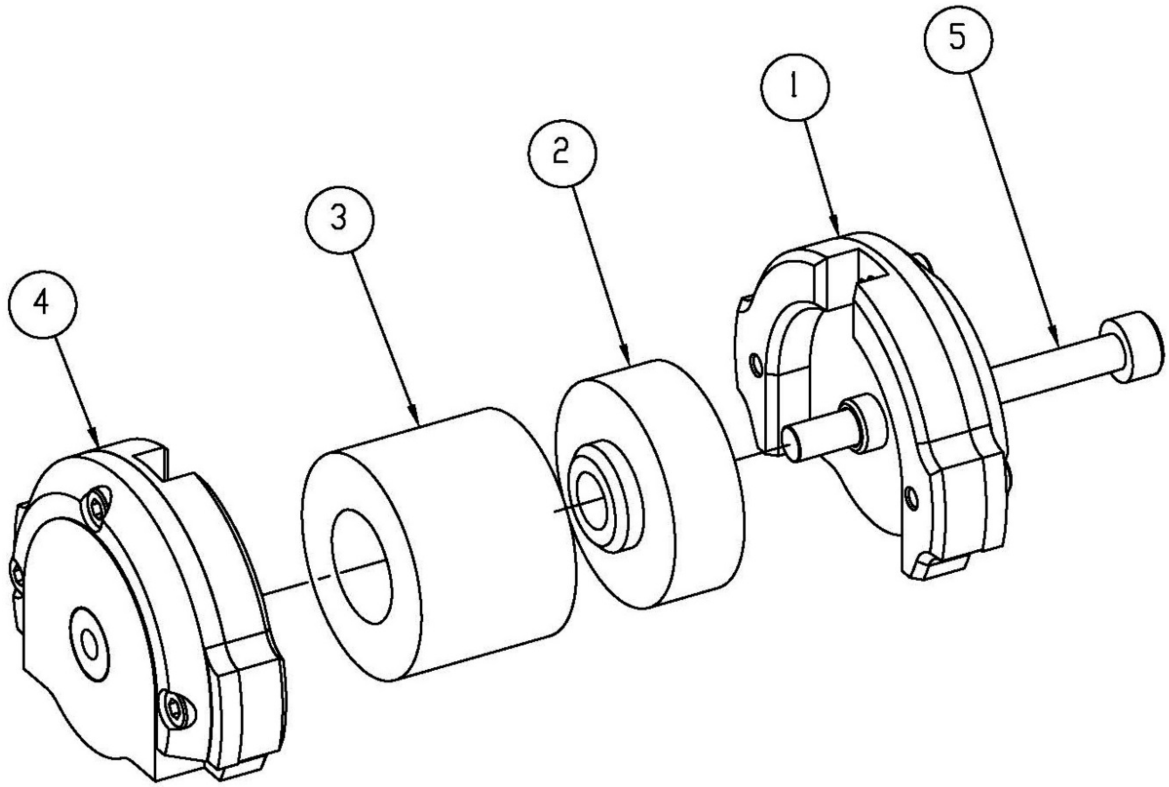


Figure 80. Pubic load cell assembly – exploded view

Table 15. Hip Joint Slide Assembly Components

Part Description	Quantity	Part Number	Figure #	Item #
Hip Joint Slide	1	020-7144	74	1
Hip Joint Sleeve	1	020-7139	74	2
Hip Joint Slide Spacer	1	020-7125	74	3
Screw, SHCS M2.5-0.45 x 5mm	3	5000641	74	4

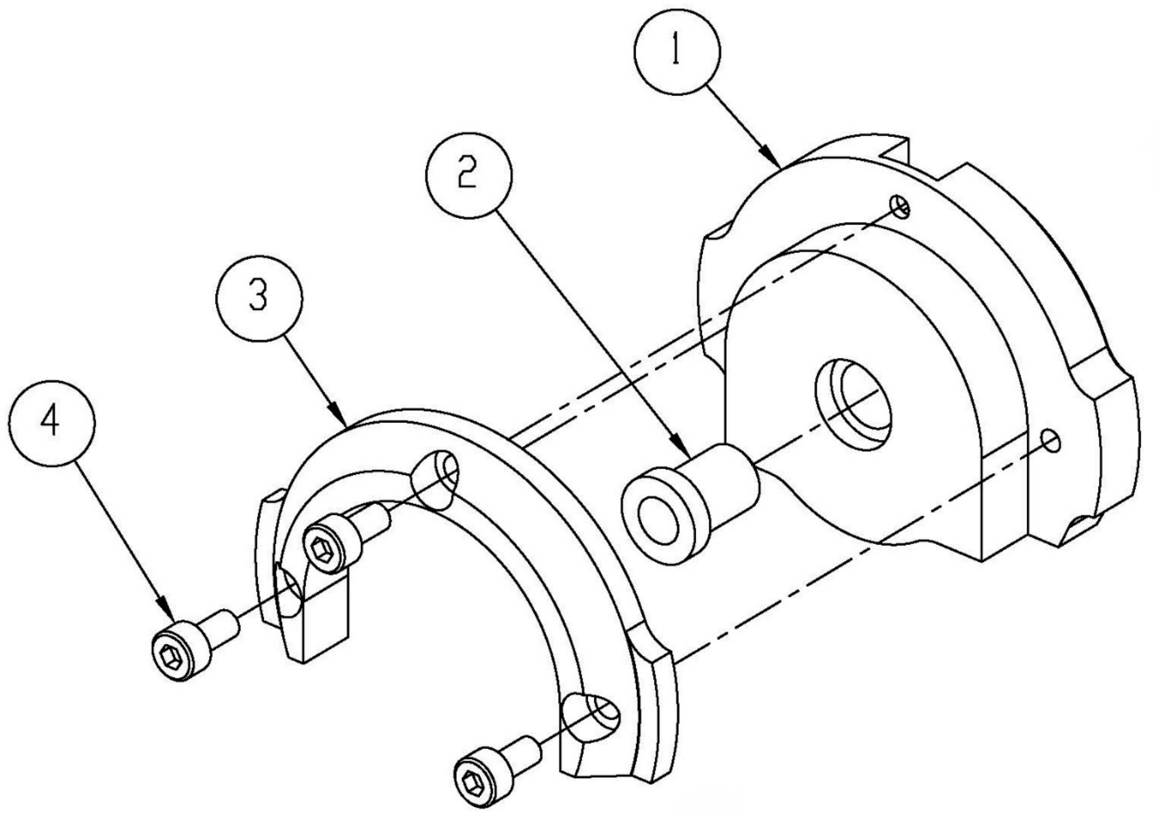


Figure 81. Hip joint slide assembly – exploded view

Table 16. Hip Joint Slide Assembly (Spacer Side) Components

Part Description	Quantity	Part Number	Figure #	Item #
Hip Joint Slide	1	020-7144	75	1
Hip Joint (Thread) Sleeve	1	020-7138	75	2
Hip Joint Slide Pin	1	020-7143	75	3
Hip Joint Slide Spacer	1	020-7125	75	4
Screw, SHCS M2.5-0.45 x 5mm	3	5000641	75	5

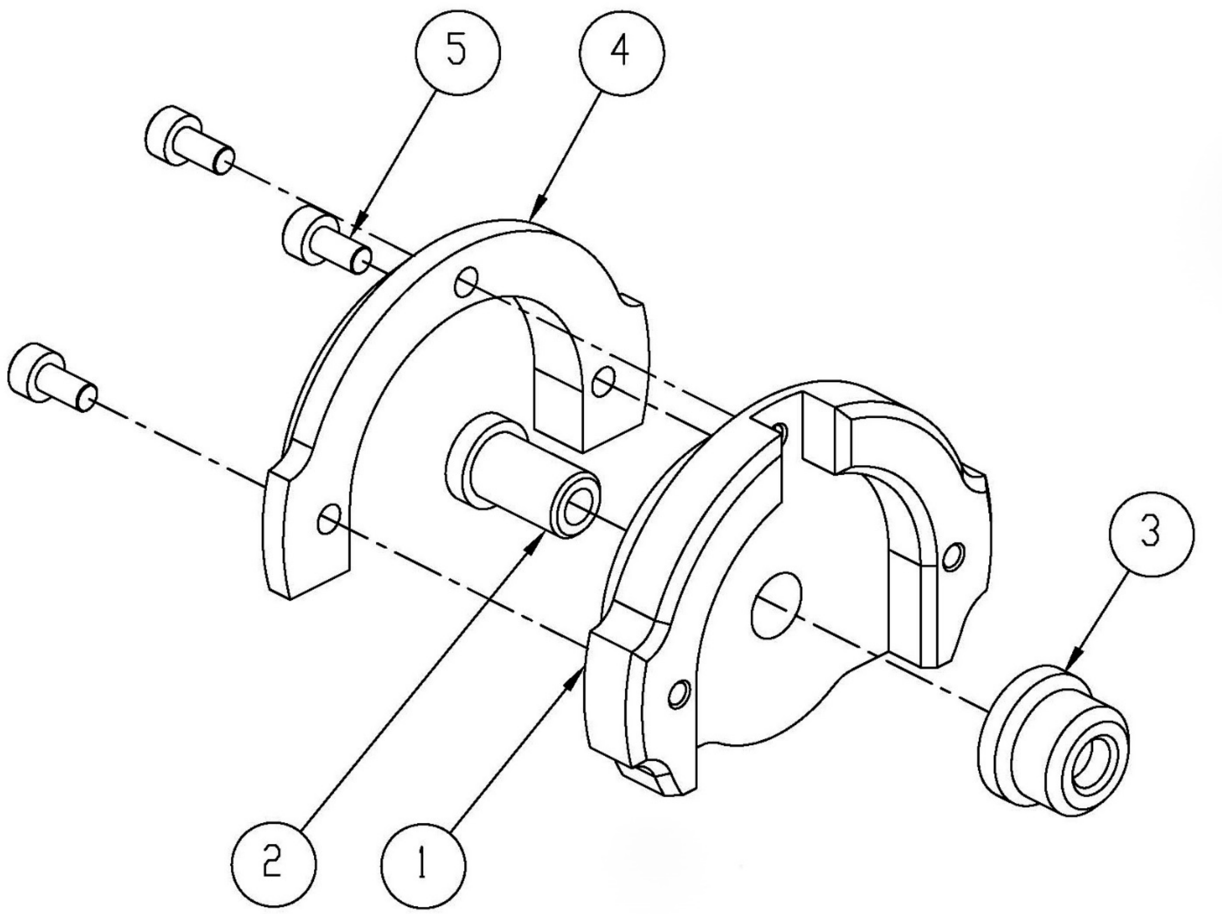


Figure 82. Hip joint slide assembly (spacer side) components

5.7.1 Lower Torso Disassembly

1. Disassemble the hip joint assembly from the leg by removing the two M3-0.5 x 8mm BHCS (Figure 83 - Figure 85).

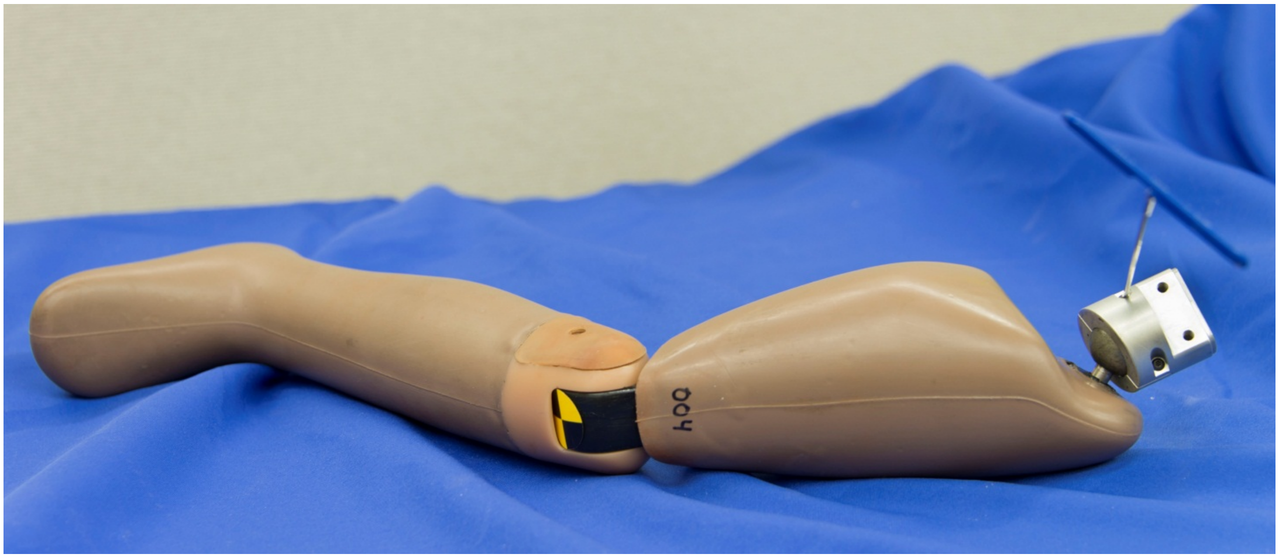


Figure 83. Remove hip joint assembly from leg

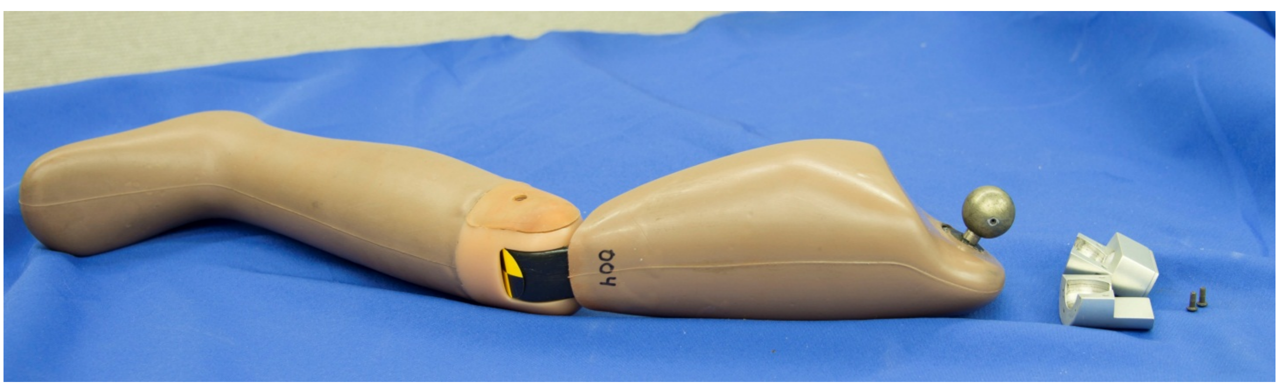


Figure 84. Hip joint assembly removed from leg

Figure 85. Hip joint after separating from leg

2. Take off the spring retainer plate by removing the two M3-0.5 x6mm FHCS (Figure 86 and Figure 87). The spring and detent peg can then be removed from the recess (Figure 88).

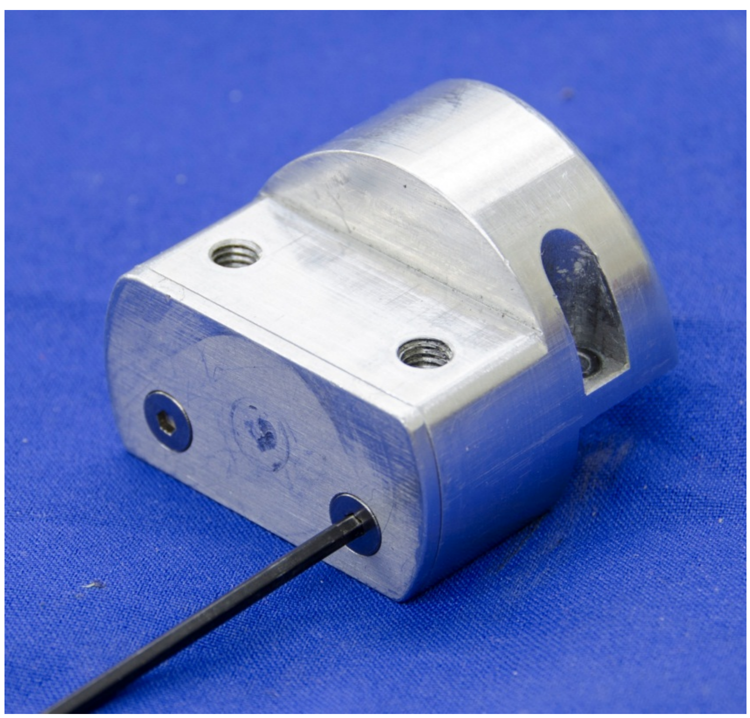


Figure 86. Remove spring retainer plate

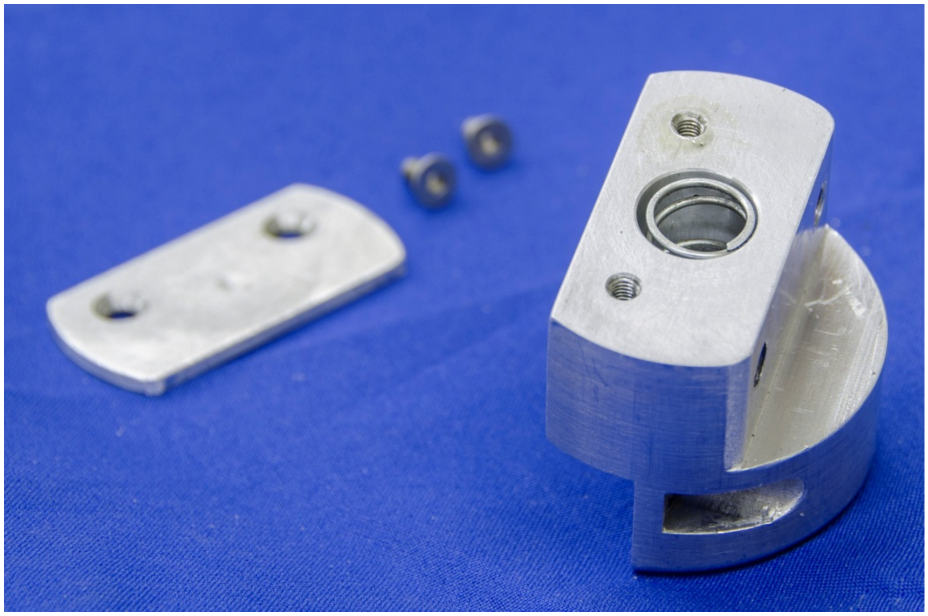


Figure 87. Spring retainer plate removed from hip joint assembly

Figure 88. Spring and detent peg removed from hip joint assembly

3. Remove the abdomen by pulling it upwards out of the pelvis (Figure 89).

Figure 89. Remove abdomen from pelvis

4. Remove the pelvis flesh from the pelvis assembly by grasping the lumbar spine assembly and rocking the pelvis bone out of the flesh (Figure 90).

Figure 90. Remove pelvis flesh

5. Separate the lumbar spine assembly from the pelvis by removing the M5-0.8 x 12mm FHCS which attach the lumbar spine to the pelvis (Figure 91).

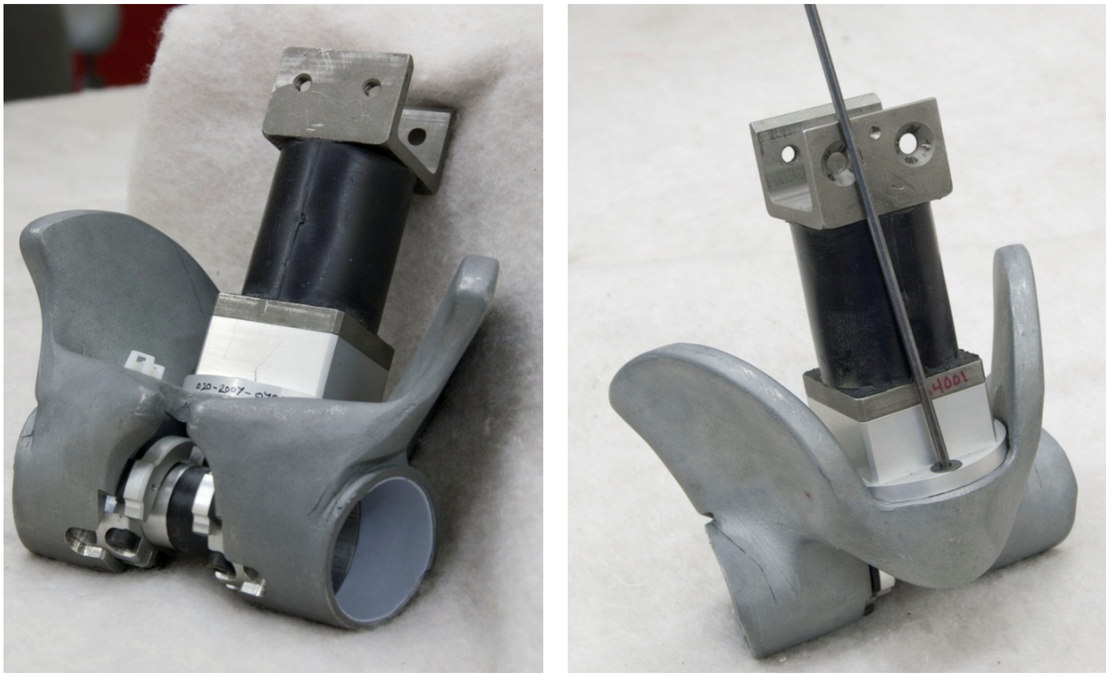


Figure 91. Remove lumbar spine from pelvis

6. Detach the lumbar load cell structural replacement from the bottom of lumbar spine by removing four M5-0.8 x 12mm SHCS (Figure 92).

Figure 92. Remove lumbar load cell structural replacement

7. To remove the cable from the lumbar spine, remove the M6 jam nuts and associated M6 flat washer[5] (Figure 93). Remove the cable from the lumbar by pushing on the threaded end of the cable to force it out of the top of the lumbar.

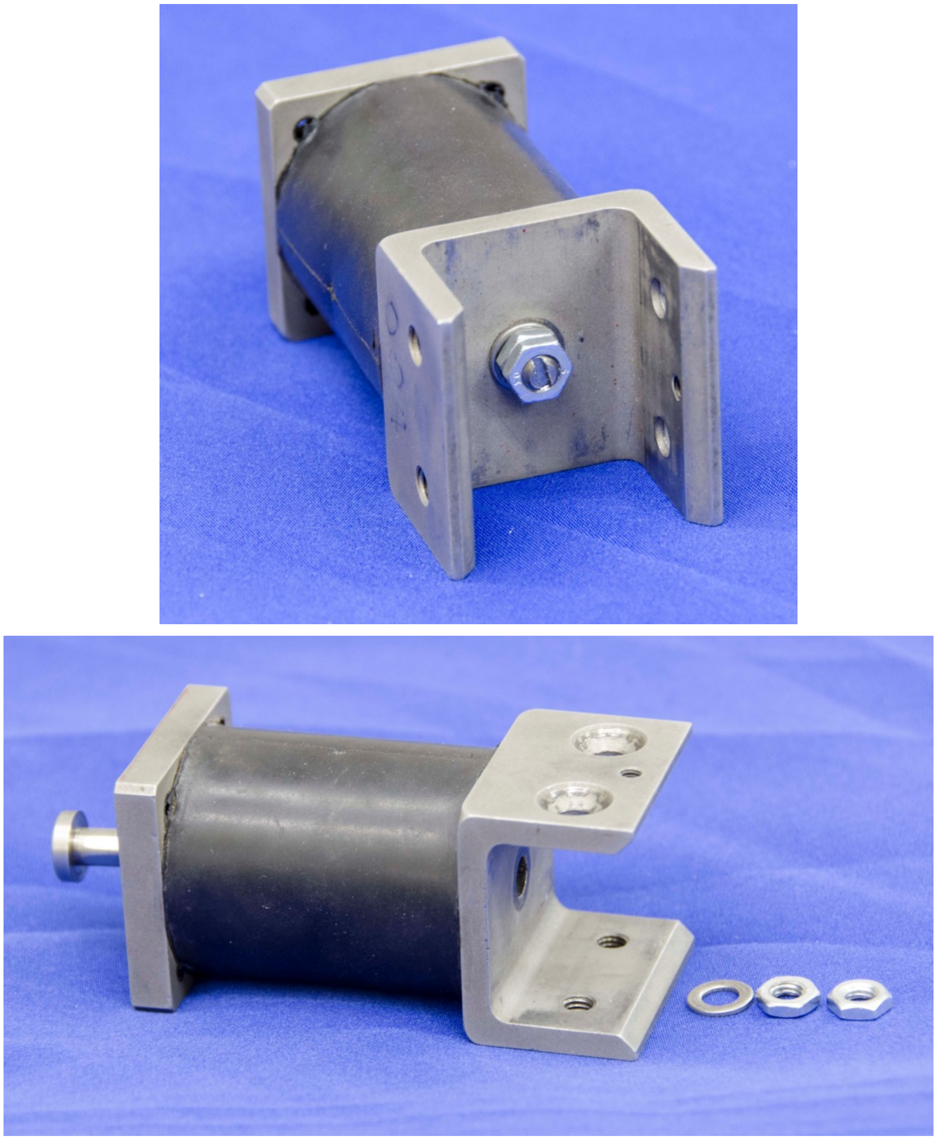


Figure 93. Remove cable from lumbar spine

[5] Part number 5000094 (0.67 ID x 12.5 OD x 1.0 mm thick)

8. To begin disassembly of the pubic load cell assembly from the machined pelvis, first remove the two M5-0.8 x 10mm SHCS *on the pubic load cell structural replacement side*[6] of the hip joint slide cover (Figure 94).

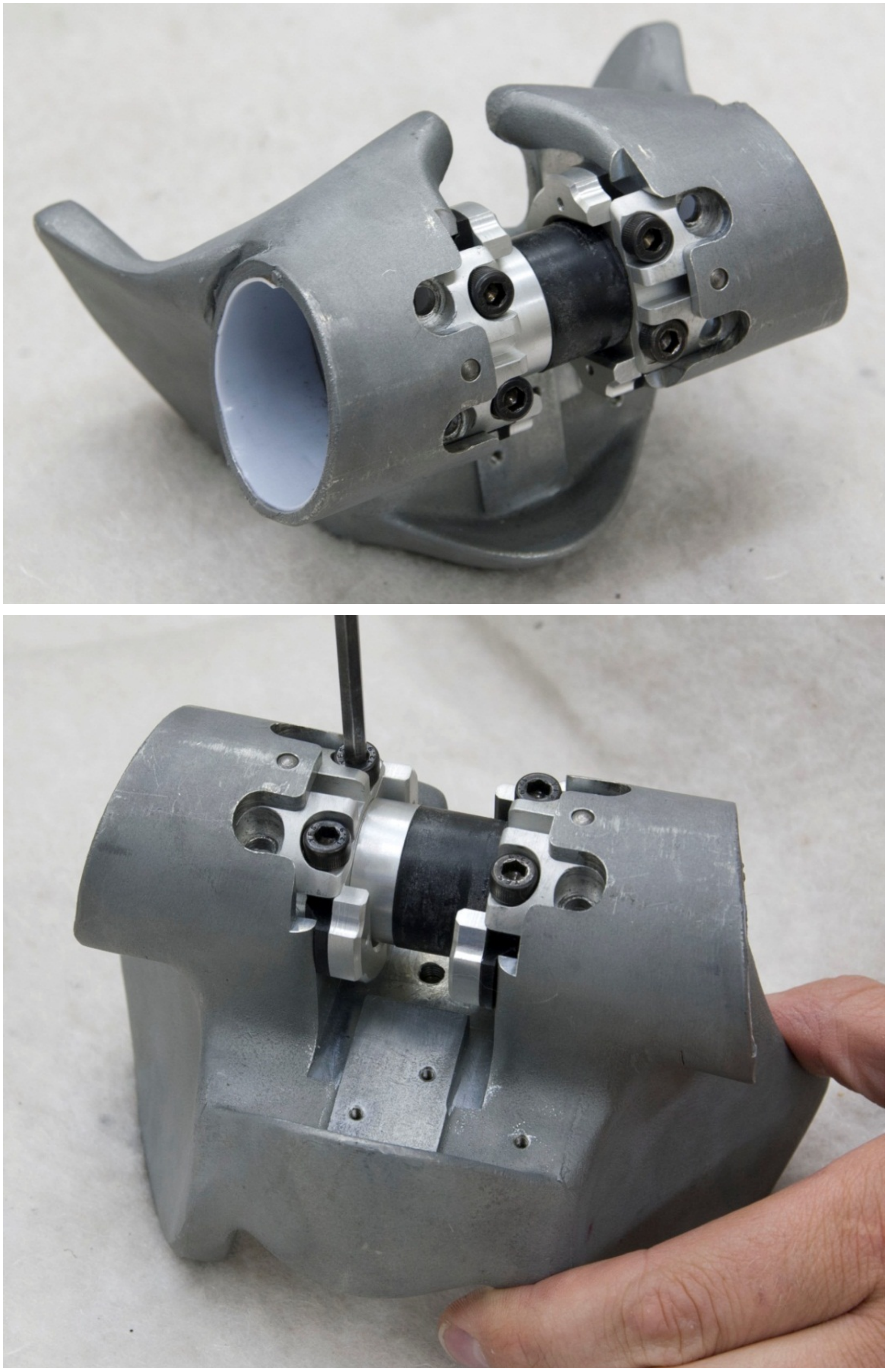


Figure 94. Begin disassembly of pubic load cell assembly from machined

[6] The structural replacement is always installed on the struck side of the pelvis. The pubic load cell is always installed on the non-struck side of the pelvis.

9. Remove the hip joint slide cover on the pubic load cell structural replacement side of the machined pelvis (Figure 95).

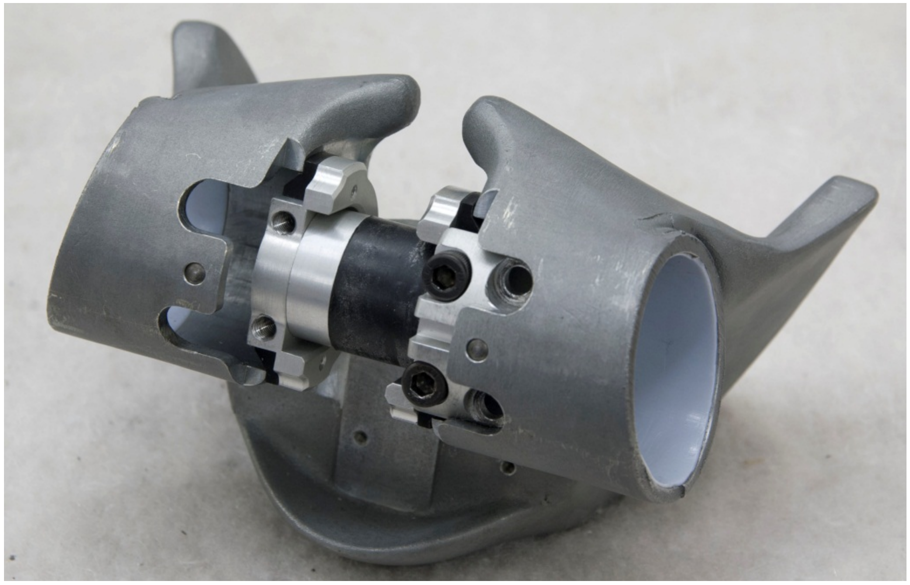


Figure 95. Remove hip joint cover on pubic load cell structural replacement side of machined pelvis

10. Insert an M4-0.7 x 40mm SHCS into the pubic load cell assembly on the load cell structural replacement side. Screw in the SHCS until there is sufficient compression of the pubic load cell assembly to remove it from the machined pelvis (Figure 96).

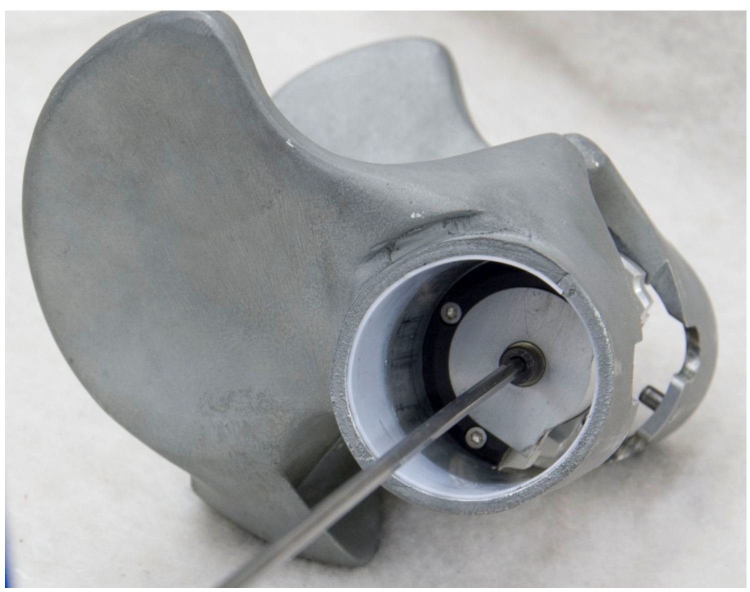
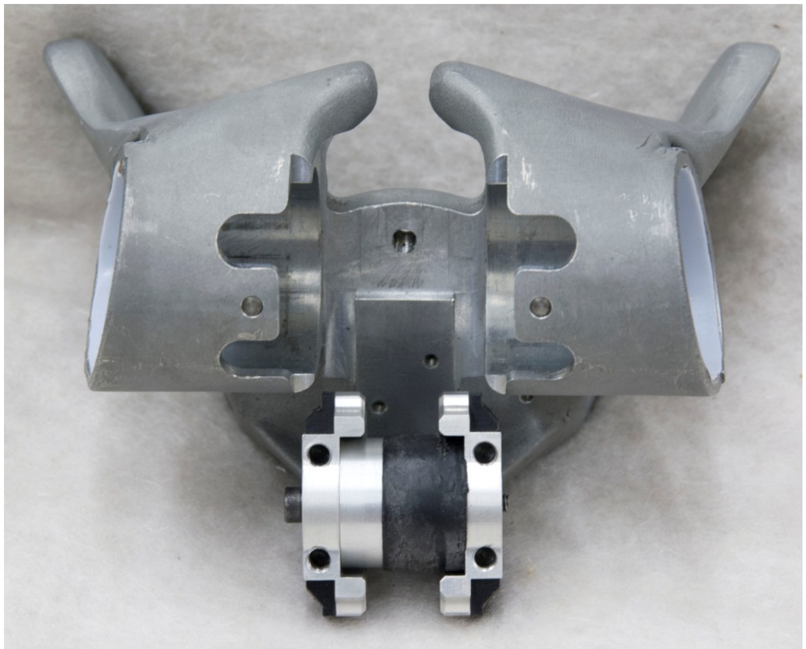


Figure 96. Remove pubic load cell assembly from machined pelvis

11. Remove the two M5-0.8 x 10mm SHCS from the molded pubic buffer side (also referred to as the “spacer side”) and remove the hip joint slide cover (similar to Figure 94). Figure 97 shows the pubic load cell assembly with hip joint slide cover removed.



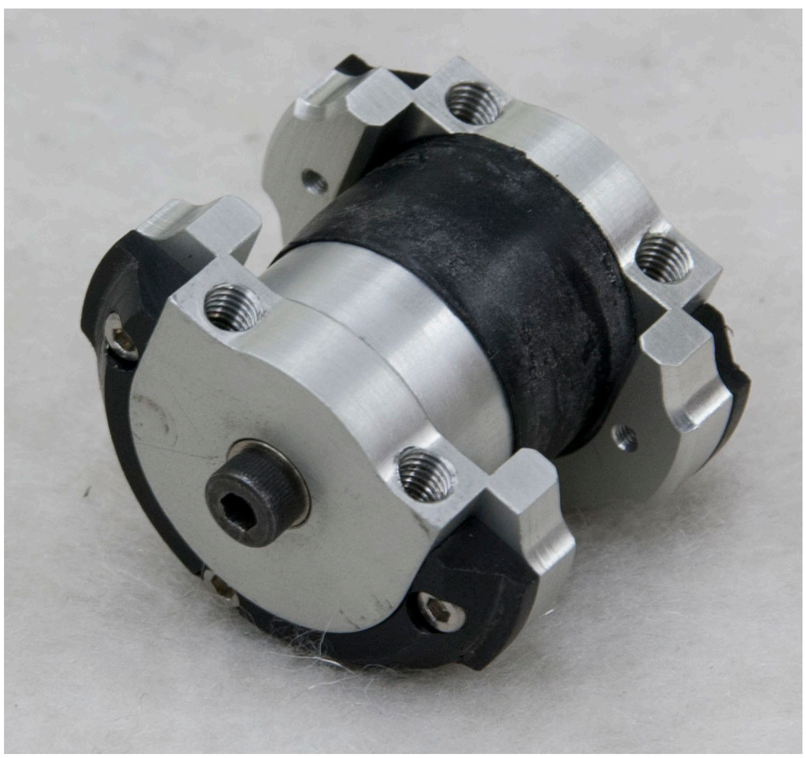


Figure 97. Pubic load cell assembly after removal from machined pelvis

12. Remove the M4-0.7 x 40mm SHCS from the pubic load cell assembly to release the compression and allow for full disassembly (Figure 98).

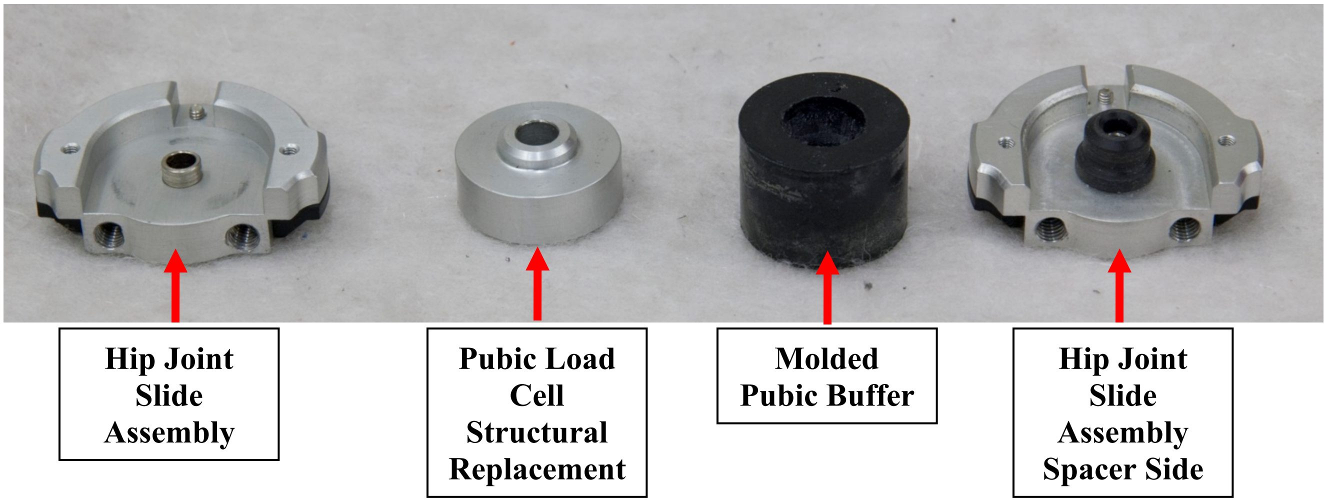


Figure 98. Pubic load cell assembly

13. To detach the hip joint slide spacer from each hip joint slide assembly, remove the three M2.5-0.45 x 5mm SHCS from each hip joint slide assembly. Figure 99 shows this procedure for the hip joint slide assembly. Removal of this part on the spacer side is similar.

Figure 99. Remove hip joint slide spacer from hip joint slide assembly

14. To separate the #4 cable tie mount on the right front side of the pelvis bone, remove the M2.5 x 6mm BHCS (Figure 100).

Figure 100. Remove #4 cable tie mount from machined pelvis

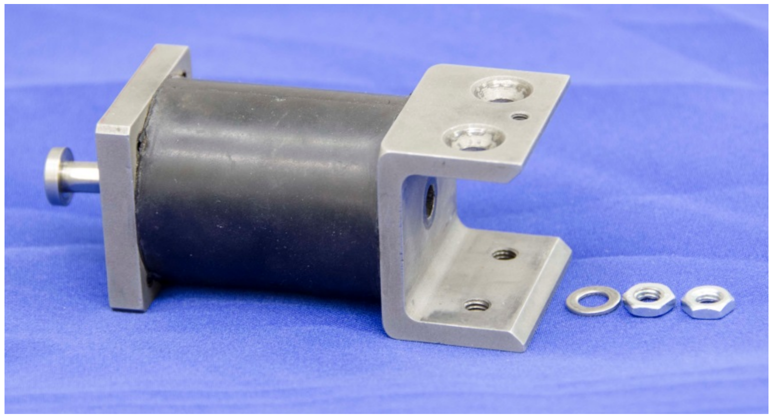
5.7.2 Lower Torso Inspection

- Be certain that the pubic load cell (or structural replacement) is located on the non-struck side of the dummy.
- Inspect the molded pubic buffer for cracks and/or warping. Replace if the buffer is damaged.
- Examine the pelvic flesh for tears or damage. Repair or replace as warranted.
- Inspect the lumbar spine for damage. Check for deformation, tears, or breaks in the rubber. Replace if damaged.
- Check the lumbar cable by observing the condition of the strands. If they are not tightly wound, if frays are visible, or the cable appears larger in diameter on one end, replace the cable. If the cable is permanently bent or if the proper torque cannot be achieved, replace the cable.
- Check the torque on the M6 jam nuts in the end of the lumbar cable. They should be set to 2 in-lb.

5.7.3 Lower Torso Assembly and Installation

To assemble the lower torso, reverse the process described in the Lower Torso Section observing the following reassembly points:

- Set the torque on M6 jam nuts on the end of the lumbar cable:
  - Install the lumbar cable through the lumbar spine. Insert an M6 washer, then install an M6 jam nut to 2 in-lb of torque (Figure 101). Note that the flat edge of the jam nut should be installed towards the lumbar spine.



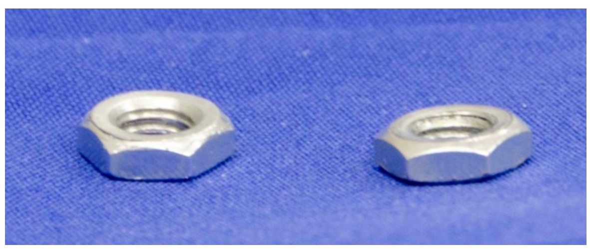


Figure 101. Install jams nuts on lumbar cable

  - Once the inner jam nut is installed to 2 in-lb, install the outer jam nut to a torque of 2 in-lb as well (Figure 102). Hold the inner nut with a wrench so it will not turn while installing the outer nut.

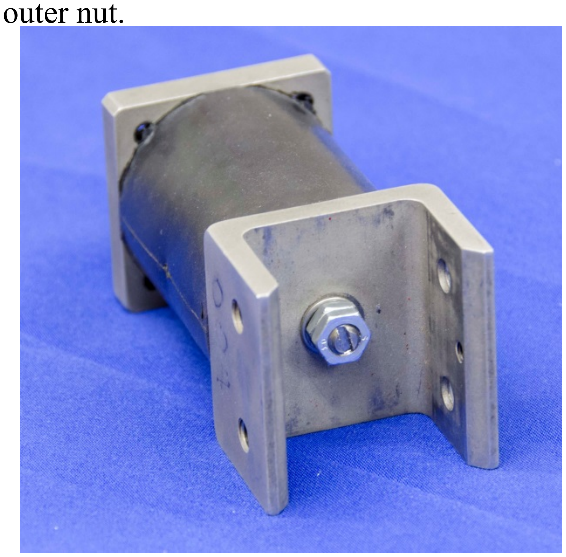


Figure 102. Lumbar spine with jam nuts installed

- Set the torque on the lumbar spine mounting screws (Item 2, Figure 77) to 50 in-lb (5.6 N-m).
- Set the torque on the M5-0.8 x 10mm SHCS (Item 7, Figure 78) to 25 in-lb (2.8 N-m); these screws hold the hip joint slide covers to the pubic load cell assembly.
- Check that the spring and detent peg in each hip joint assembly is properly seated so that the plunger travels freely without jamming.
- When reinstalling the pubic load cell assembly:
    - *Prior to compressing the pubic load cell assembly* for reinsertion into the machined pelvis, install the hip joint slide cover *only on the spacer side* using two M5-0.8 x 10mm SHCS; otherwise, pinching of the molded pubic buffer may occur.
    - After the spacer slide cover is installed, insert the M4-0.7 x 40mm SHCS into the pubic load cell assembly on the load cell structural replacement and screw the SHCS until the pubic load cell assembly can be reinserted into the machined pelvis.
    - Insert the compressed pubic load cell assembly into the pelvis. Unscrew and remove the M4-0.7 x 40mm SHCS to relieve the compression. Next, reinstall the hip joint slide cover on the load cell side of the assembly within the machined pelvis. Proceed with reassembly by reversing the remaining procedures in Section 5.7.1.

6 INSTRUMENTATION INSTALLATION

This section provides instruction for the installation of all instrumentation available for the Q3s dummy. The instrumentation is installed for a left side impact in this section. Instrumentation for a right side impact would be similar. Any differences in installation between right and left side setup are noted in Section 8. Table 17 lists the available instrumentation for the Q3s. Figure 103 and Figure 104 illustrate the installed locations of the instrumentation.

Table 17. Q3s Instrumentation Components

Part Description	Quantity	Part Number	Figure #	Item #
Uniaxial Piezoresistive Accelerometer	10	SA572-S4	96, 97	1
Q Head Accelerometer Mount Block	1	SA572-S86	96	2
Q3s Upper Torso Mount Block	1	SA572-S88	96, 97	3
Screw, SHCS M1.4-0.3 x 4mm	20	5000375-FT	96	4
Screw, SHCS M2.5-0.45 x 16mm	4	5000283-FT	96	5
Screw, SHCS M3-0.5 x 16mm	2	5000436-FT	96, 97	6
ARS Mount Block, Q3s Pelvis	1	SA572-S89	96	7
Q3s Neck Load Cell	3	SA572-S8	96, 97	8
String Pot Assembly (Left Side)	1	SA572-S38	96, 97	9
String Pot Assembly (Right Side)	1	SA572-S39	96	10
Q3s IR-TRACC	1	SA572-S37	96	11
ARS Mount Block, Q3s Head	1	SA572-S87	96	12
ARS, 1500	3	SA572-S55	96	13
ARS, 8K	3	SA572-S56	96	14
ARS, 12K	3	SA572-S57	96	15
ARS, 18K	3	SA572-S58	96	16
Q3s Pubic Load Cell	1	SA572-S7	97	17
2 Axis Tilt Sensor	1	SA572-S44	97	18
Q3s Tilt Sensor Mount Block	1	SA572-S84	97	19
Screw, SHCS, M4-0.7 x 20mm	1	5000287-FT	97	20
Screw, SHCS M2-0.4 x 10mm	2	5000215-FT	97	21
Mount DTS-ARS Thorax A3s	1	SA572-S45	97	22
Accelerometer Plate MT 7264C DTS-ARS Q3s Pelvis	1	SA572-S46	96	23
Accelerometer Block MT 7264 DTS-ARS Q3s Pelvis	1	SA572-S47	96	24

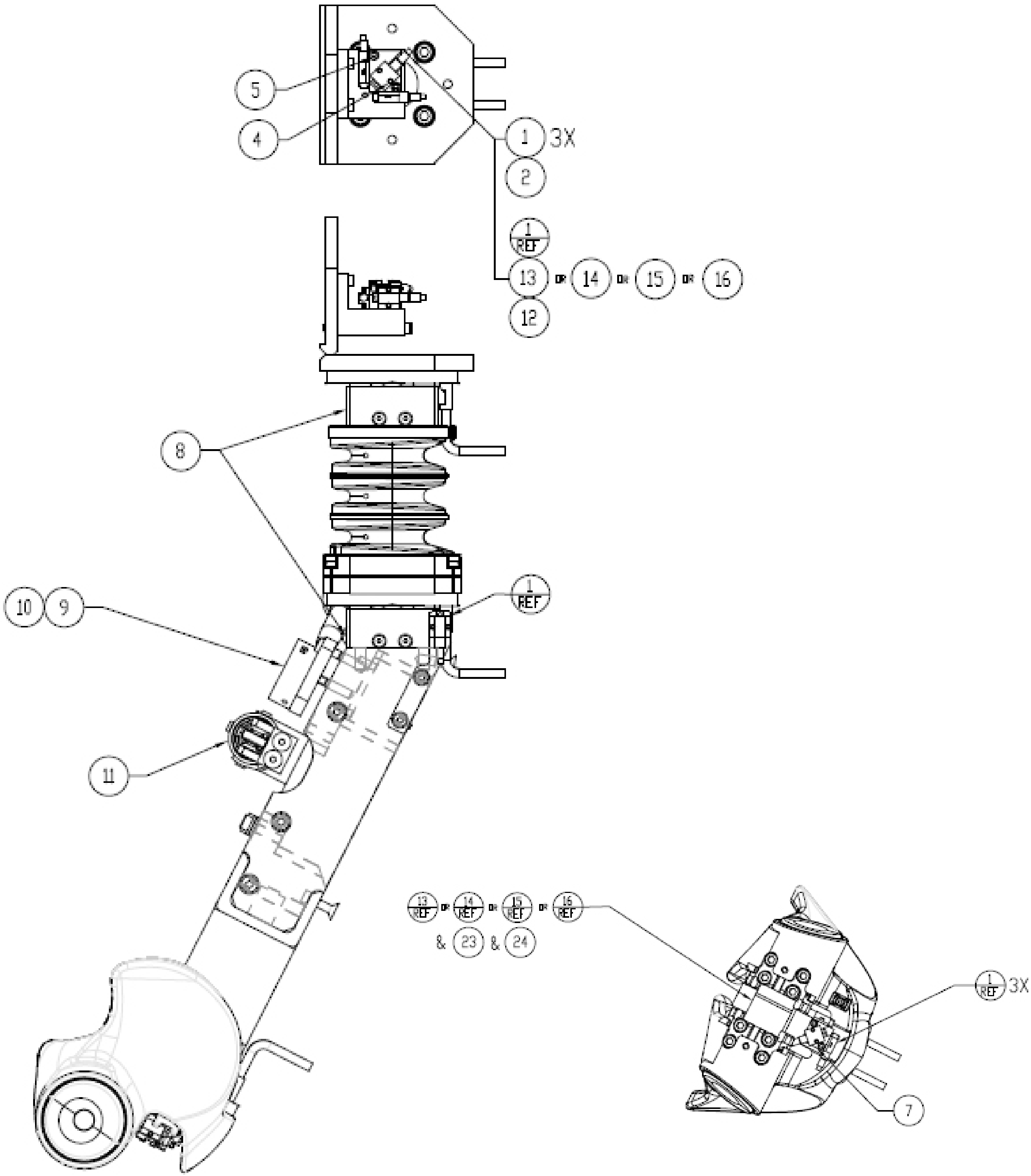


Figure 103. Instrumentation assembly drawing (1 of 2)

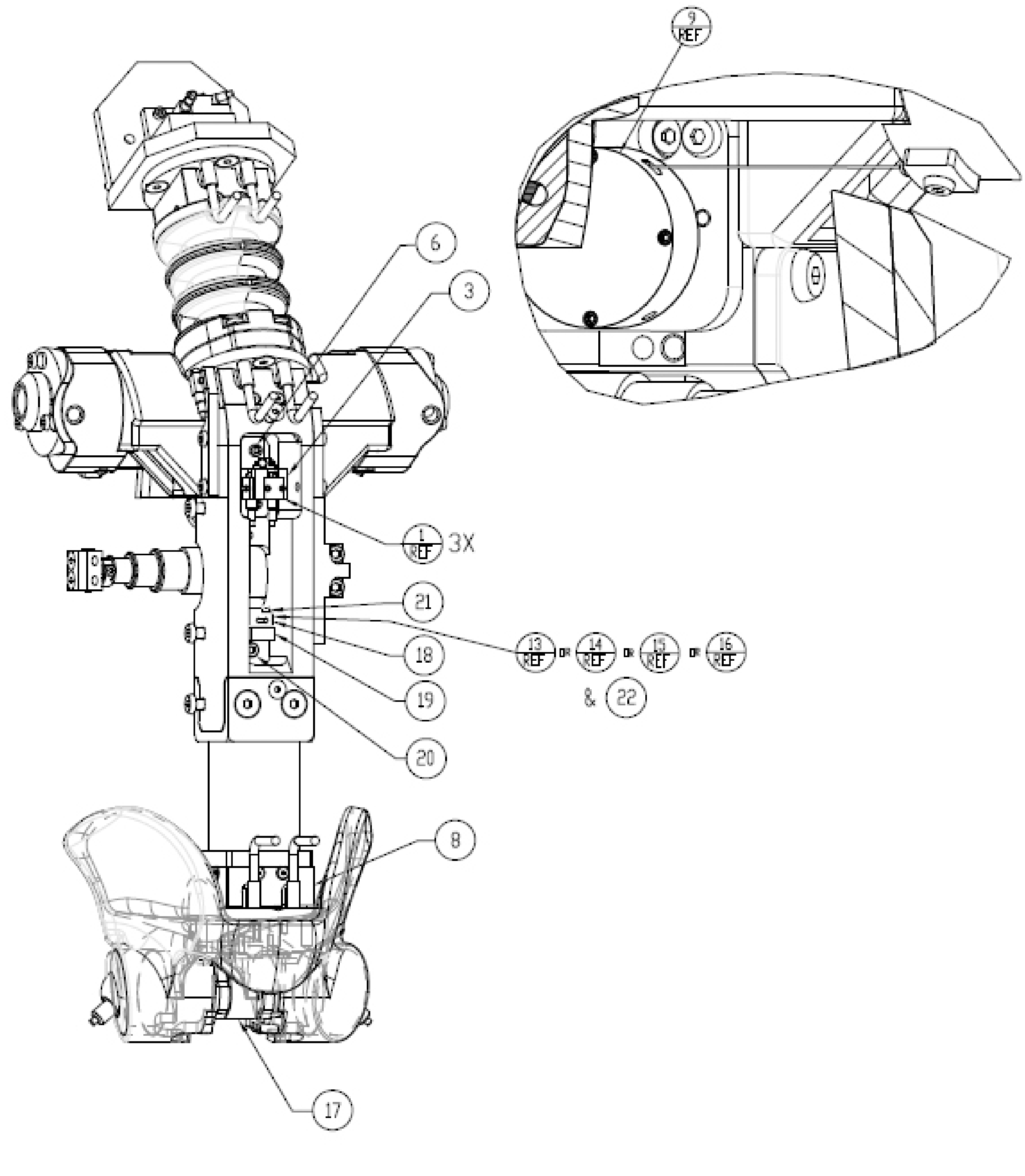


Figure 104. Instrumentation assembly drawing (2 of 2)

6.1 Head

The Q3s head is equipped to accept a three-axis accelerometer array (three uniaxial accelerometers mounted on a block) to measure Ax, Ay, and Az at the head center of gravity. In addition to using the 3-axis accelerometer array in the head, a three-axis angular rate sensor (ARS) array is available. Table 18 and Table 19 summarize the parts used for instrumentation in the head.

Table 18. Head Instrumentation Parts: Accelerometer Configuration

Part Description	Quantity	Part Number
Uniaxial Piezoresistive Accelerometer	3	SA572-S4
Screw, SHCS M1.4-0.3 x 4mm	6	5000375-FT
Accelerometer Mount Block Q Head	1	SA572-S86
Screw, SHCS M2.5-0.45 x 16mm	2	5000283-FT
Instrumentation Bracket Assembly	1	020-1013A
Screw, SHCS M3-0.5 x 10mm	2	5000119
Screw, SHCS M3-0.5 x 40mm	1	5000649

Table 19. Head Instrumentation Parts: ARS Configuration

Part Description	Quantity	Part Number
Uniaxial Piezoresistive Accelerometer	3	SA572-S4
Screw, SHCS M1.4-0.3 x 4mm	6	5000375-FT
Screw, SHCS M2.5-0.45 x 16mm	2	5000283-FT
Instrumentation Bracket Assembly	1	020-1013A
Screw, SHCS M3-0.5 x 10mm	2	5000119
Screw, SHCS M3-0.5 x 40mm	1	5000649
Angular Rate Sensor	3	SA572-S58[7]
6 Axis Accel/ARS Mount	1	SA572-S87
Screw, SHCS M1.4-0.3 x 8mm	6	5000727

[7] This ARS has an 18K frequency response. Select an ARS which meets the required output response without unwanted noise.

6.1.1 Installation of Head Accelerometers

1. Mount the three uniaxial piezoresistive accelerometers onto the triaxial accelerometer mounting block with two each M1.4-0.3 x 4mm SHCS so that their seismic masses all point to one corner of the block (Figure 105).

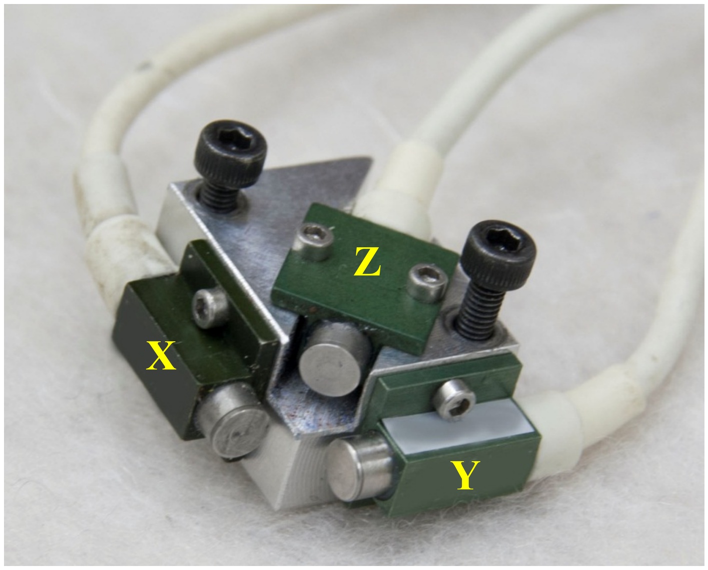


Figure 105. Install accelerometers to triaxial block

2. Secure the accelerometer mounting block to the instrumentation bracket assembly using two M2.5-0.45 x 16mm SHCS on the corners of the accelerometer mounting block (Figure 106).

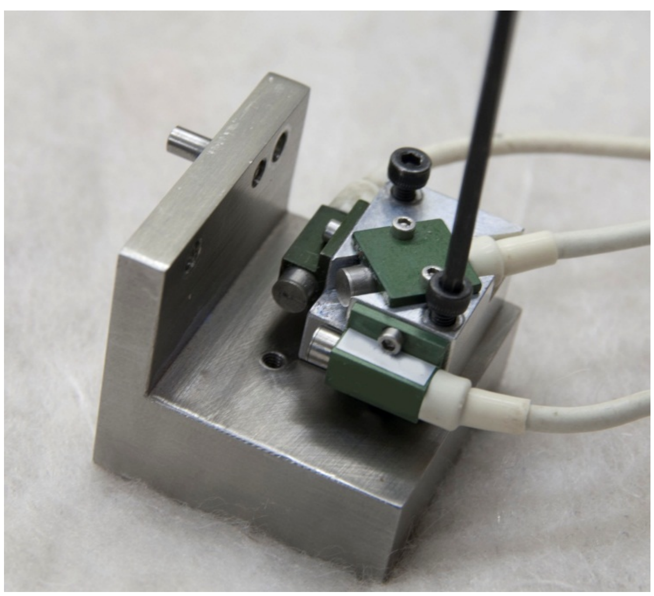


Figure 106. Secure accelerometer mounting block to instrumentation bracket

3. Align the pin on the instrumentation bracket with the hole on the anterior skull. Install two M3-0.5 x 10mm SHCS in the upper bracket holes and one M3-0.5 x 40mm SHCS on the bottom of the bracket (Figure 107 and Figure 108).

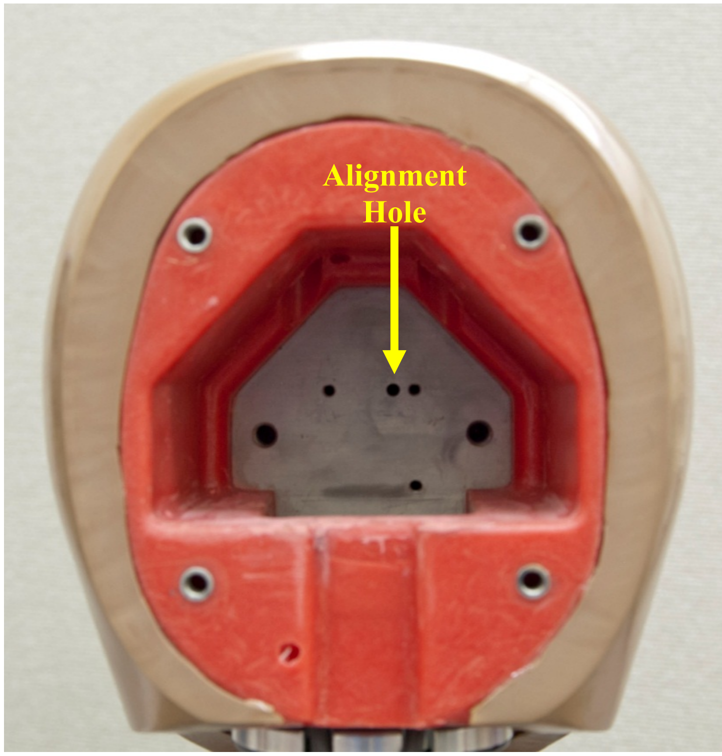


Figure 107. Skull showing alignment hole

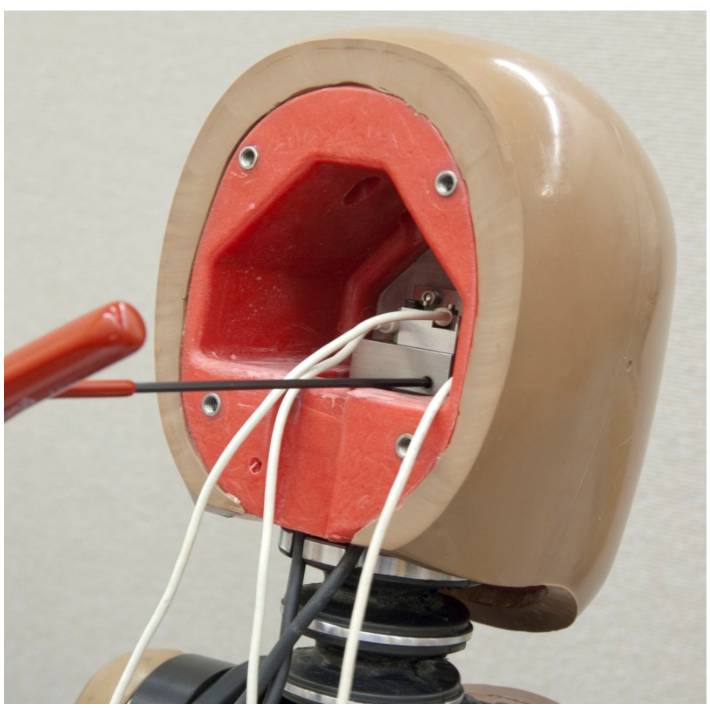


Figure 108. Installing M3-0.5 x 40mm SHCS to lower portion of instrumentation bracket

The mounted orientation for each accelerometer (with respect to the accelerometer's positive axis of acceleration) should be (Figure 109):

- X: FORWARD
- Y: LEFT
- Z: DOWN

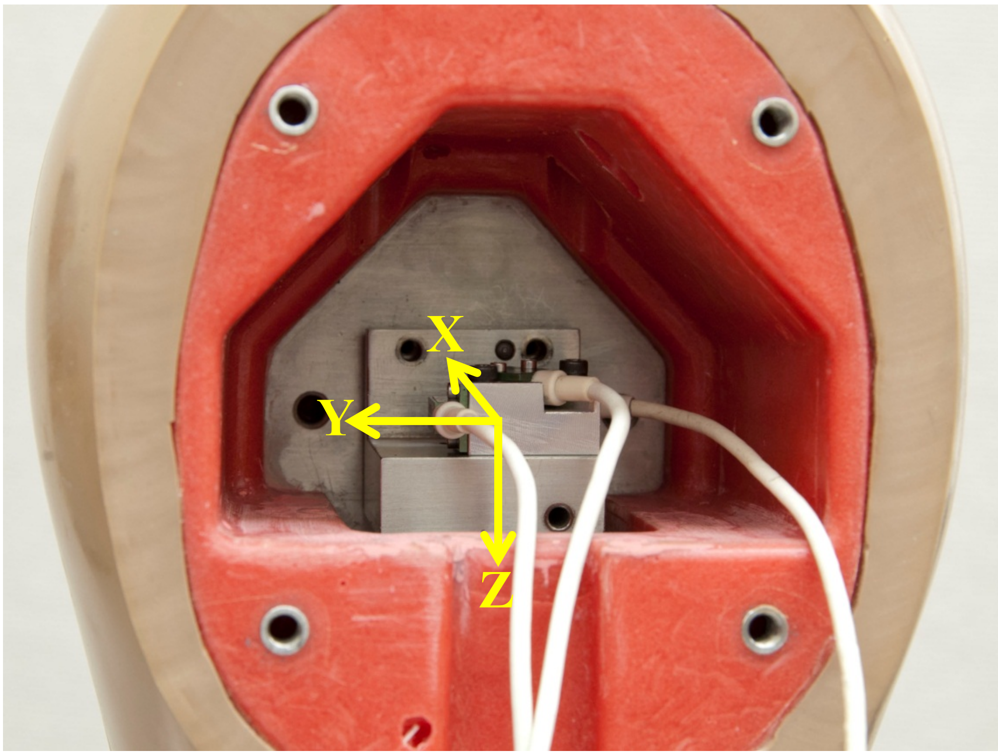


Figure 109. Head accelerometers installed in head

6.1.2 Installation of Angular Rate Sensors (ARS)

1. Mount the three uniaxial piezoresistive accelerometers onto the accelerometer/ARS mount with two each M1.4 x 0.3 x 4mm SHCS so that their seismic masses all point to one corner of the block. Mount the ARS sensors to the block using two each M1.4 x 0.3 x 8mm SHCS as indicated. Note that there is an ARS mounted in the recessed area on the underside of the mount (Figure 110).

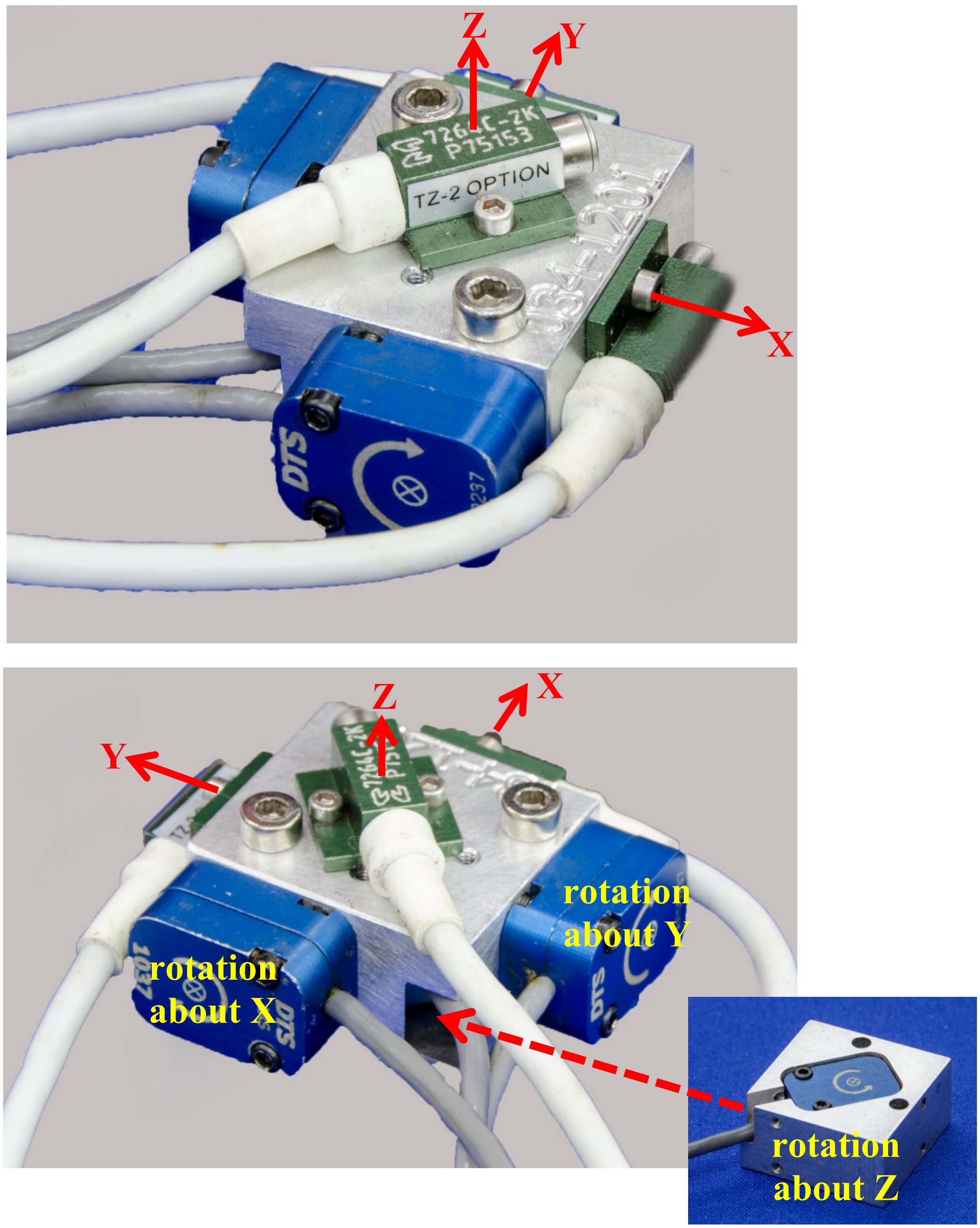


Figure 110. Mount ARS transducers and accelerometers to accel/ARS mount

2. Install the accelerometer/ARS mount to the instrumentation bracket assembly using two M2.5-0.45 x 16mm SHCS on the corners of the mounting block (Figure 111). Note that the ARS which measures angular velocity about the Z axis is on the underside of the block.

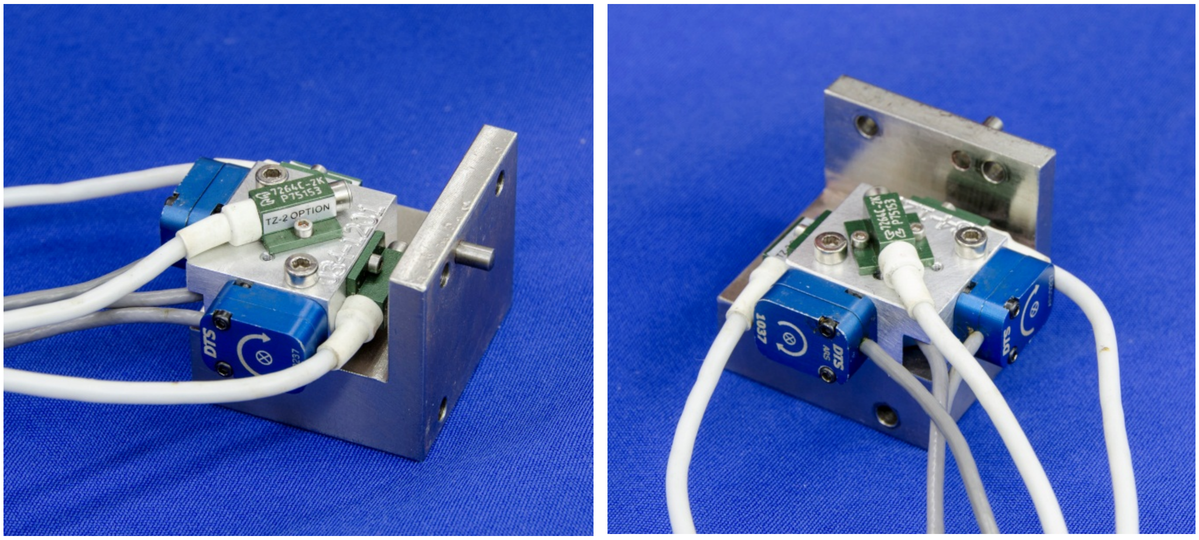


Figure 111. Accelerometer/ARS mount installed to bracket

3. Align the pin on the instrumentation bracket with the hole on the anterior skull. Install two M3-0.5 x 10mm SHCS in the upper bracket holes and one M3-0.5 x 40mm SHCS on the bottom of the bracket (Figure 112 -Figure 113).

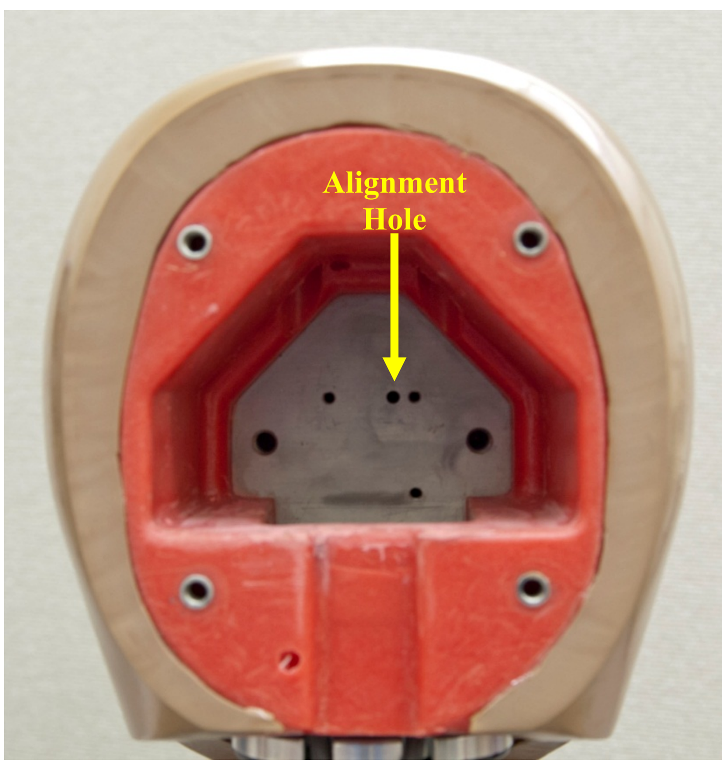


Figure 112. Skull showing alignment hole

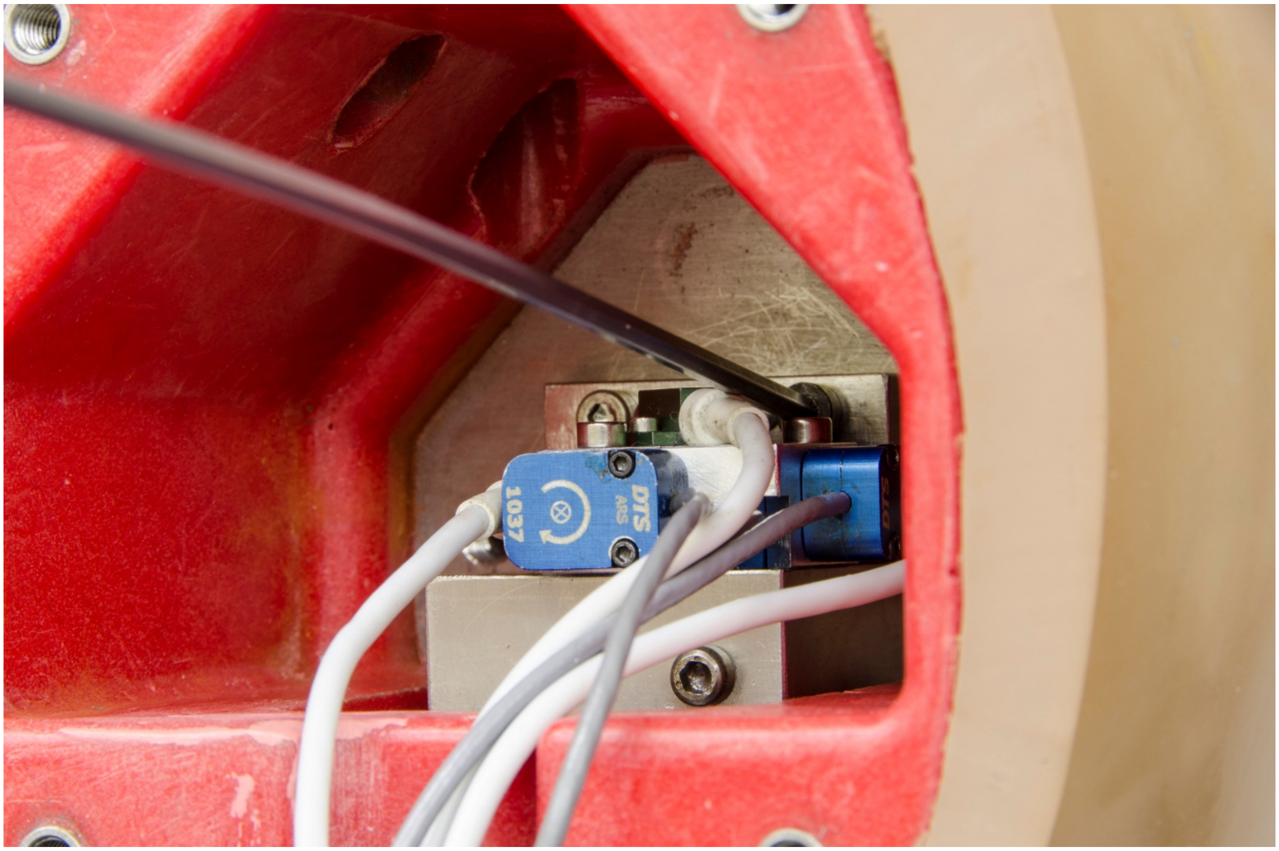


Figure 113. Install instrumentation bracket into head

4. The mounted orientation for each accelerometer (with respect to the accelerometer's positive axis of acceleration) should be (Figure 114):
   - X: FORWARD
   - Y: LEFT
   - Z: UP

   The mounted orientation for each ARS should be (Figure 114):
   - Rotation about X: REAR of block
   - Rotation about Y: RIGHT side of block
   - Rotation about Z: UNDERSIDE of block

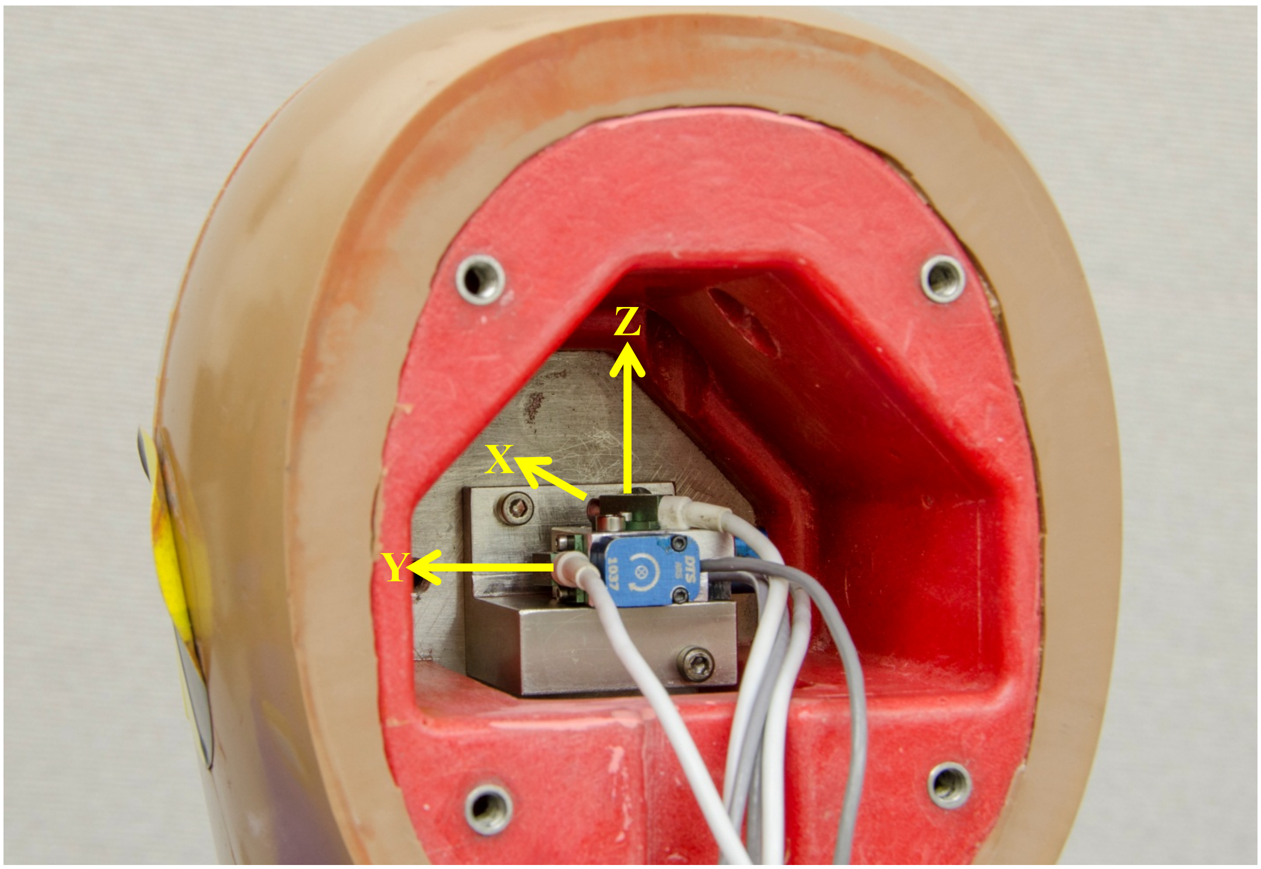


Figure 114. ARS assembly installed in head

6.2 Neck

The neck instrumentation includes six-axis upper and lower neck load cells which measure Fx, Fy, and Fz forces and Mx, My, and Mz moments. Table 20 summarizes the parts used for instrumenting the neck.

Table 20. Neck Instrumentation Parts

Part Description	Quantity	Part Number
6-Axis Upper Neck Load Cell	1	SA572-S8
6-Axis Lower Neck Load Cell	1	SA572-S8
Screw, FHCS M5-0.8 x 12mm	8	5000096-FT
Screw, SHCS M5-0.8 x 12mm	4	5000002-FT

6.2.1 Upper Neck Load Cell

1. Use four M5-0.8 x 12mm FHCS to install the upper neck load cell to the base of the skull (Figure 115). The load cell wiring should protrude from the rear of the head.

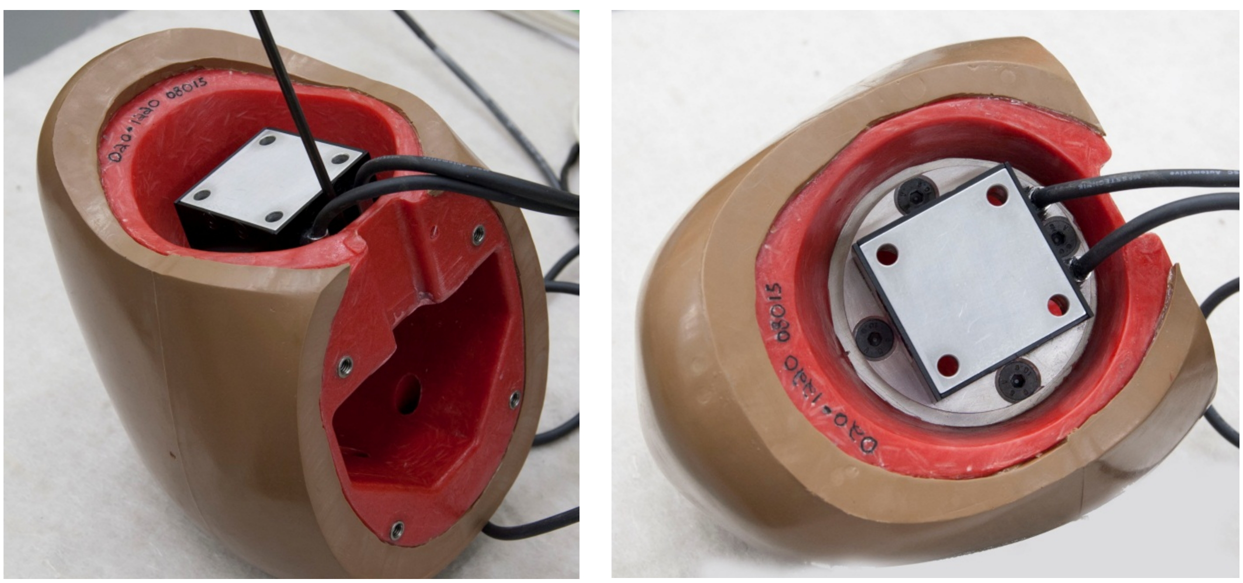


Figure 115. Install Upper neck load cell to base of head.

6.2.2 Installation of Lower Neck Load Cell

1. To install the lower neck load cell, first install the neck/torso interface plate to the top of the load cell using four M5-0.8 x 12 FHCS (Figure 116).

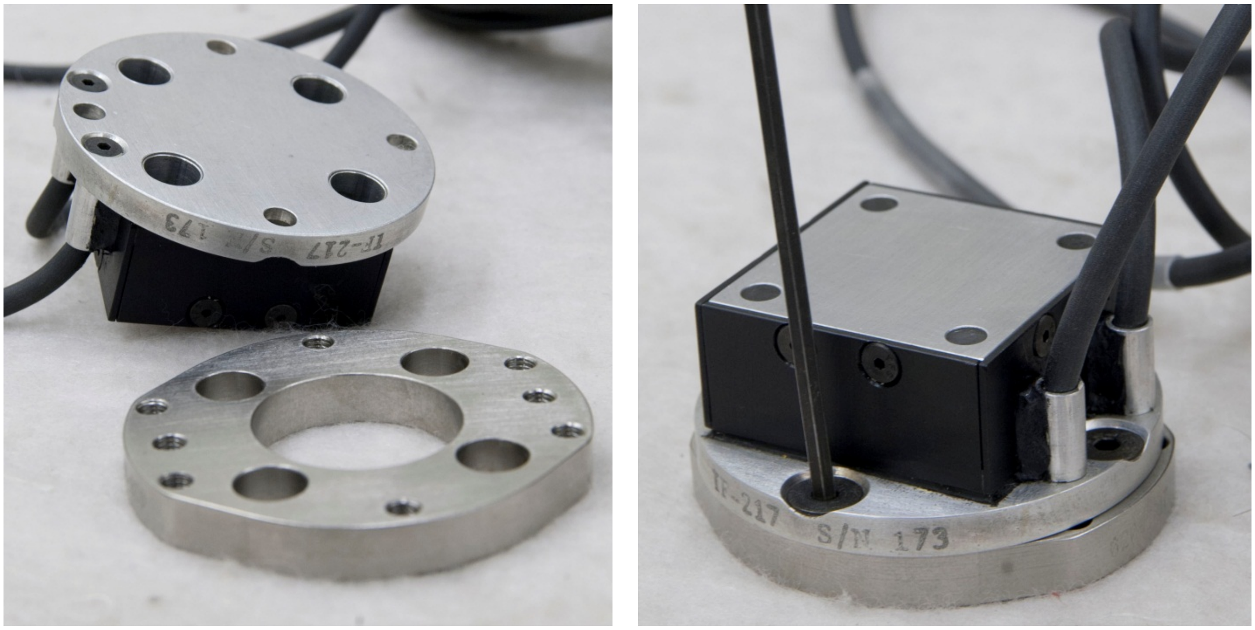


Figure 116. Install neck/torso interface plate to lower neck load cell

2. Install the load cell interface to the thorax with four M5-0.8 x 12mm SHCS (Figure 117) and mount the neck as described in Section 5.3.4.

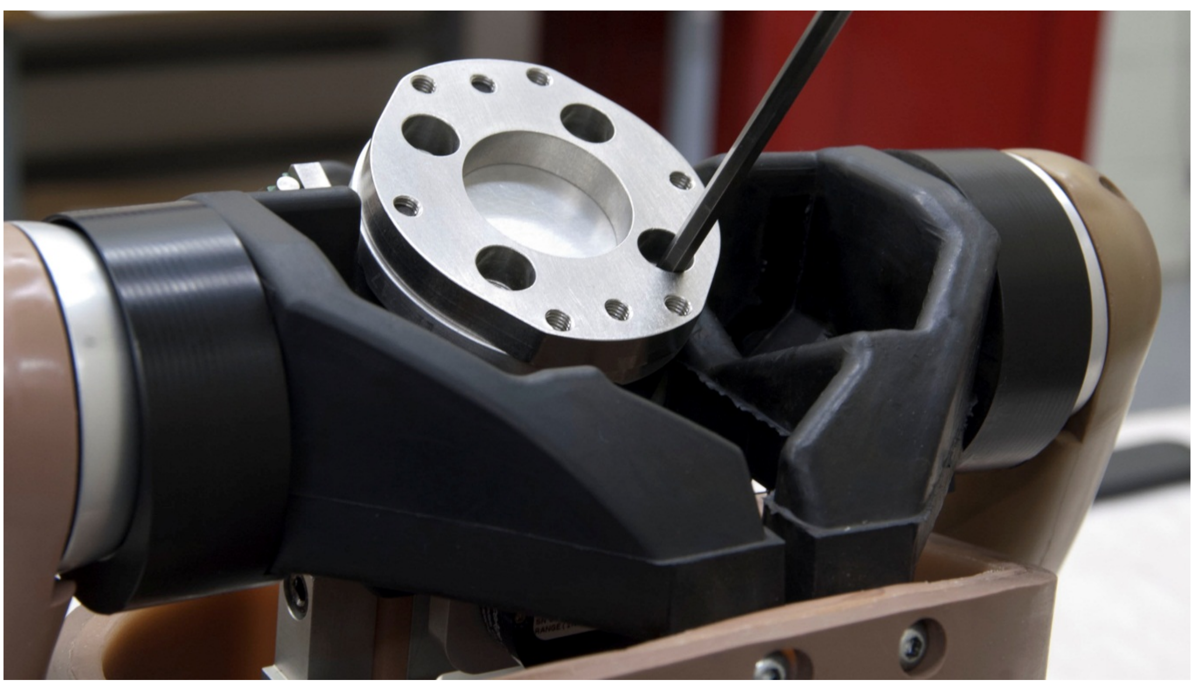


Figure 117. Install lower neck load cell to torso

6.3 Shoulder

Instrumentation in the shoulder includes a shoulder (Y) displacement string potentiometer. Table 21 lists the parts associated with the shoulder instrumentation.

Table 21. Shoulder Instrumentation Parts

Part Description	Quantity	Part Number
Shoulder Stringpot (left)	1	SA572-S38
Shoulder Stringpot (right)	1	SA572-S39
Shoulder Stringpot mounting bracket	1	020-3539
Screw, BHCS M4-0.7 x 10mm	2	5000010-FT
Screw, SHCS #2-56 x ¼” SHCS	2	9000159
Screw, BHCS M3-0.5 x 8mm	1	5000410-FT
Stringpot Retainer	1	020-3549

6.3.1 Shoulder String Potentiometer

1. Loosen, but do not remove, the four front clavicle M4-0.7 x 10mm BHCS and the two M4-0.7 x 16mm BHCS screws that secure the molded shoulder assembly to the spine to allow for easy installation of the shoulder stringpot (Figure 118).

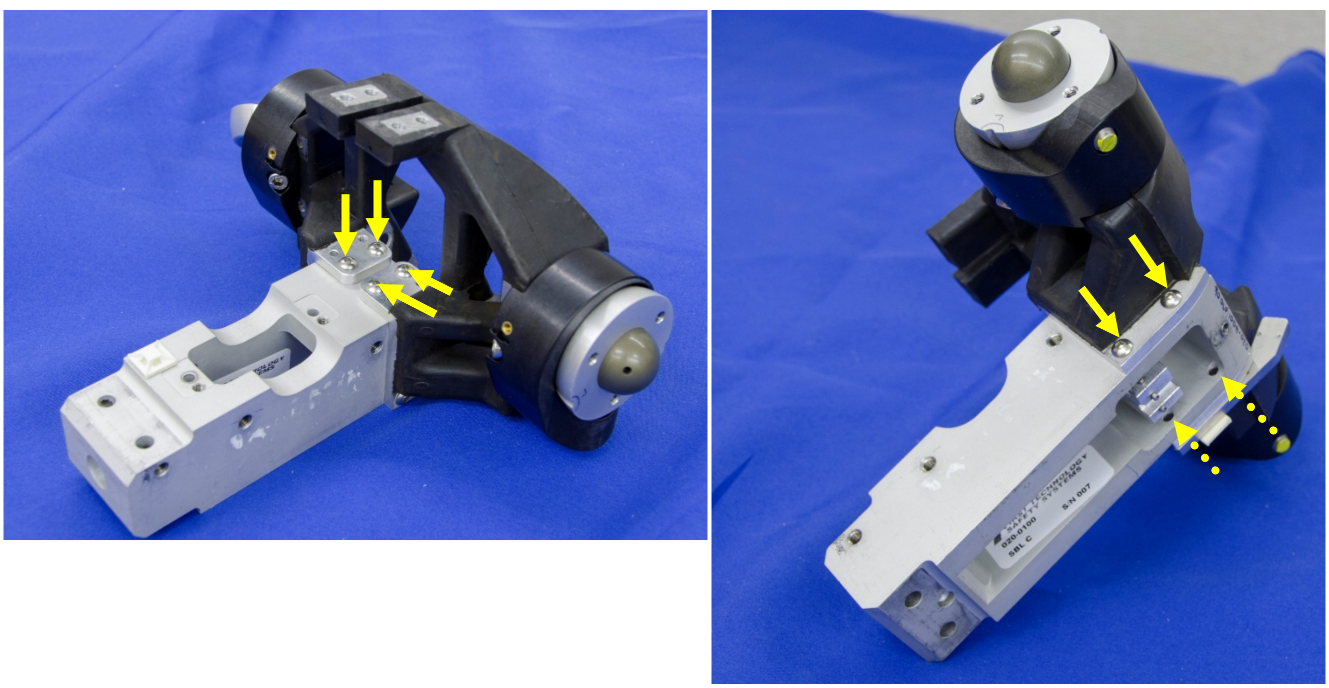


Figure 118. Loosen clavicle and molded shoulder assembly screws in preparation for shoulder stringpot installation

2. The impact side shoulder should be installed. Secure the string potentiometer[8] to the shoulder stringpot mounting bracket using two #2-56 x ¼" SHCS (Figure 119).

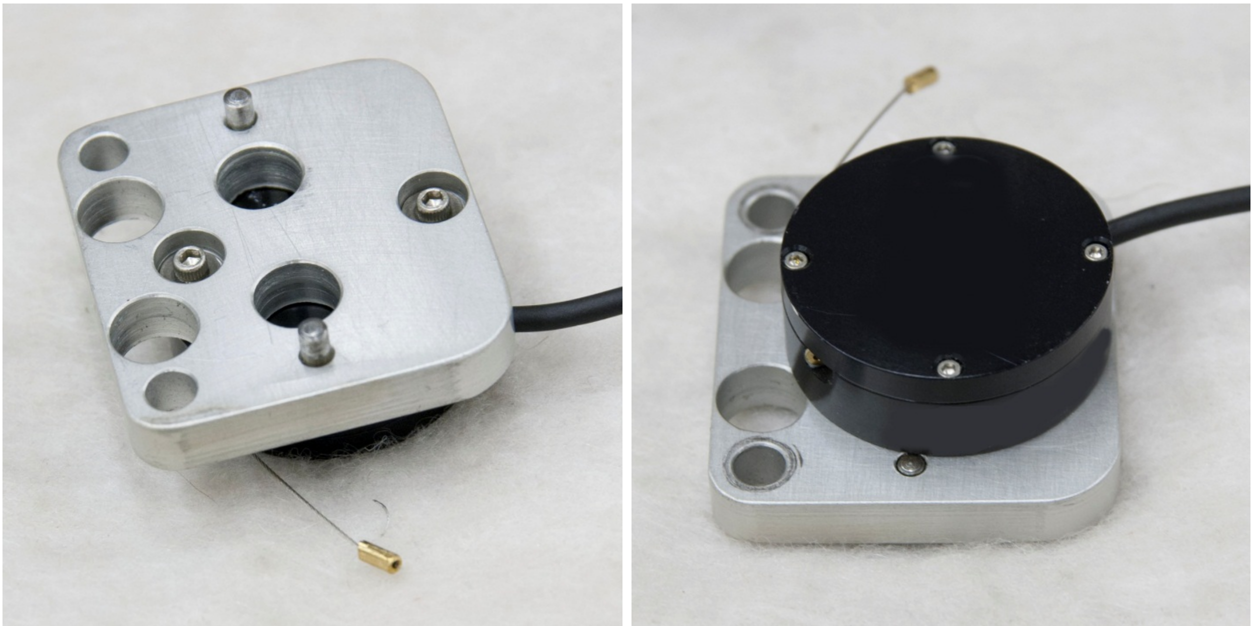


Figure 119. Install string potentiometer to mounting bracket

3. Insert the alignment pins on the bracket into the locator holes on the thoracic spine (Figure 120). Since the screws in Figure 118 were loosened, this should allow for slight adjustment needed to insert the alignment pins.

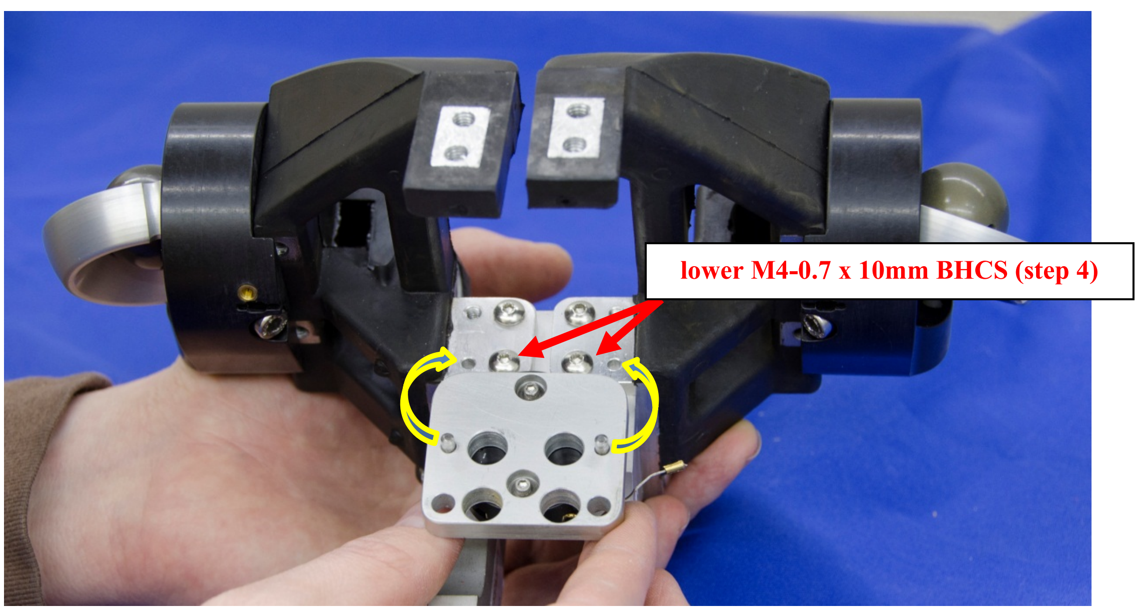


Figure 120. Install shoulder stringpot bracket alignment pins into locator holes

[8] Use caution to install the correct potentiometer as right and left shoulder stringpots are different part numbers.

4. To properly position the stringpot bracket, tighten the two top front M4-0.7 x 10mm BHCS on the thoracic spine through the access hole in the stringpot bracket (Figure 121). Then remove the stringpot bracket to access and tighten the bottom two M4-0.7 x 10mm BHCS (see Figure 120).

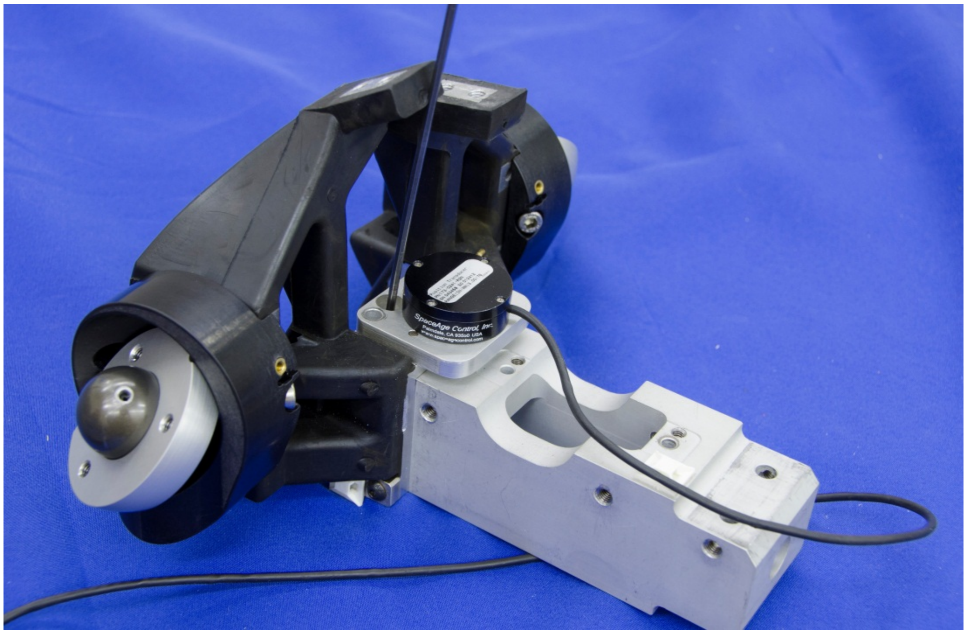


Figure 121. Tighten top front clavicle screws to position stringpot

5. Reinstall the pot assembly and secure it with two M4-0.7 x 10mm BHCS at the top of the bracket (Figure 122).

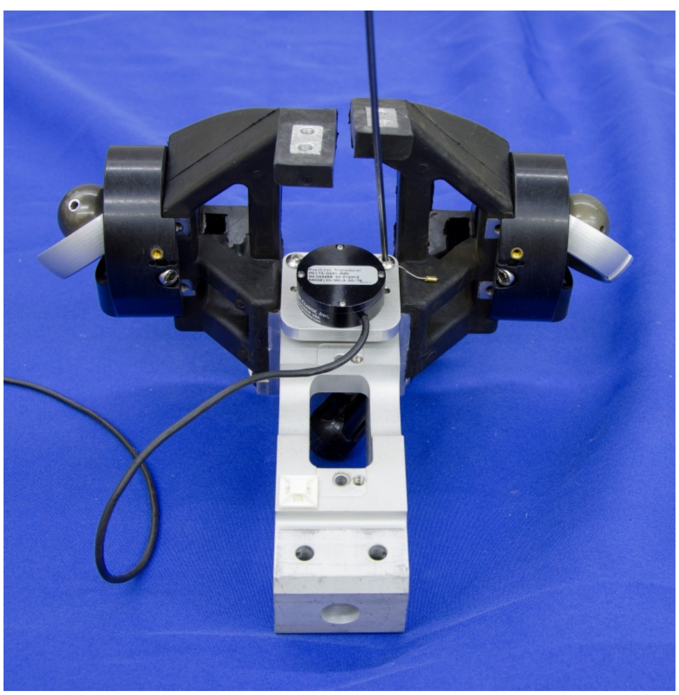


Figure 122. Secure stringpot assembly to thoracic spine

6. Tighten the two M4-0.7 x 16mm BHCS on the T1 accelerometer adaptor assembly as well as the two BHCS on the opposite side.
7. Connect the stringpot to the shoulder using the *forward-most* shoulder hole. Slide the cylindrical end of the stringpot swage into the recess in the shoulder cup (Figure 123).

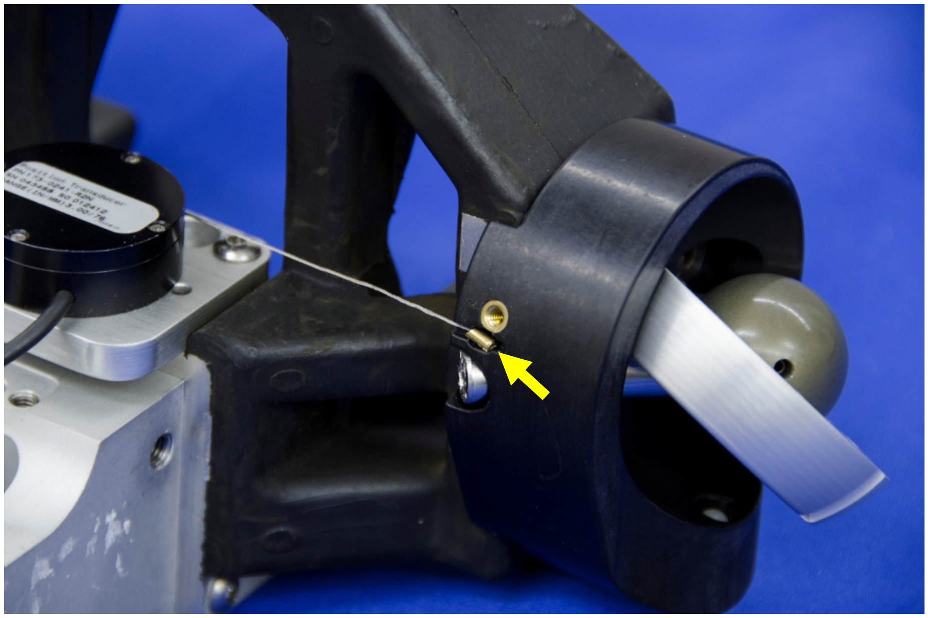


Figure 123. Install stringpot to shoulder

8. Install the stringpot retainer to the shoulder cup over the end of the stringpot with an M3-0.5 x 8mm BHCS assuring that the radius follows the shoulder contour (Figure 124).

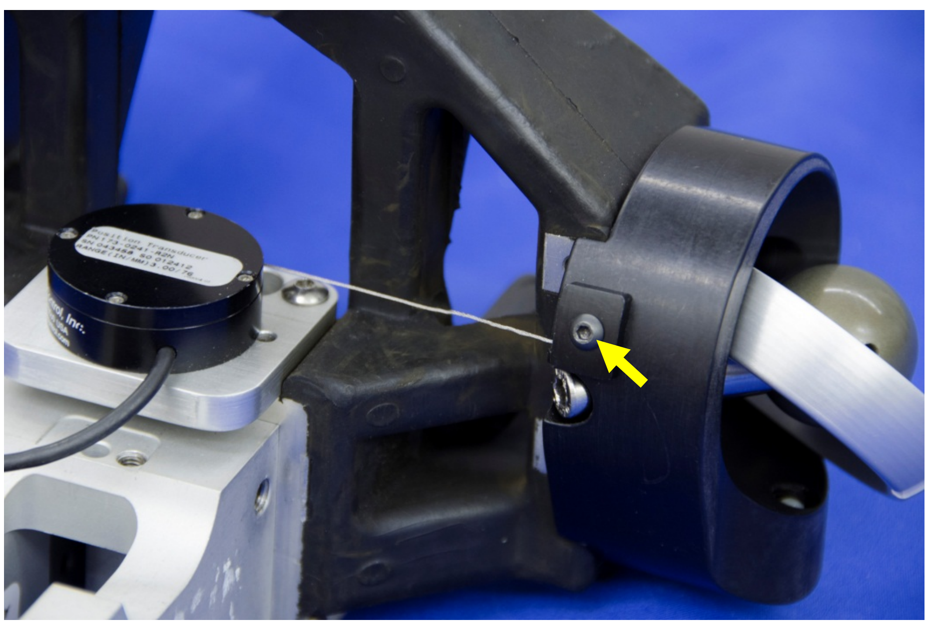


Figure 124. Install stringpot retainer into shoulder cup over end of stringpot

6.4 Thorax

The Q3s thorax is equipped to accept a three-axis accelerometer (three uniaxial accelerometers mounted on a block) to measure Ax, Ay, and Az on the upper spine and an accelerometer (Ay) to measure acceleration at T1. In addition, an IR-TRACC measures thoracic deflection. A biaxial tilt sensor can be used to measure thoracic angle prior to test. Table 22 summarizes the parts used for instrumentation in the thorax.

Table 22. Thorax Instrumentation Parts

Part Description	Quantity	Part Number
Uniaxial Piezoresistive Accelerometer	4	SA572-S4
Screw, SHCS M1.4-0.3 x 4mm	6	5000375-FT
Transducer Mounting Block (Upper Spine Accelerometers)	1	SA572-S88
Screw, BHCS M3-0.5 x 10mm	2	5000436-FT
Accelerometer Adaptor Assembly	1	020-4515
Screw, BHCS M4-0.7 x 16mm	2	5000153-FT
Screw, SHCS M1.4-0.3 x 4mm	2	5000375-FT
IR-TRACC	1	SA572-S37
IR-TRACC Bracket	1	020-4503
IR-TRACC Bracket 1	1	020-4505
IR-TRACC Bracket 2	1	020-4502
Biaxial Tilt Sensor	1	SA572-S44
Tilt Sensor Mount	1	SA572-S84
Screw, SHCS M2-0.4 x 10mm	2	5000215
Screw, SHCS M4-0.7 x 20mm	1	5000287

6.4.1 Upper Spine Accelerometers

1. Install the three (Ax, Ay, and Az) accelerometers to the transducer mounting block (for upper spine accelerometers) mounting bracket with two M1.4-0.3 x 4mm SHCS per accelerometer (Figure 125). Note that the X and Y accelerometers are installed upside down in the recess of the bracket.

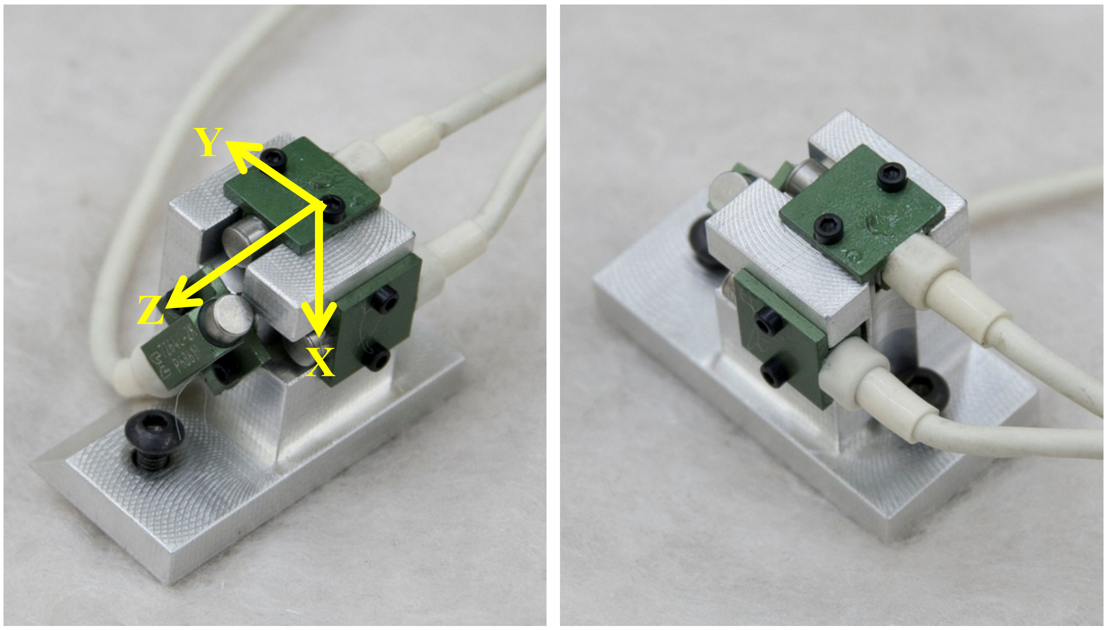


Figure 125. Upper spine accelerometer mounting bracket with accelerometers installed

2. Install the upper spine transducer mounting block into the thoracic spine with two M3-0.5 x 10mm BHCS located at the top and bottom of the bracket. The mounted orientation for each accelerometer (with respect to the accelerometer's positive axis of acceleration) should be (Figure 126):
    - X: FORWARD
    - Y: RIGHT
    - Z: UP

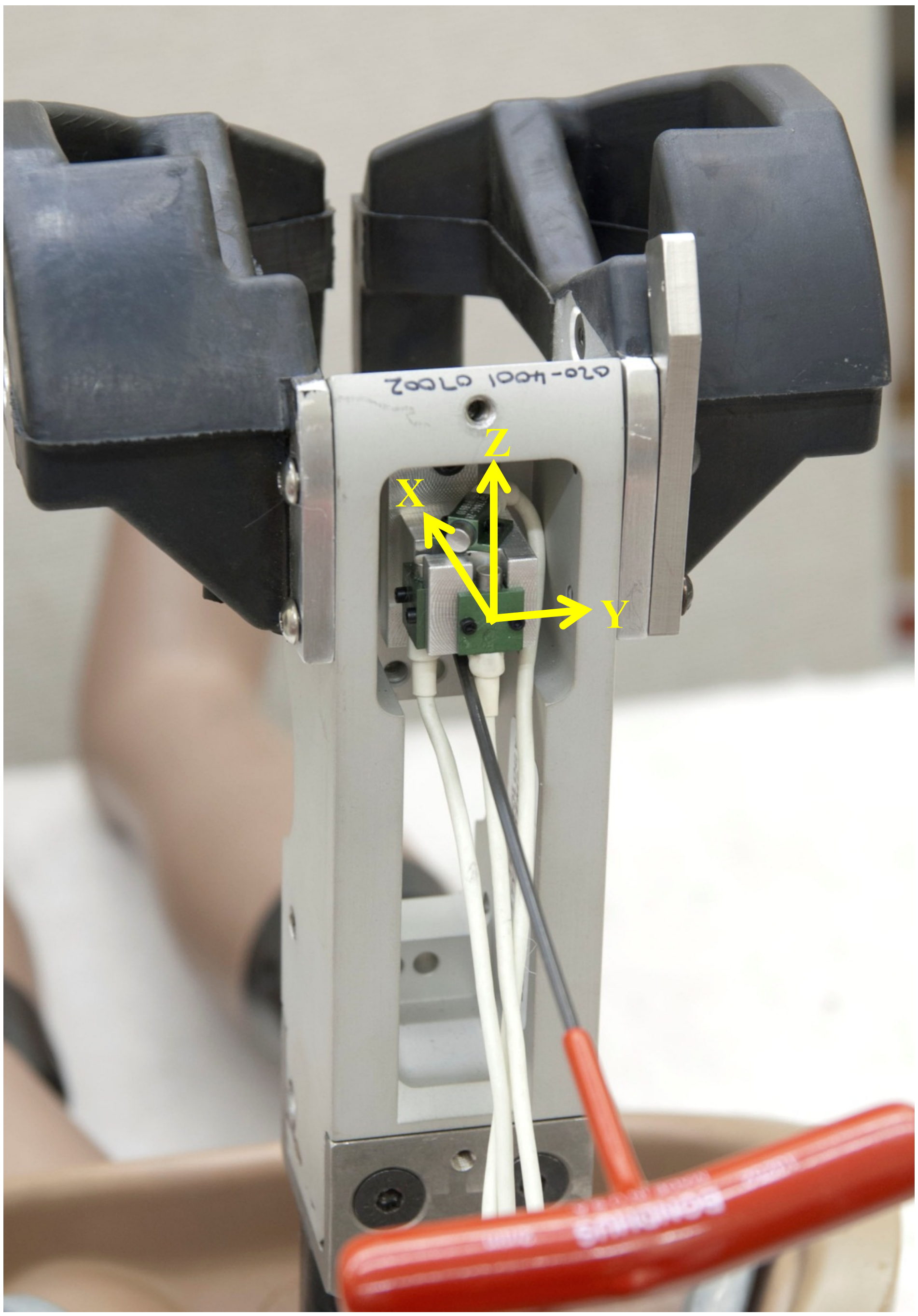


Figure 126. Install upper spine accelerometers into thoracic spine

6.4.2 T1 Accelerometer

1. Install the T1 accelerometer adaptor using two M4-0.7 x 16mm BHCS on the non-struck side of the dummy (Figure 127).

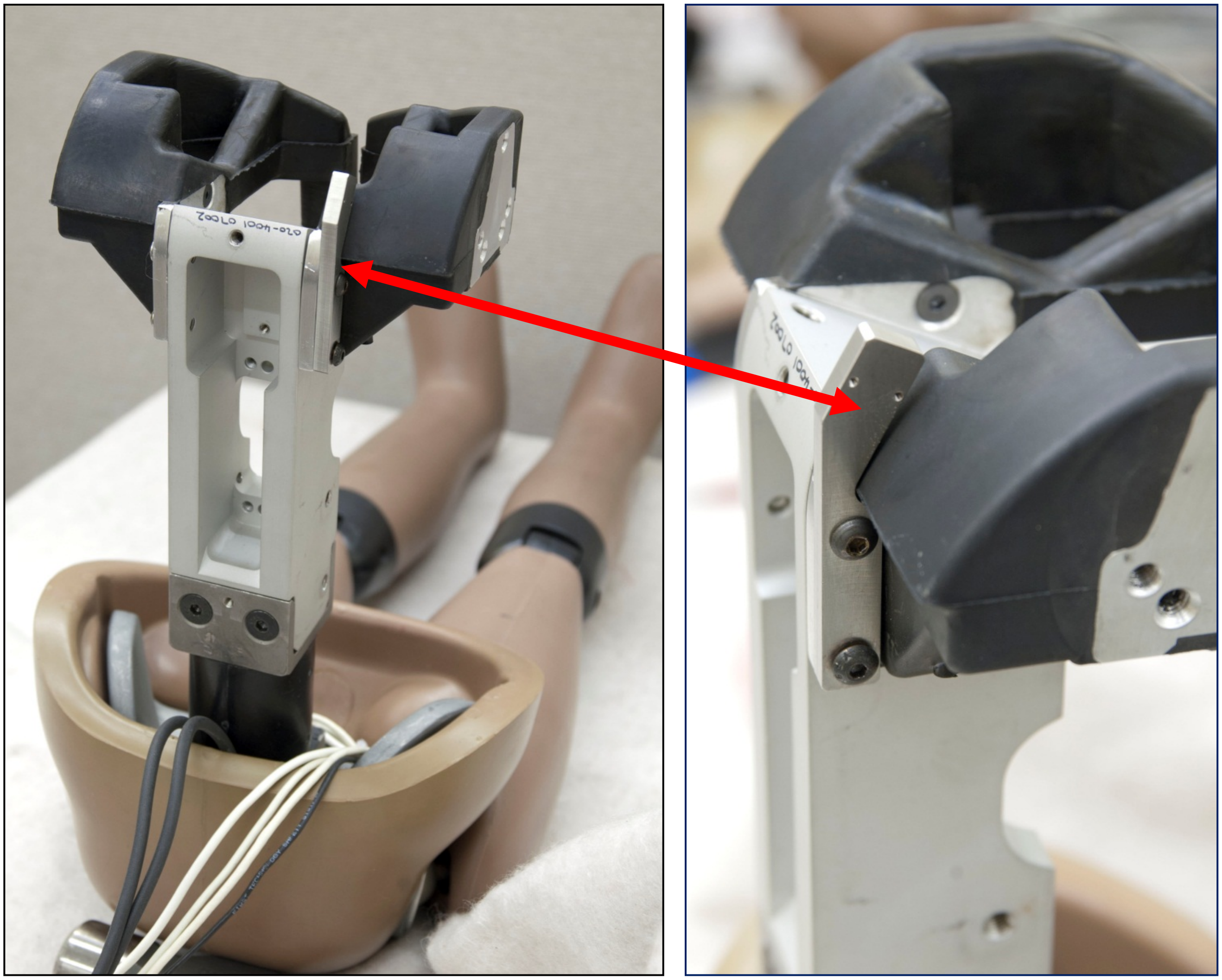


Figure 127. Install T1 accelerometer adaptor assembly on non-struck side of Q3s thoracic spine

2. Install the accelerometer to the T1 accelerometer adaptor assembly using two M1.4-0.3 x 4mm SHCS (Figure 128).

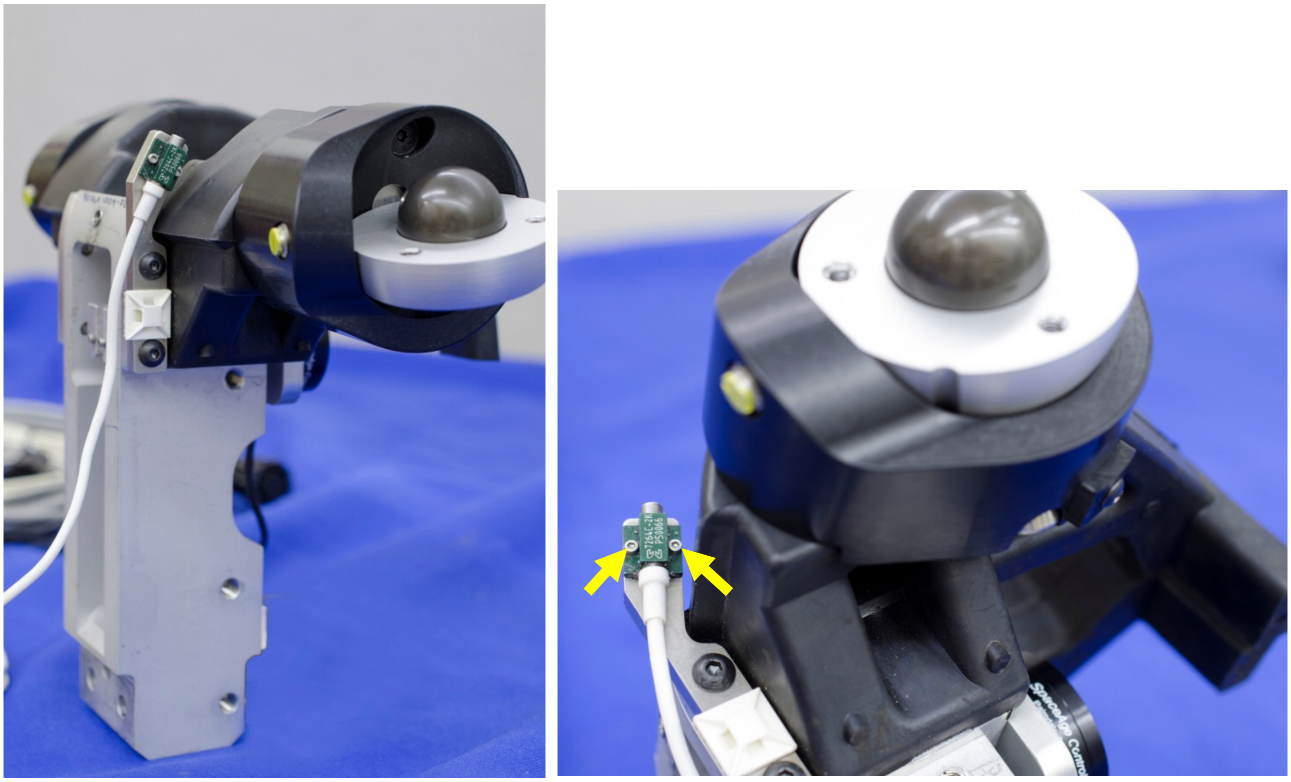


Figure 128. T1 accelerometer installed

6.4.3 Thoracic IR-TRACC

1. The IR-TRACC assembly configured for installation into the thorax is shown in Figure 129 (see Appendix F for information on processing IR-TRACC data). See Section 5.6.1 for additional information on configuring this assembly.

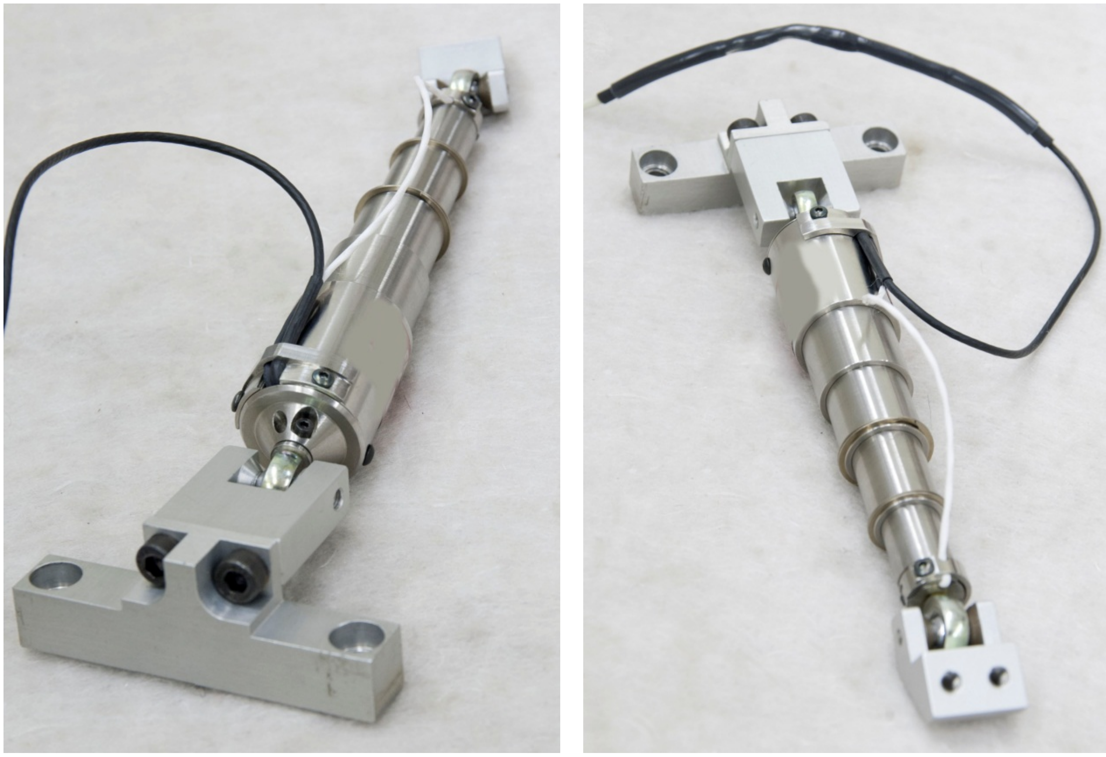


Figure 129. IR-TRACC assembly configured for installation in thorax

2. Secure the ribcage assembly to the shoulder only with four M5-0.8 x 12mm BHCS on the anterior side before installing the IR-TRACC (Figure 130).

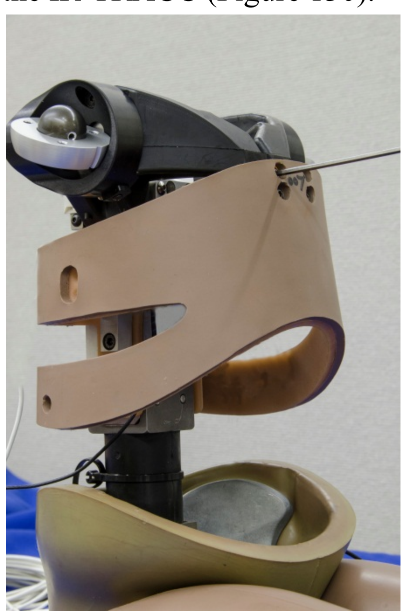
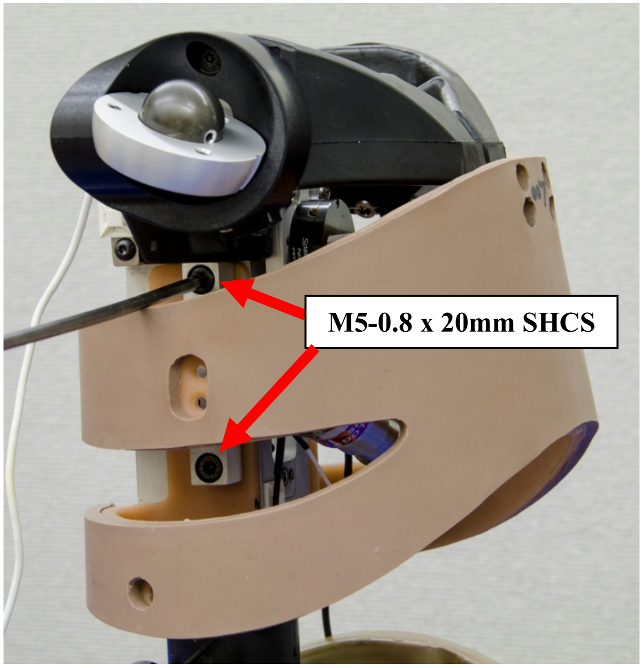


Figure 130. Secure the ribcage assembly at the sternum prior to mounting IR-TRACC

3. Install two M5-0.8 x 20mm SHCS through the IR-TRACC Bracket 1 into the thoracic spine and one M5-0.8 x 10mm BHCS on the lower thoracic spine on the non-impact side of the dummy (Figure 131).



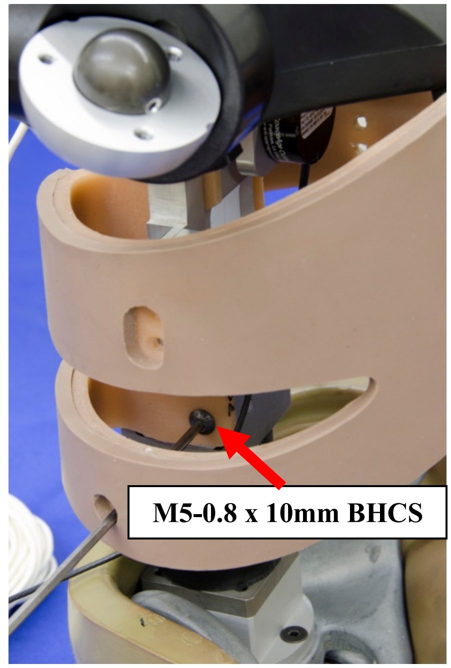


Figure 131. Secure non-impact side of rib cage to thoracic spine

4. Install three M5-0.8 x 10mm BHCS to attach the ribcage to the thoracic spine on the impact side of the dummy to complete attaching the ribcage to the spine (Figure 132).

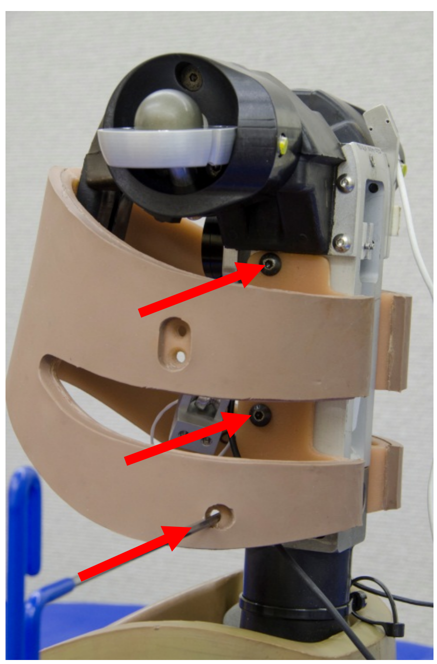


Figure 132. Install 3 BHCS to thoracic spine on impact side

5. Install the two M4-0.7 x 8mm FHCS through the ribcage to the IR-TRACC bracket to secure the impact end of the IR-TRACC to the ribcage (Figure 133). Note that the wiring protruding from each end of the IR-TRACC should be oriented *and installed in the orientation in which it was calibrated* in order to avoid measurement error within the IR-TRACC. Figure 134 and Figure 135 show the proper orientation of the IR-TRACC bracket and the completed installation of the IR-TRACC.

Figure 133. Secure IR-TRACC bracket to ribcage

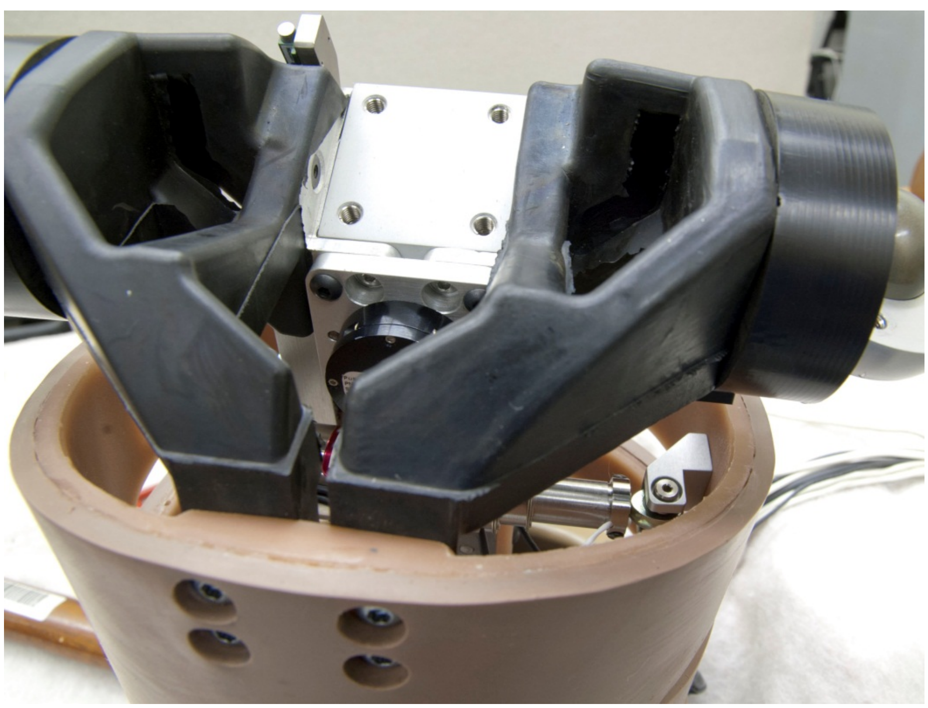


Figure 134. Orientation of IR-TRACC bracket

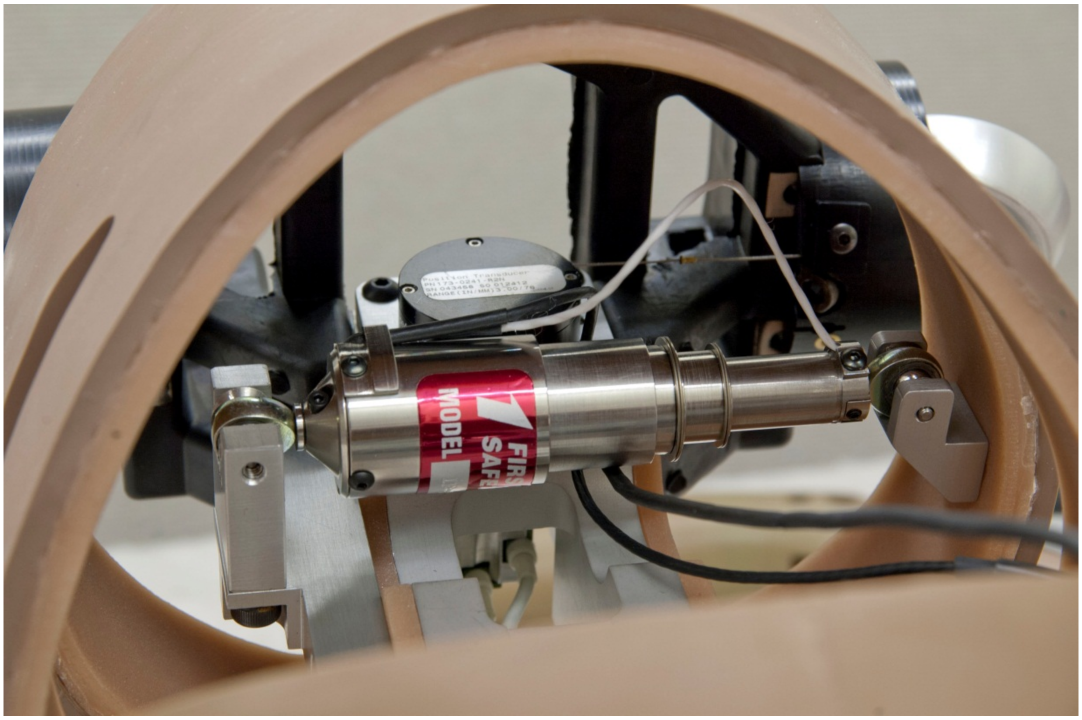


Figure 135. IR-TRACC installed in Q3s thorax

6.4.4 Thorax (Biaxial) Tilt Sensor

1. To install the tilt sensor in the thorax, first mount the tilt sensor to the tilt sensor bracket[9] using two M2-0.4 x 10mm SHCS (Figure 136 and Figure 137).

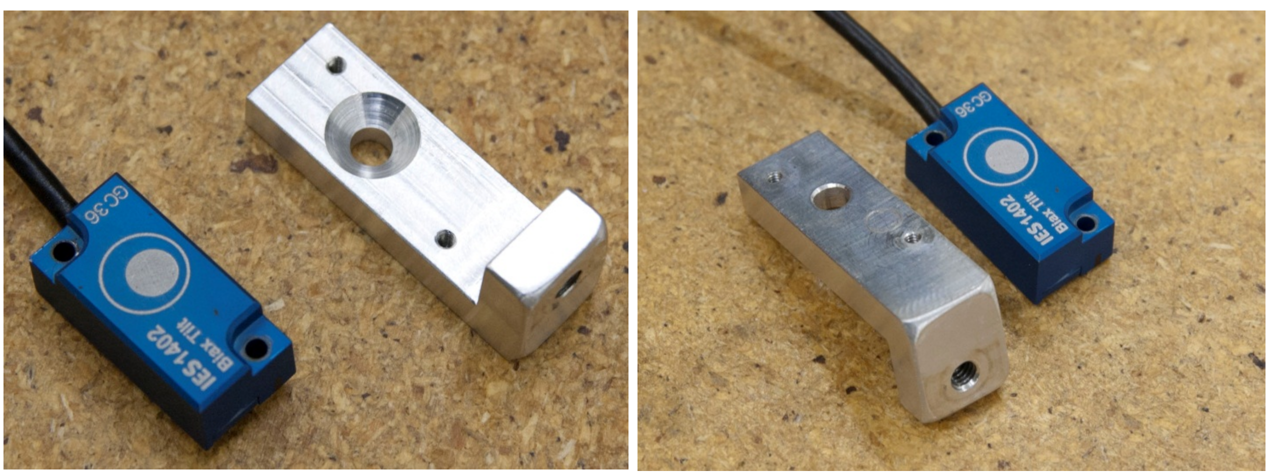


Figure 136. Tilt sensor and bracket for Q3s

[9] This bracket is designed to accommodate the IES 1402 biaxial tilt sensor (Part Number SA572-S44). Alternative tilt sensors may require a different bracket design.

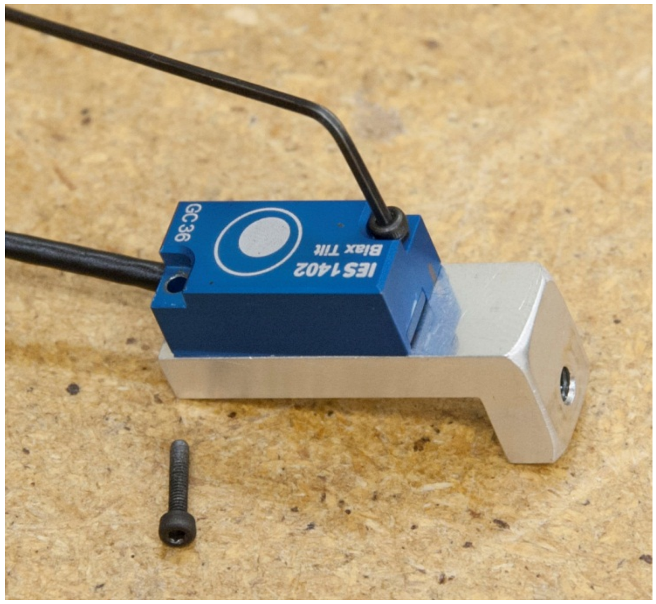


Figure 137. Install tilt sensor to bracket

2. Uninstall the cable cover from the thoracic spine and the cable mount if it is present[10] (Figure 159). Insert the mounted tilt sensor into the back of the thoracic spine so that its "L" shaped edge overhangs the anterior surface of the spine. The wiring for the tilt sensor should protrude from the back of the spine (Figure 138).

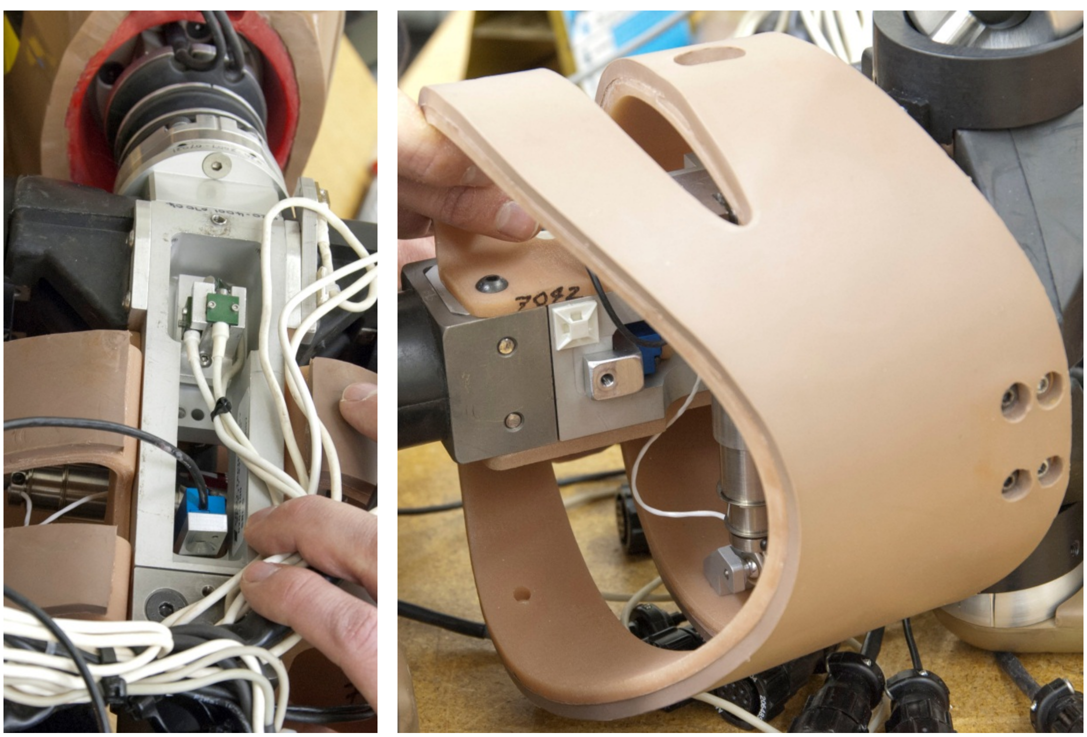


Figure 138. Insert the mounted tilt sensor into the thoracic spine

---

[10] If the cable clamp is installed as in Figure 1538, it will interfere with the tilt sensor mount. An alternative stick-on mount may be used.

3. From the posterior thoracic spine, secure the tilt sensor bracket to the thoracic spine with an M4-0.7 x 20mm SHCS. This screw will thread into the tilt sensor bracket overhanging the anterior side of the spine (Figure 139).

Figure 139. Install tilt sensor mount to thoracic spine

4. Figure 140 shows the tilt sensor installed in the Q3s thorax.

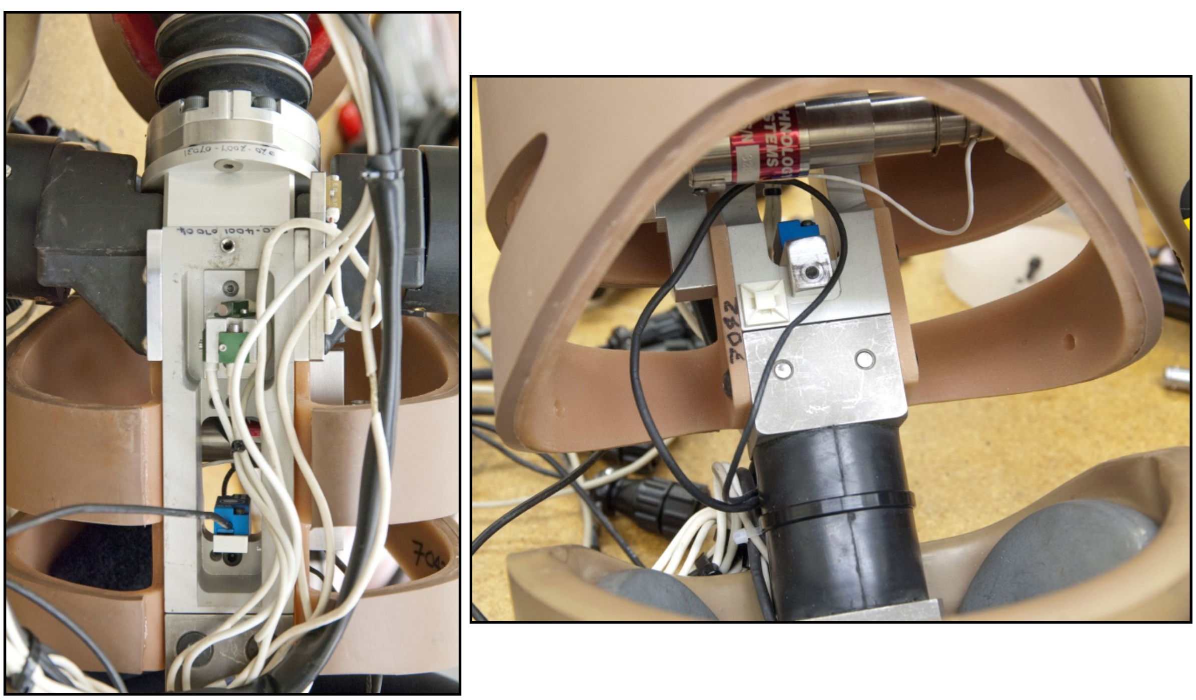


Figure 140. Tilt sensor installed into Q3s thorax

6.5 Pelvis

Instrumentation in the pelvis includes a single axis (Fy) pubic load cell, six-axis lumbar spine load cell (Fx, Fy, Fz, Mx, My, Mz), and a three-axis accelerometer array (three uniaxial accelerometers mounted on a block) to measure Ax, Ay, and Az. Table 23 summarizes the parts used for instrumentation in the pelvis.

Table 23. Pelvis Instrumentation Parts

Part Description	Quantit	Part Number
6-Axis Lumbar Load Cell	1	SA572-S8
Q3s Pubic Load Cell	1	SA572-S7
Pubic Buffer	1	020-7128
Hip Joint Slide Assembly	1	020-7136
Hip Joint Slide Assembly (Spacer Side)	1	020-7137
Screw, SHCS M4-0.7 x40mm	1	5000666
Uniaxial Piezoresistive Accelerometer	3	SA572-S4
Screw, SHCS M1.4-0.3 x 4mm	6	5000375-FT
Transducer Mounting Block (for Pelvis Accelerometers)	1	SA572-S89
Screw, SHCS M2.5-0.45 x 16mm	2	5000283-FT

6.5.1 Pubic Load Cell

1. The pubic load cell is installed on the *non-impact side* of the pelvis. Figure 141 shows the parts needed for the pubic load cell assembly.

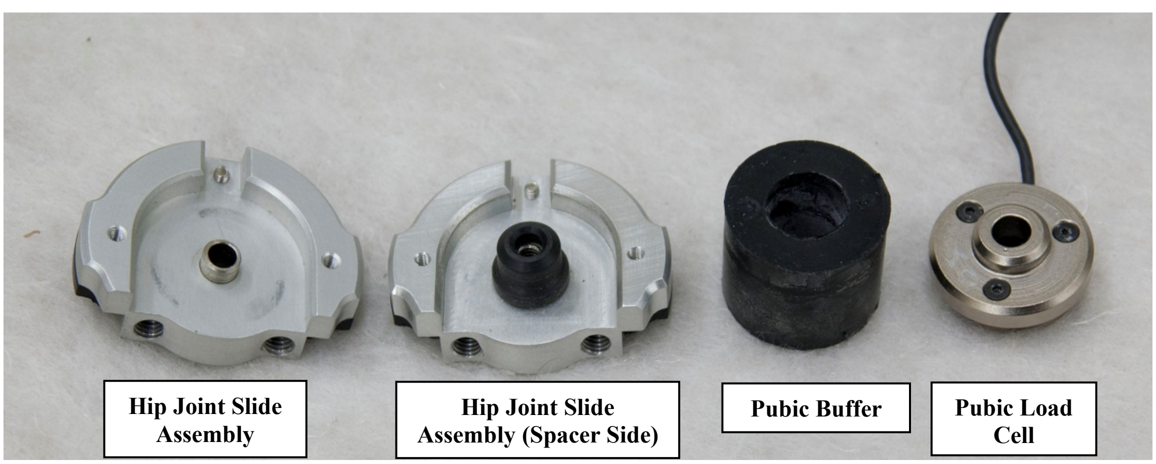


Figure 141. Parts needed for pubic load cell assembly

2. First, place the pubic load cell over the end of the pubic buffer (Figure 142).

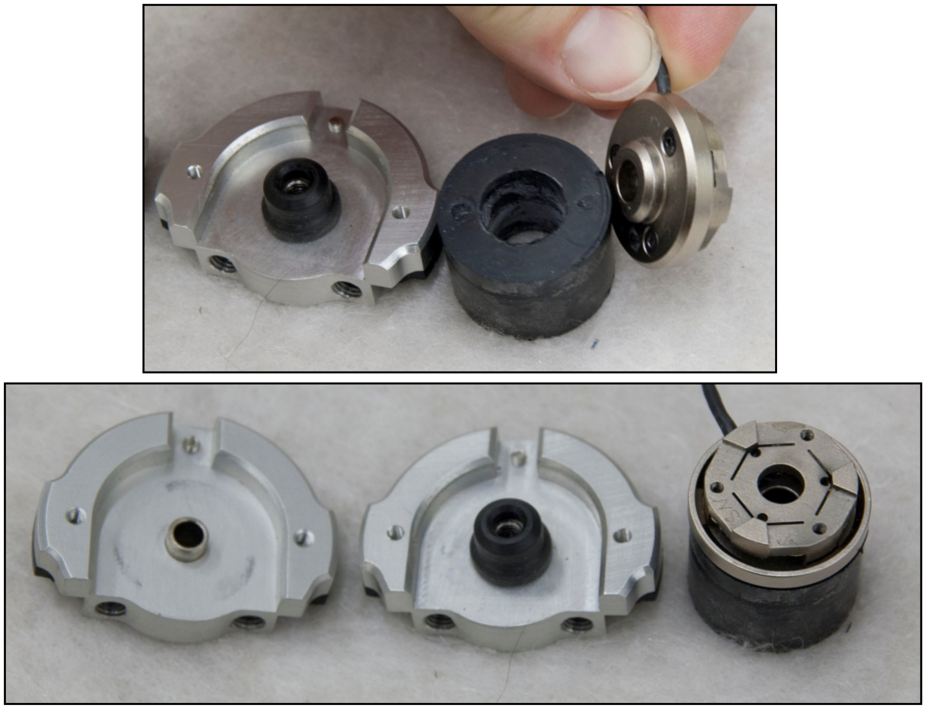


Figure 142. Place pubic load cell over end of pubic buffer

3. Install the pubic buffer into the hip joint slide assembly (spacer side) (Figure 143).

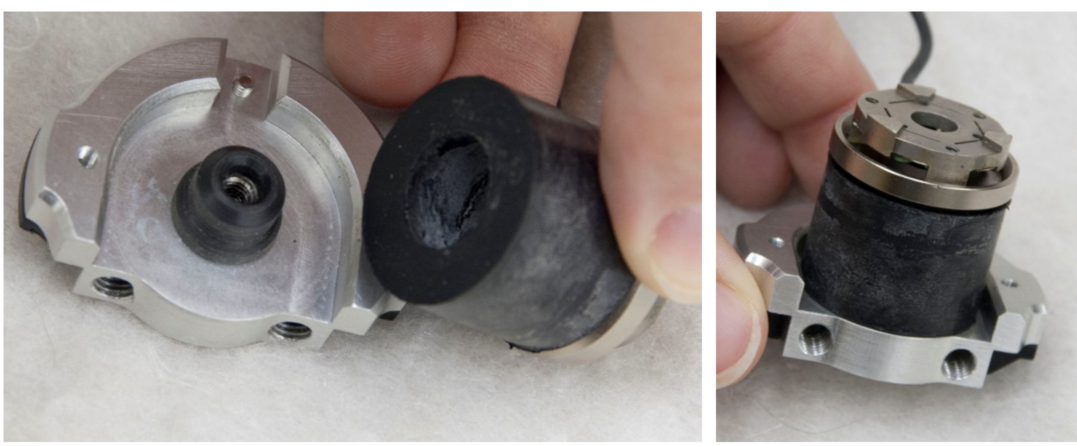


Figure 143. Install pubic buffer into hip joint slide assembly (spacer side)

4. Install the hip joint slide assembly over the pubic load cell (Figure 144).

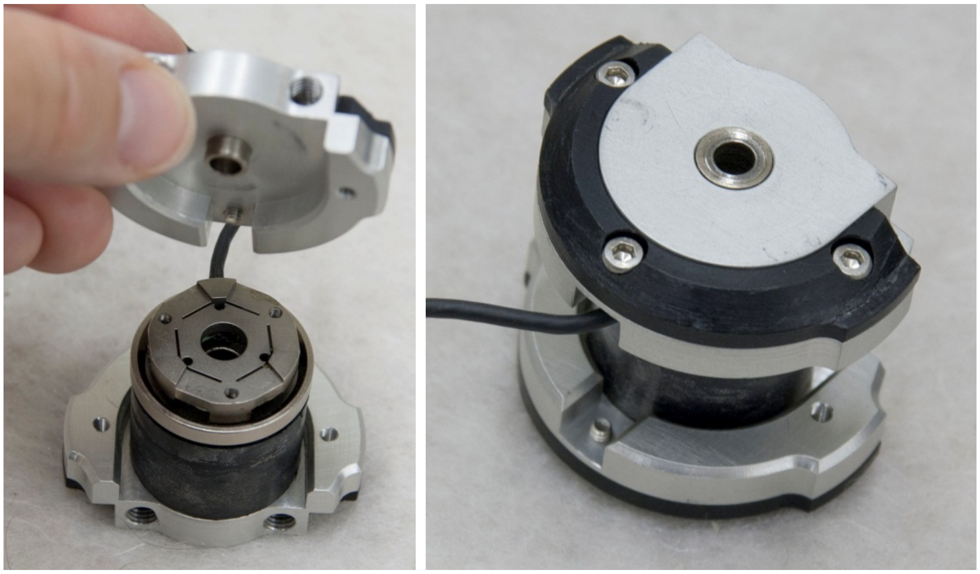


Figure 144. Install hip joint slide assembly over pubic load cell

5. Loosely install the M4-0.7 x40mm SHCS, *but do not compress the pubic buffer* (Figure 145).

Figure 145. Install SHCS to hold pubic load cell assembly together

6. Install the hip joint slide cover *on the struck side* of the pubic load cell assembly with two M5-0.8 x 10mm SHCS. *This must be installed* ***prior*** *to placing any compression on the pubic buffer element or interference will result!* Once the hip joint slide cover is installed, tighten the M4-0.7 x40mm SHCS until the pubic buffer is compressed just enough to fit the pubic load cell assembly into the pelvis. Be certain that the pubic load cell wiring is not pinched during compression (Figure 146).

Figure 146. Install hip joint slide cover on struck side of pubic load cell assembly *then* compress pubic buffer

7. Insert the (compressed) pubic load assembly into the machined pelvis (Figure 147).

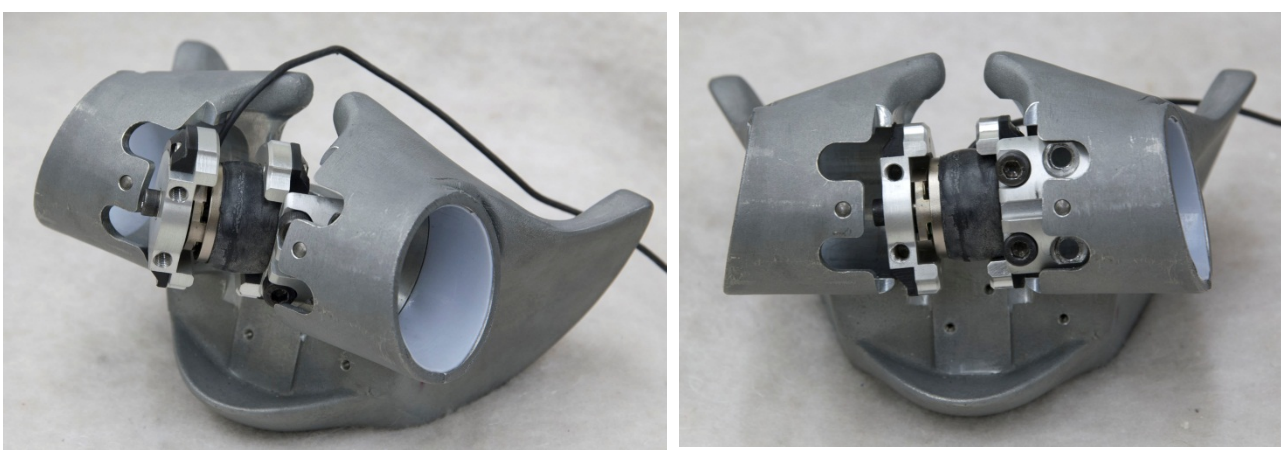


Figure 147. Insert compressed pubic assembly into machined pelvis

8. Install the non-struck side hip joint slide cover (Figure 148).

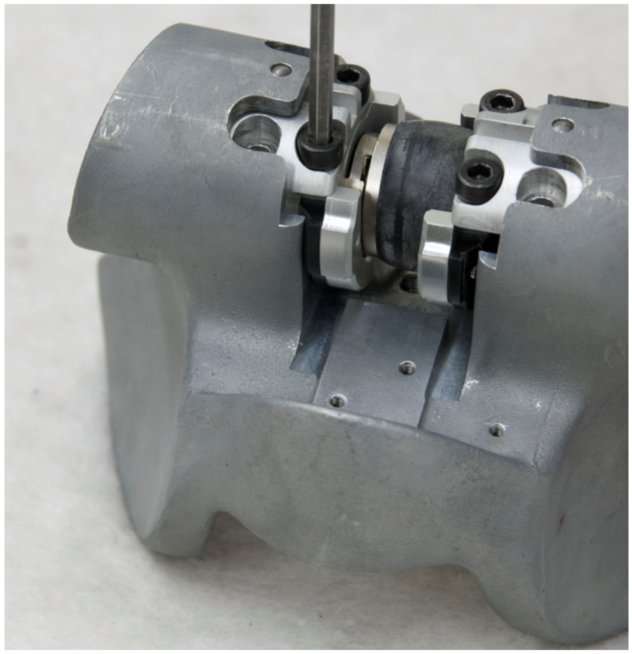


Figure 148. Install non-struck side hip joint cover

9. Loosen and remove the M4-0.7 x40mm SHCS to relieve compression on the pubic buffer (Figure 149). Figure 150 illustrateds the pubic load cell installed in the Q3s pelvis.

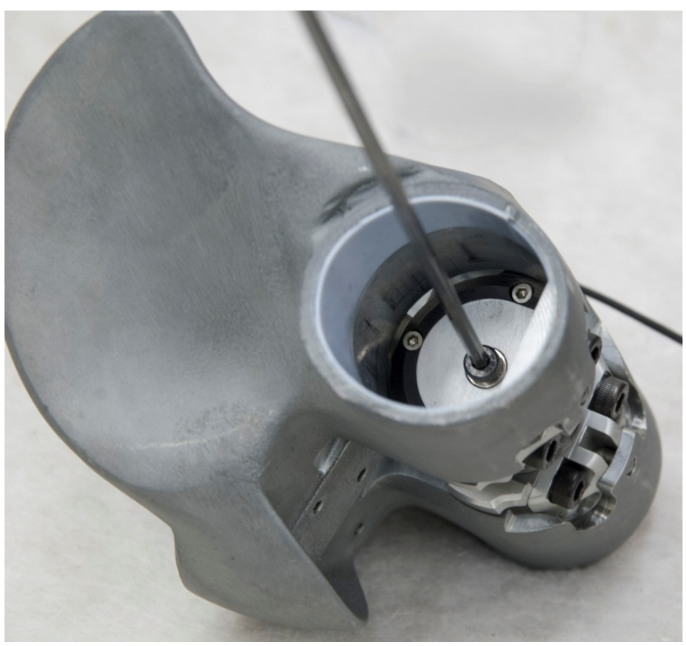


Figure 149. Remove SHCS to relive compression on pubic buffer

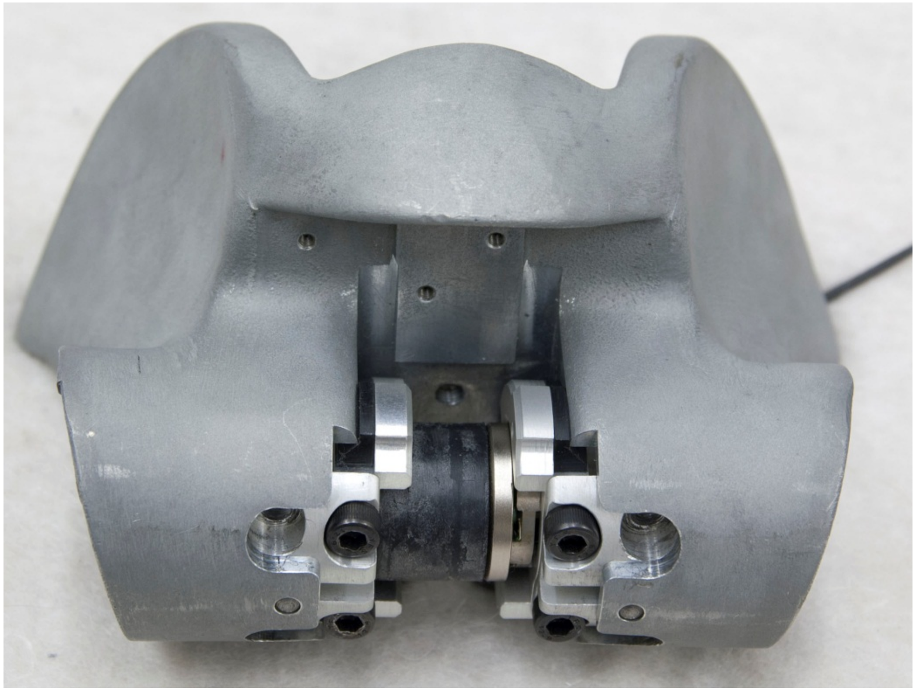


Figure 150. Pubic load cell installed in Q3s pelvis

6.5.2 Pelvis Accelerometers

5. Install three accelerometers (X, Y, and Z) on the accelerometer block using two M1.4-0.3 x4mm SHCS for each accelerometer. Note that the Z accelerometer is installed (upside-down) into the recess of the block (Figure 151).

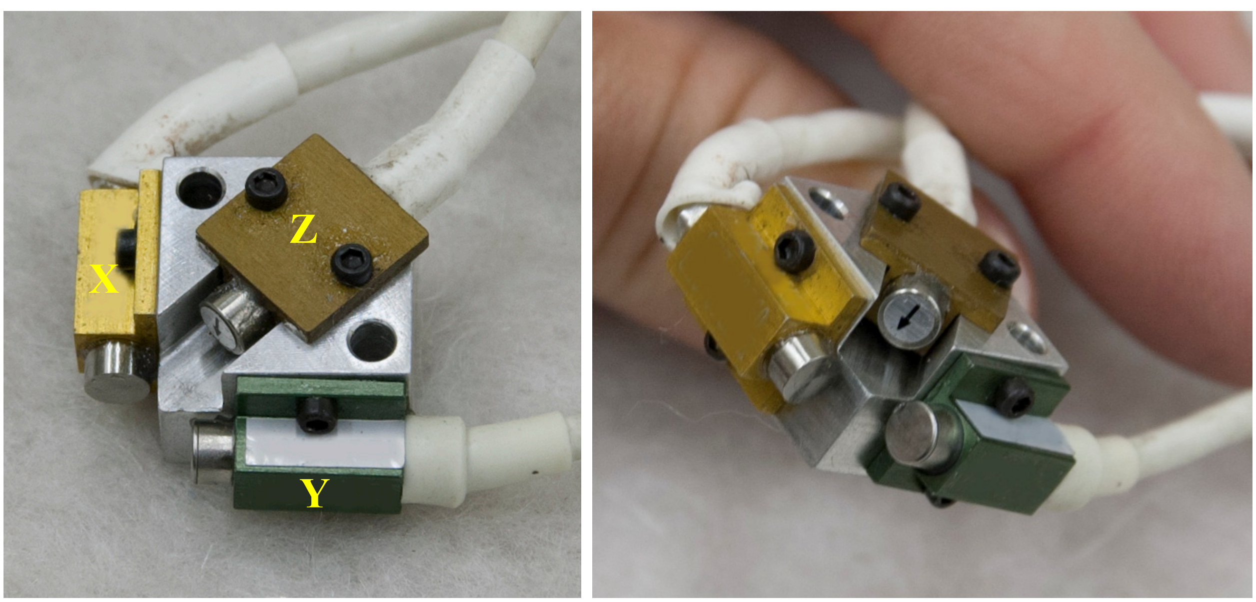


Figure 151. Install pelvis accelerometers to block

6. Install the accelerometer block to the rear underside of the machined pelvis using two M2.5-0.45 x 16mm SHCS (Figure 152). The mounted orientation[11] for each accelerometer (with respect to the accelerometer's positive axis of acceleration) should be:
    - X: FORWARD
    - Y: RIGHT
    - Z: UP

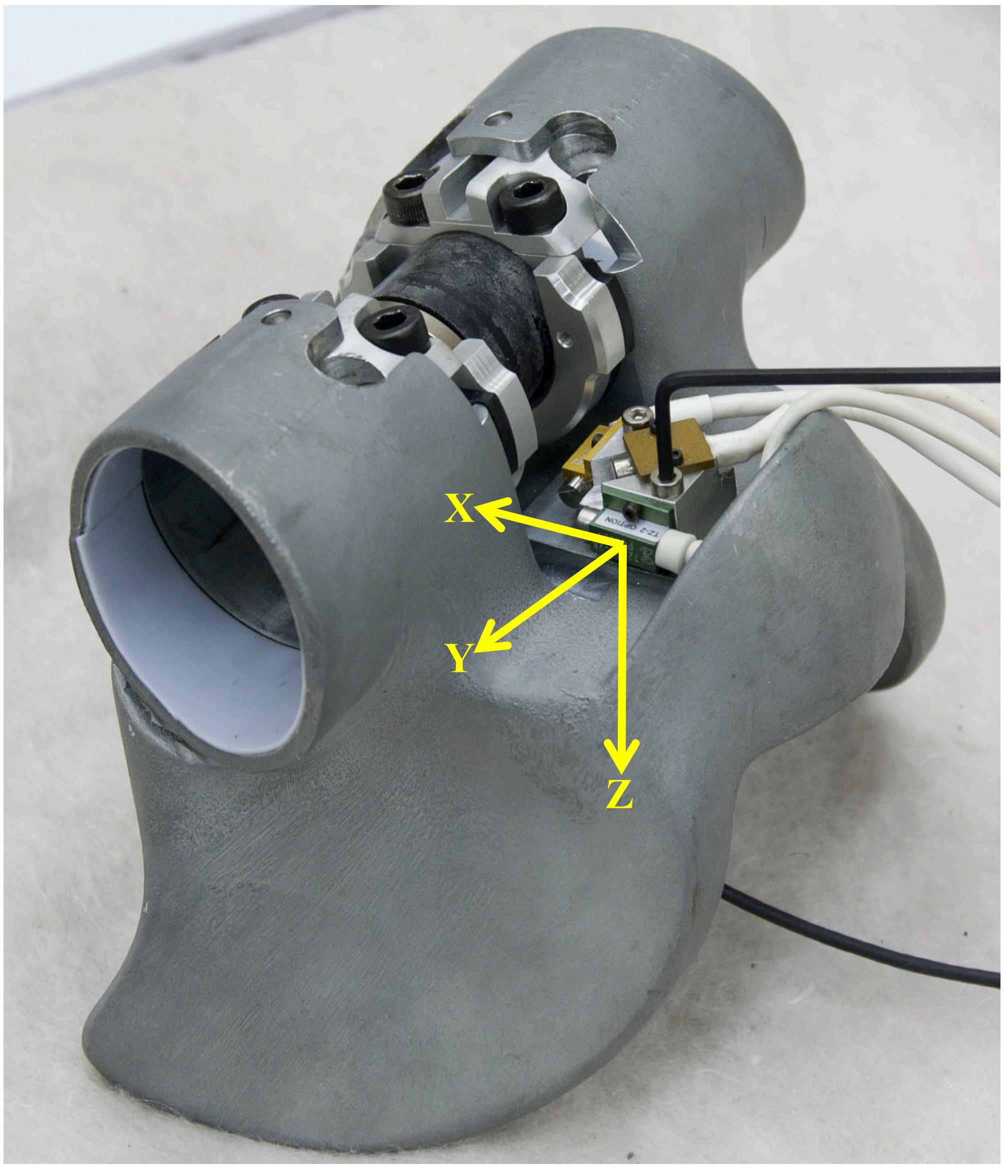


Figure 152. Install pelvis accelerometer block into machined pelvis

[11] This is the installed orientation regardless of whether impact is left or right side.

7. Group and tape the three accelerometer wires together to minimize pinching and route them along the underside of the pubic buffer element (Figure 153).

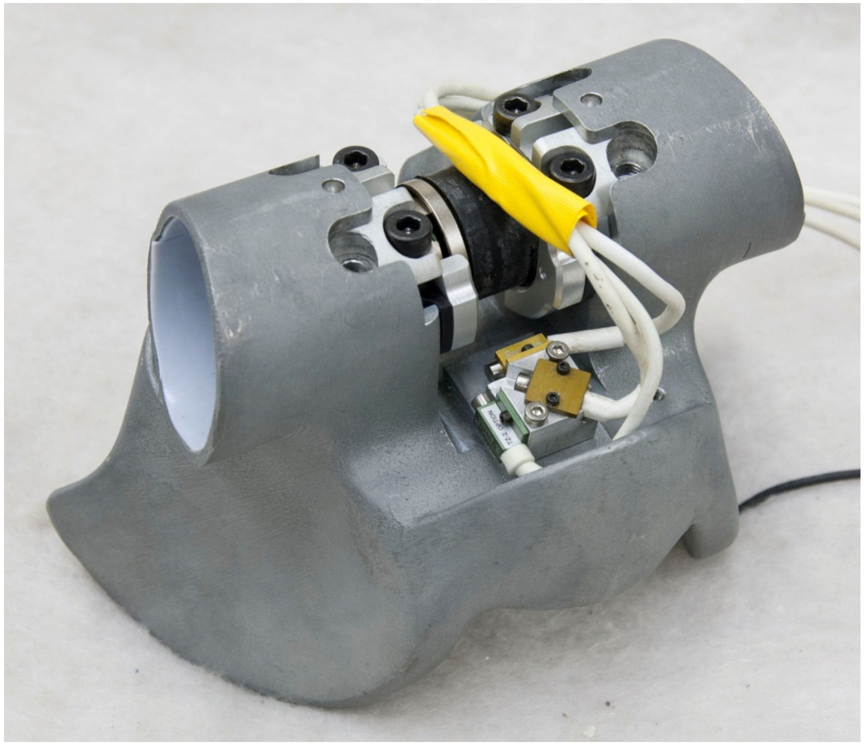


Figure 153. Route pelvis load cell wiring along pubic buffer

6.5.3 Lumbar Load Cell

1. After assuring a 2 in-lb torque on the jam nuts on the end of the lumbar cable, the lumbar load cell can be installed. Attach the lumbar load cell to the bottom of the lumbar spine with four M5-0.8 x 12mm SHCS. The load cell should be oriented so that the wiring protrudes from the rear side of the lumbar spine (Figure 154).

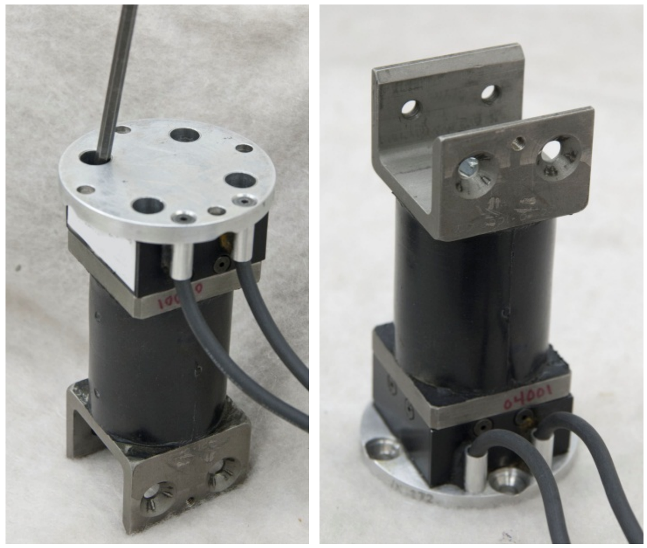


Figure 154. Install lumbar load cell to the bottom

2. With the lumbar load cell wires oriented towards the posterior side of the pelvis, install the lumbar load cell to the machined pelvis using four M5-0.8 x 12mm FHCS (Figure 155).

Figure 155. Install lumbar load cell to machined pelvis

3. Slide the machined pelvis bone into the pelvis skin, assuring that the bone is properly seated within the skin (Figure 156).

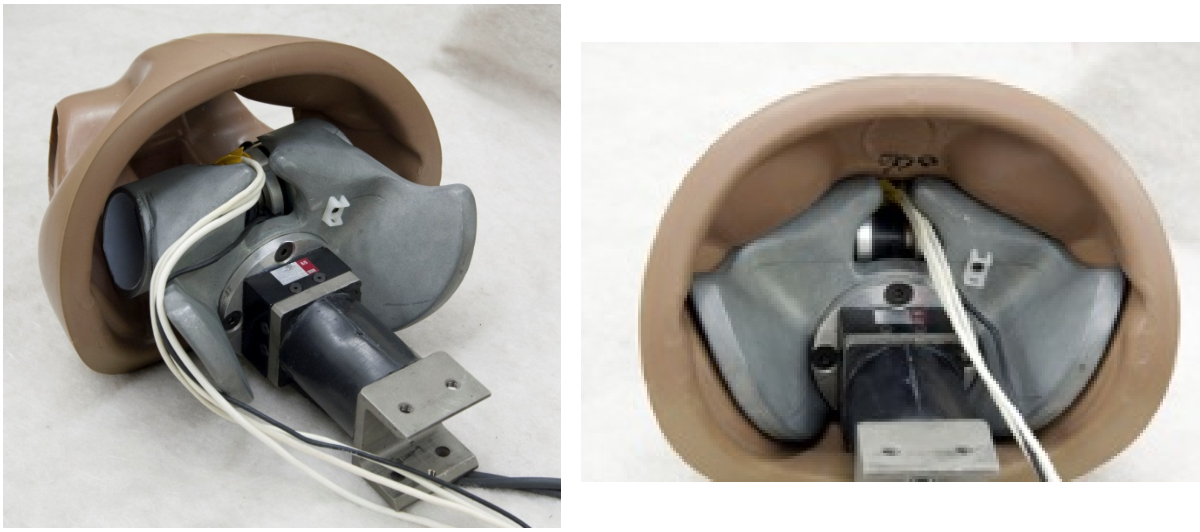


Figure 156. Insert pelvis bone into pelvis skin

7 INSTRUMENTATION CABLE ROUTING

The dummy contains provisions for mounting numerous electronic instruments to evaluate various types of occupant restraint systems. Typically, the instruments are connected to the data acquisition system through the use of long cables. The instrumentation cables must be routed in and around the dummy in a manner that ensures that the dummy's motion is not affected by the cables while also being careful not to place the cables in a position where they are susceptible to damage from the test event. There are many acceptable methods of routing the cables and the following section is intended as a reference.

7.1 Grounding

To reduce the possibility of static electricity discharge and subsequent noise in the data acquisition system, a small length of cable, referred to as a grounding cable, is placed between the dummy and ground. In the Q3s, this cable is typically placed between the bottom of the T1 accelerometer adaptor and ground; it is routed along the edge of the cable guide cover (Figure 157).

Figure 157. Installing grounding wire

7.2 Head and Neck Cable Routing (head accelerometers, upper and lower neck load cells)

1. Assure that the accelerometer cables exiting the head are not pinched by the skull cap.
2. Leaving enough slack for neck flexion and extension, use cable ties to gather the head accelerometer cables and neck load cell cables (Figure 158).

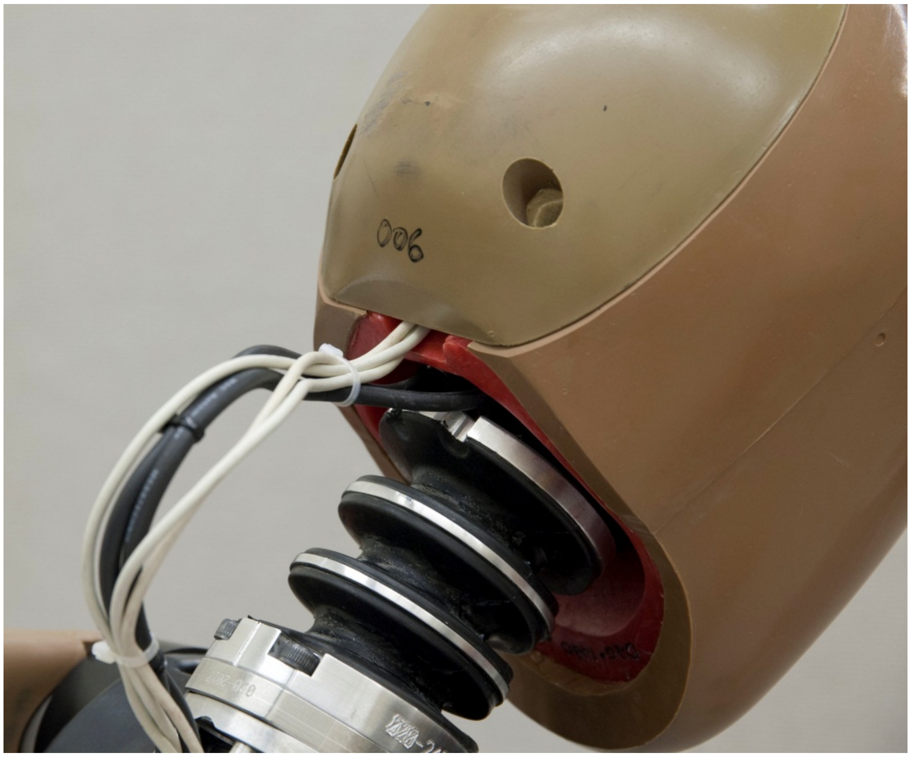


Figure 158. Cable routing for head and neck

7.3 Thorax Cable Routing (T1 accelerometer, upper spine accelerometers, IR-TRACC, shoulder stringpot, tilt sensor)

1. Route the cables for the IR-TRACC and the shoulder stringpot through a strain nylon loop clamp on the lower spine[12]. Orient the clamp so that the wiring falls on the *non-struck* side of the dummy (Figure 159). The clamp utilizes a M4-0.7 x 16mm SHCS for installation. Leave some slack in the cables for strain relief above the cable clamp. The protruding wiring also comes out on the non-struck side.

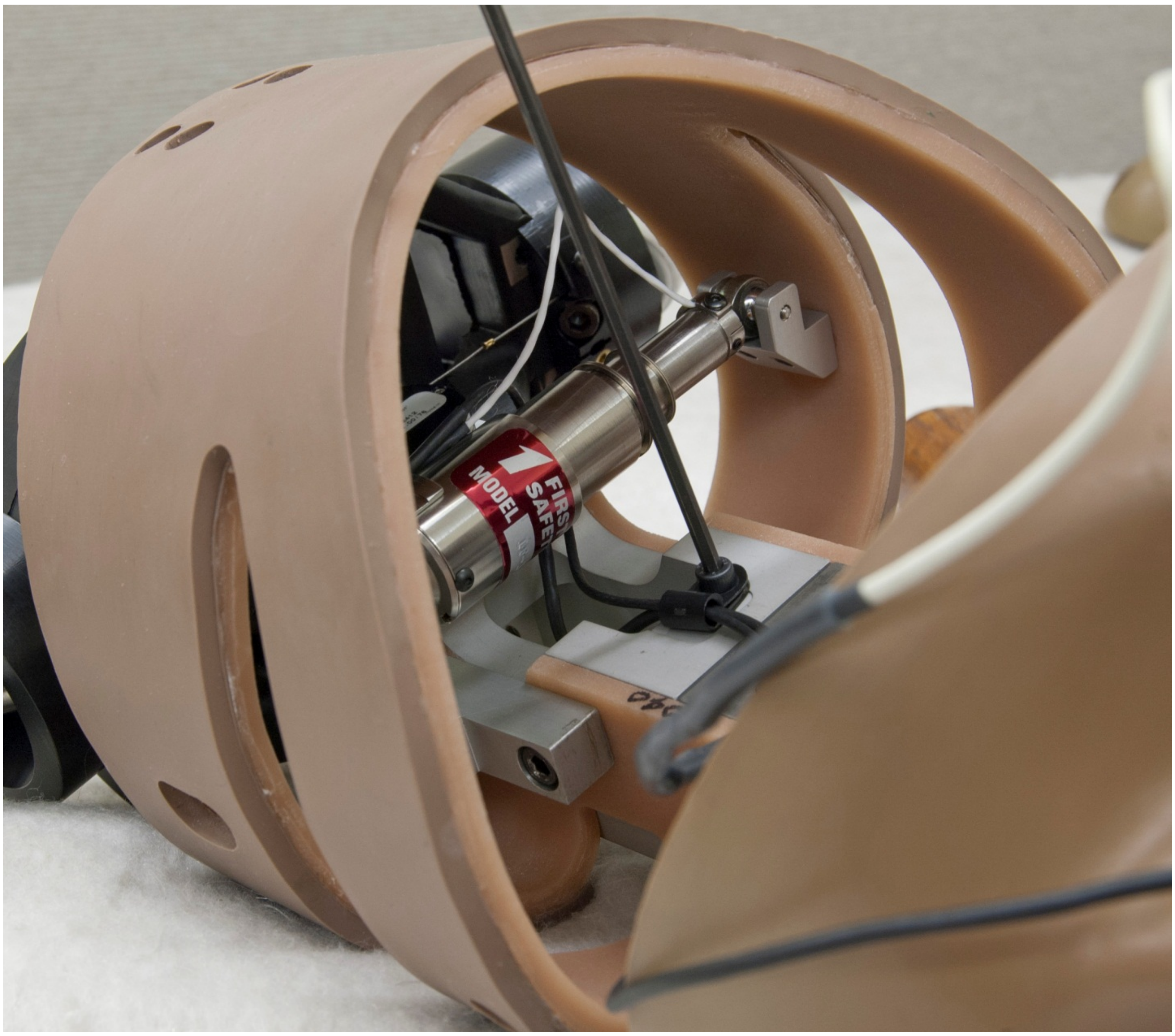


Figure 159. Cable routing for IR-TRACC and shoulder stringpot (for clarity, tilt sensor not installed in this photo)

[12] If a tilt sensor is installed, this clamp will not be present. In that case, an adhesive stick-on tie clamp can be used (Figure 135, right photo).

2. Route the wiring for the T1 and upper pine accelerometers along the posterior thoracic spine (Figure 160).

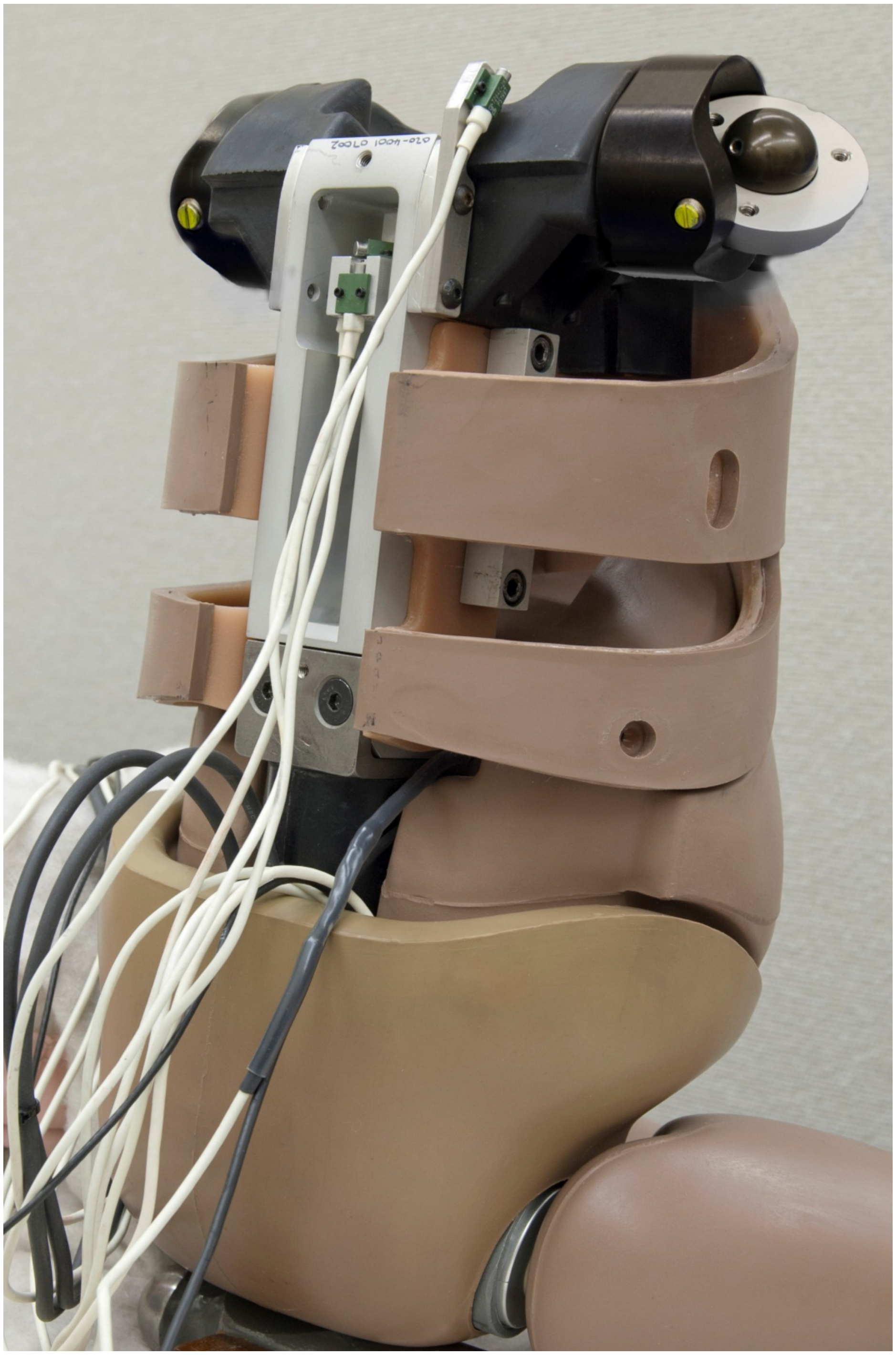


Figure 160. Wire routing for T1 and upper spine accelerometers

7.4 Pelvis Cable Routing (Pelvis Accelerometers, Pubic Load Cell, Lumbar Load Cell)

1. Route the pelvis accelerometer wiring under the pubic buffer and around to the anterior pelvis. Tape or tie-wrap the three accelerometer wires together (Figure 161).

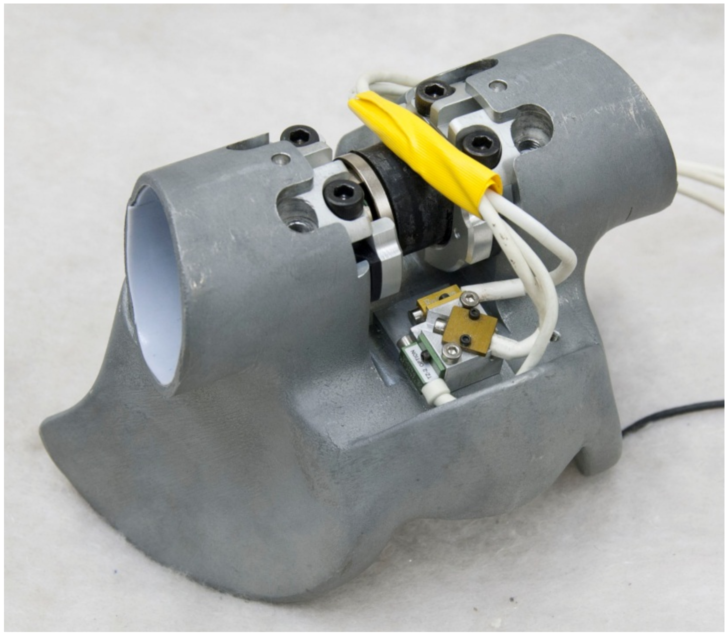


Figure 161. Pelvis accelerometer cable routing

2. The wires for the pubic load cell should follow the pelvis accelerometers on the anterior side of the pelvis. The lumbar load cell wiring should be on the posterior lumbar spine (Figure 162).

Figure 162. Wire route for pelvis accelerometers, pubic load cell, and lumbar load cell

3. After the pelvis skin is installed, the pelvis wiring should be gathered, affixed to the pelvis via a tie-wrap clamp, and routed around the lumbar spine on the *non-struck* side of the pelvis (Figure 163).

Figure 163. Pelvic wiring with pelvis skin installed

7.5 Overall Cable Routing

1. Route the wiring from the head, neck, T1, and upper spine down the recess in the posterior thoracic spine. Divide the wires to follow either the right or left side of the thoracic spine before placing the cable guide spine cover over the spine. Install the cable guide using two M4-0.7 x 16mm FHCS at the top and bottom of the cable guide. Be careful not to pinch the wiring between the edges of the cable guide and the thoracic spine (Figure 164).

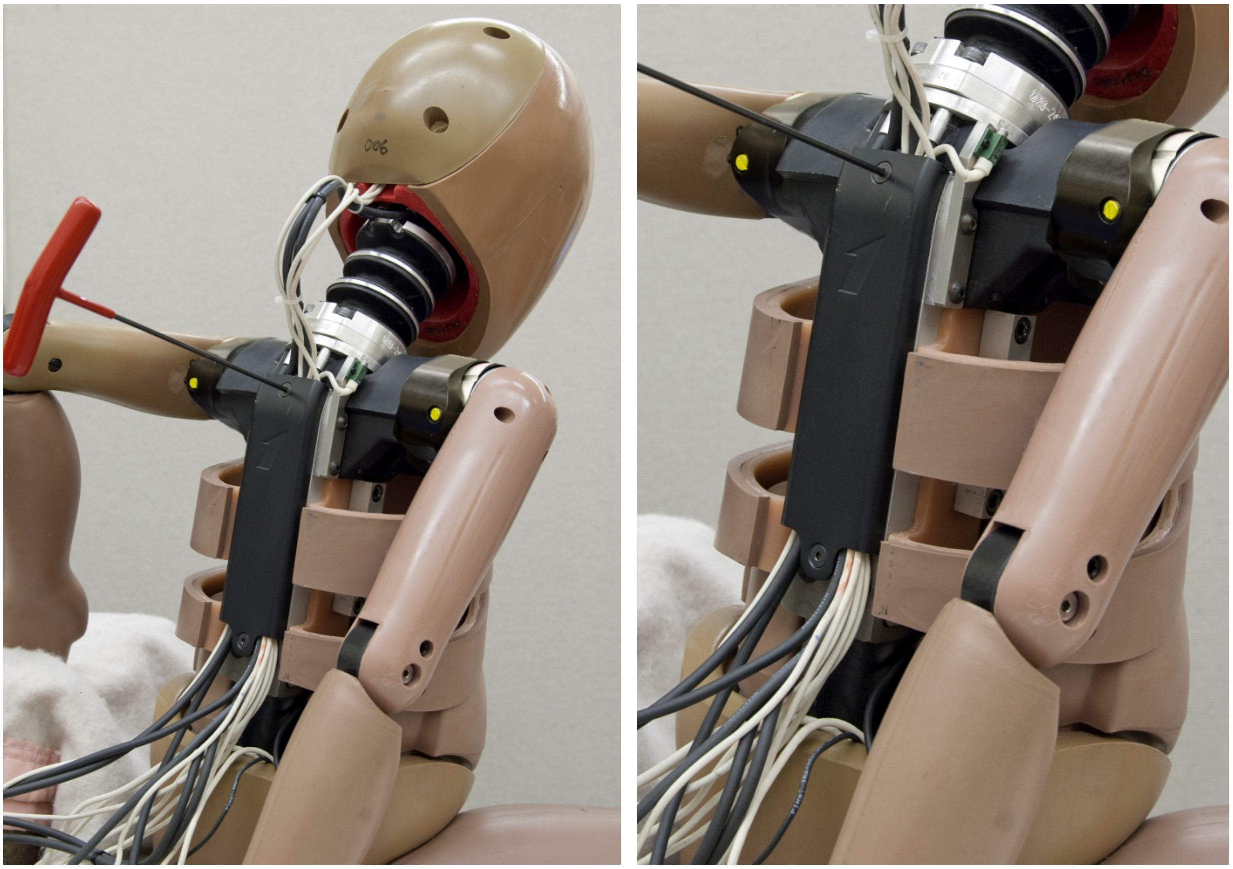


Figure 164. Installing cable guide to thoracic spine

2. Gather the wiring protruding from the thoracic spine cable cover along with the pelvis instrumentation wiring. Place a tie-wrap on the bundle allowing some slack. The bundle should be oriented towards the non-struck side of the dummy (Figure 165).

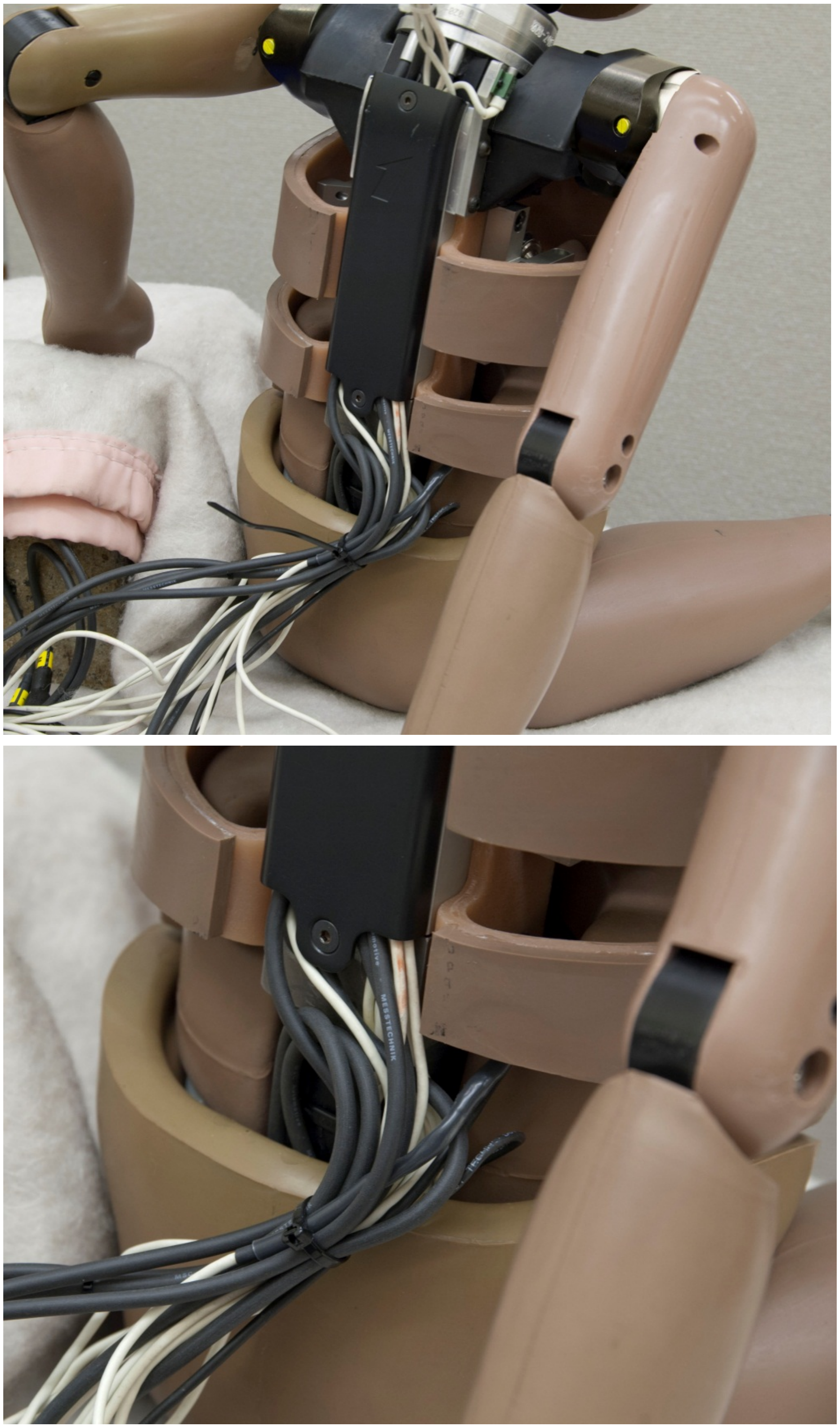


Figure 165. Gather wiring from thoracic spine and pelvis

3. Install the suit on the dummy. The wiring should protrude from the non-struck side of the Q3s. Additional tie-wraps should be used along the cable bundle to hold the wiring together (Figure 166).

Figure 166. Wiring bundles after installation of suit

8 CONFIGURING FOR RIGHT SIDE IMPACT

Assembly of the Q3s with respect to parts is identical for a dummy subjected to a right side impact. All instrumentation is installed the same for right side as left side with the following exceptions. This instrumentation must be re-oriented for a right side impact:

1. Change the shoulder stringpot to the right side. The shoulder stringpot is a different part number for right and left sides. Be certain to install the right side stringpot (Part Number SA572-S39).
2. Move the T1 accelerometer adaptor and accompanying accelerometer from the right side to the left side. This accelerometer is mounted on the non-struck side of the dummy.
3. Change the pubic load cell from the right side to the left side. The pubic load cell is mounted on the non-struck side of the dummy.
4. Re-orient the IR-TRACC in the thorax from the left side to right side.

Installation of this instrumentation follows the same procedure as found in Section 6 except for it is installed with orientation as described above.

9 EXTERNAL DIMENSIONS

These measurements shall be taken prior to testing with the dummy in order to verify key external dimensions and identify possible deficiencies in the dummy molded parts or problems with the internal structural configuration. These dimensions shall be checked without any instrumentation cabling coming from the rear of the dummy as this bundle may affect the measurements. Figure 167 and Table 24 illustrate the external dimension details for the Q3S dummy. Table 25 indicates the specifications for each of the Q3s external dimensions.

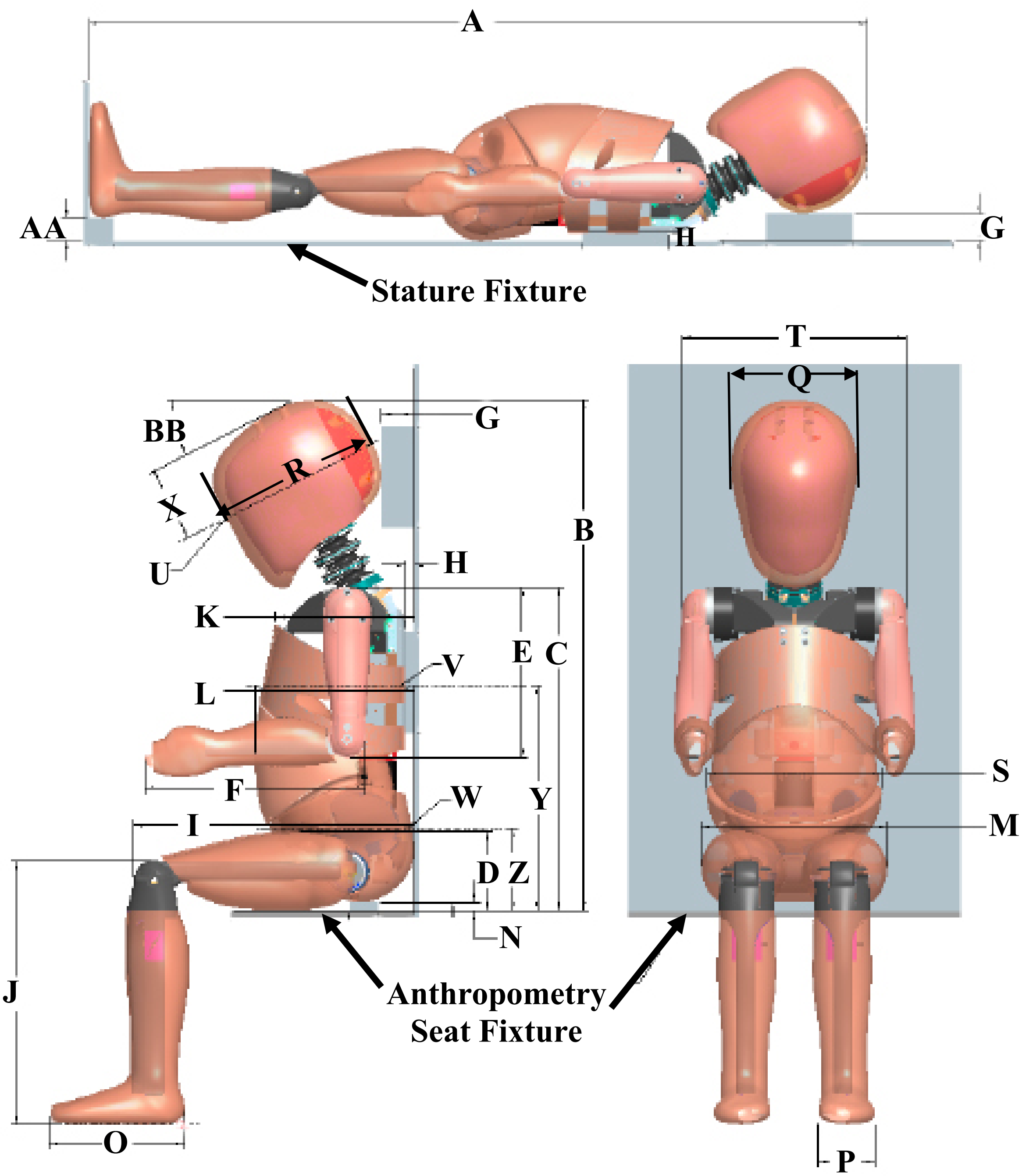


Figure 167. External dimensions of the Q3s dummy

Table 24. Q3s External Dimension Details

Dim.	Description	Details
A	Stature	Top of head to bottom of feet when measured in stature fixture
B	Total Sitting Height	seat surface to highest point on top of head when back of head is in contact with spacer block (G)
C	Shoulder Height Sitting	top of upper arm above seat surface
D	Thigh Clearance	thigh height at highest point above seat
E	Shoulder to Elbow Length	top of upper arm at shoulder to bottom of upper arm at elbow
F	Elbow to Fingertip Length	back of upper arm to front of fingertip parallel to long axis of lower arm
G	Head Back to Seat Back	measurement set by fixture
H	Spine Box Back to Seat Back Line	measurement set by fixture
I	Knee to seat back Line Seated	front of knee in line with knee pivot centerline to seat back
J	Knee Height Seated	top of knee to foot plate measured in line with knee pivot centerline
K	Chest Depth Upper	top front point of rib cage molding to seat back
L	Abdominal Depth	Forward most point of abdomen to seat back parallel to the seat pan
M	Hip Breadth Sitting	width of pelvis across the femurs in line with femur centerlines
N	Pelvis Height Above Seat	measurement set by fixture
O	Foot Length	length of foot from toes to heel parallel to long axis of the foot
P	Foot Width	width of foot at widest point perpendicular to long axis of foot
Q	Head Width	width of head at widest point
R	Head Length	length of head from front to rearmost projection of skull cap along reference line X
S	Waist Width Sitting	width across waist at widest point at top of pelvis
T	Shoulder Width	width across arms at shoulder pivot centerline
U	Head Circumference	circumference of head at head length measurement location
V	Chest Circumference	circumference of chest at center of the top rib at the reference location for chest circumference

W	Waist Circumference	circumference of chest at center of the top rib at the reference location for chest circumference
X	Head reference Line	distance below crown of head for length and circumference measurement
Y	Reference Location for Chest Circumference	height above seat for chest circumference measurement
Z	Reference Location for Waist Circumference	height above seat for waist circumference measurement
AA	Head Back to Back Line Standing	set by fixture
BB	Head Reference Line Angle	measure with protractor and set to correct angle

Table 25. Q3s External Dimensions

Dim.	Description	English (in)		Metric (mm)	
		Spec.	Tolerance +/-	Spec.	Tolerance +/-
A	Stature, mm	38.7	0.6	984	15
B	Total Sitting Height, mm	21.9	0.4	556	10
C	Shoulder Height Sitting, mm	13.7	0.4	347	10
D	Thigh Clearance, mm	3.3	0.3	83	8
E	Shoulder to Elbow Length, mm	7.3	0.4	186	10
F	Elbow to Fingertip Length, mm	9.6	0.4	245	10
G*	Head Back to Seat Back, mm	1.4	0.1	35	2.5
H*	Spine Box Back to Seat Back Line, mm	0.4	0.1	10	2.5
I	Knee to Seat Back Line Seated, mm	12.0	0.5	305	13
J	Knee Height Seated, mm	11.1	0.5	281	13
K	Chest Depth Upper, mm	5.9	0.3	151	8
L	Abdominal Depth, mm	6.7	0.3	171	8
M	Hip Breadth Sitting, mm	8.0	0.3	202	8
N*	Pelvis Height Above Seat, mm	0.4	0.1	9.5	2.5
O	Foot Length, mm	5.8	0.3	147	8
P	Foot Width, mm	2.4	0.3	61	8
Q	Head Width, mm	5.4	0.2	138	5
R	Head Length, mm	7.0	0.3	178	8
S	Waist Width Sitting, mm	7.3	0.3	186	8
T	Shoulder Width, mm	9.7	0.4	247	10
U	Head Circumference, mm	19.6	0.4	499	10
V	Chest Circumference, mm	20.8	0.5	529	13
W	Waist Circumference, mm	21.2	0.5	539	13
X	Head reference Line, mm	3.2	-	81	-
Y	Reference Location for Chest Circumference, mm	9.7	-	246	-
Z	Reference Location for Waist Circumference, mm	3.5	-	90	-

AA*	Heel Back to Back Line Standing, mm	1.1	0.1	29	2.5
BB	Head Reference Line Angle, deg	27°	-	-	-

* Set by fixture

9.1 Stature Measurement

1. Assemble the dummy according to the procedures defined in the PADI. Assure that the neck and lumbar cables are set to the proper torque. These dimensions shall be checked without any instrumentation cabling coming from the rear of the dummy as this bundle may affect the measurements.
2. With the dummy's jacket removed, lay the dummy on its back on a stature measurement fixture as shown in Figure 168.
3. Rest the heels on the heel spacer.
4. Align the upper torso cable guide so that it fully contacts the cable spacer guide. Note that his may compress the buttocks.
5. Place the head on the head spacer.
6. The upper and lower legs should be parallel. The bottom of the foot should be positioned flat against the foot board.
7. **Stature (A):** Measure the height from the bottom of the feet to top of head as shown in Dimension ***A***, Figure 167. A right angle plate resting on the base plate and positioned against the top of the head may aid in obtaining the measurement.
8. **Heel to Back Line Standing (AA):** dimension is set by the fixture (29 mm).

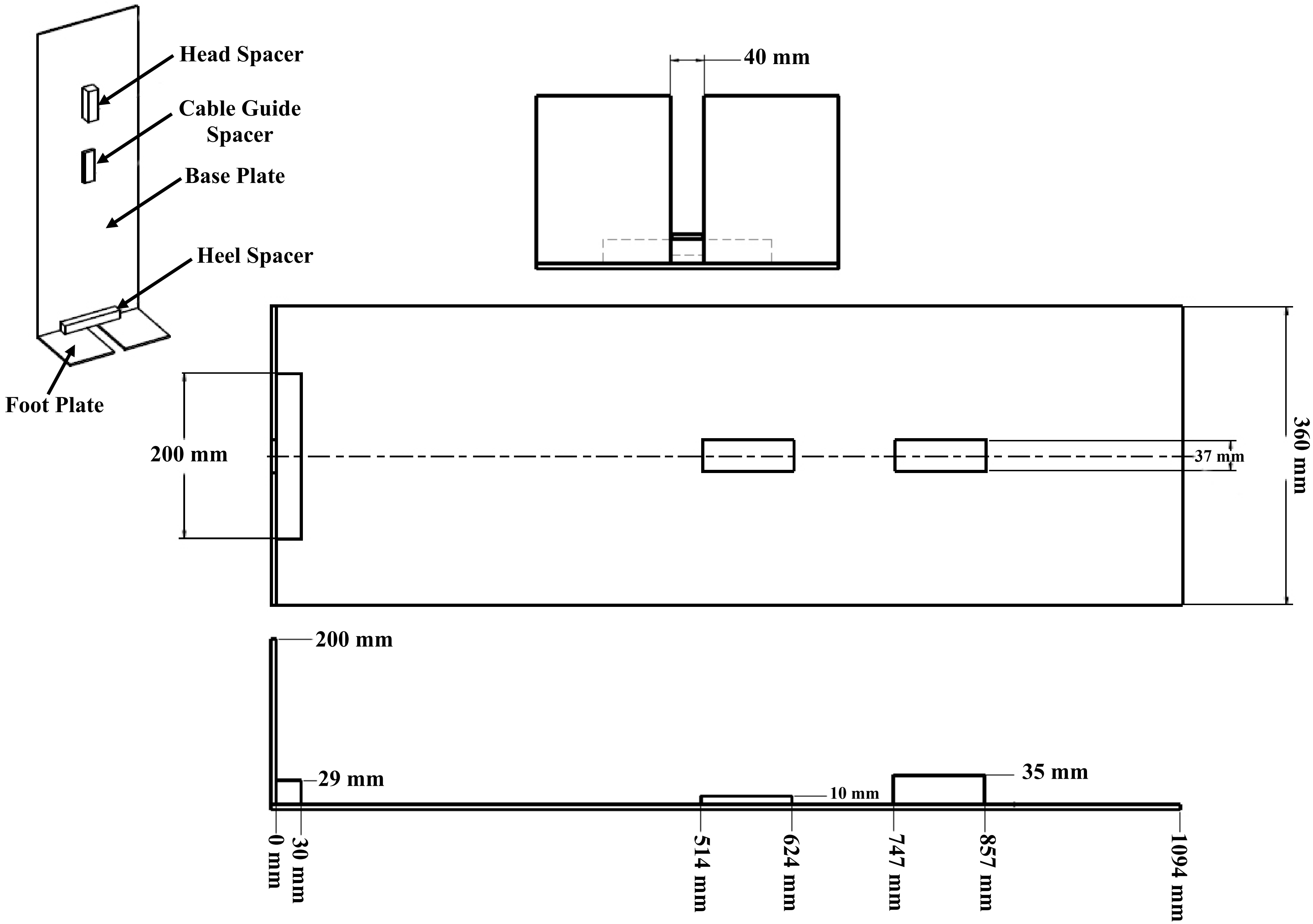


Figure 168. Stature measurement fixture details

9.2 Anthropometry Measurements

1. Assemble the dummy according to the procedures defined in the PADI. Assure that the neck and lumbar cables are set to the proper torque. These dimensions shall be checked without any instrumentation cabling coming from the rear of the dummy as this bundle may affect the measurements.
2. With the dummy's jacket removed, seat the dummy on a flat, rigid, smooth, clean, dry, horizontal surface. The seating surface must be at least 360 mm (14.2 in) wide and 200 mm (7.87 in) deep, with a vertical section at least 360 mm (14.2in) wide and 600 mm (23.6 in) high attached to the rear of the seating fixture. In addition, a 35mm thick head location block, a 10mm thick thorax location block, and a 9.5 mm thick pelvis location block are mounted to the seat as indicated in Figure 169.
3. Secure the seat to an appropriate surface.
4. Seat the dummy so that the dummy's lateral axis is parallel to the seat back.
5. Position the spine box vertically so that the cable guide is in full contact with the cable guide spacer block.
6. The head should rest against the head spacer, with the dummy looking down at an angle of 27° (see Dimension ***BB*** in Figure 167). Tape can be used to aid in positioning if necessary.
7. Align the upper legs so that a line between the knee and hip pivots is horizontal.
8. Position the lower legs 90° from the upper legs. The bottom of the feet should be parallel to the seat pan.
9. The upper arms are positioned vertically with elbows down; the lower arms are positioned 90° from the upper arms with hands forward. The lower arms are parallel to both the seat pan and the midsaggital plane of the dummy.
10. Tape may be used to aid in positioning the dummy in any of the steps above.
11. **Total Sitting Height (B):** measure from the seat surface to the highest point on top of the head. Assure that the head is in contact with the spacer block before making this measurement.
12. **Shoulder Sitting Height (C):** measure the distance from the top of the upper arm to the seat pan surface.
13. **Thigh Clearance (D):** measure the height of each thigh at its highest point relative to the seat pan surface.
14. **Shoulder to Elbow Length (E):** measure from the top of upper arm to bottom of upper arm at elbow.
15. **Elbow to Fingertip Length (F):** for each arm, measure the back of elbow to fingertip parallel to the long axis of the lower arm.
16. **Head Back to Seat Line (G):** dimension is set by the fixture (35 mm).
17. **Spine Box Back to Seat Back Line (H):** dimension is set by the fixture (10 mm).
18. **Knee to Seat Back Line (I):** measure from the front of the knee in line with the knee pivot centerline to the seat back; measure parallel to the seat pan.
19. **Knee Height Seated (J):** holding the aluminum foot plate under the left foot, adjust the foot so that it is horizontal. Measure from the top of the knee to the top of the foot plate (bottom of the foot).
20. **Chest Depth Upper (K):** measure from the top front point of the rib cage molding to the seat back line parallel to the seat pan.
21. **Abdominal Depth (L):** measure from the forward-most point of the abdomen to the seat back line parallel to the seat pan.

22. **Hip Breadth Sitting (M):** measure the width of the pelvis across the femurs aligned with the femur centerlines.
23. **Pelvis Height Above Seat (N):** dimension is set by the fixture (9.5 mm).
24. **Foot Length (O):** measure the length of the foot from the toes to the heel parallel to the long axis of the foot.
25. **Foot Width (P):** measure the width of the foot at its widest point perpendicular to the long axis of the foot.
26. **Head Width (Q):** measure the width of the head at its widest point.
27. **Head Length (R):** measure the length of the head from the front of the head to the rearmost projection of the skull cap along reference line X.
28. **Waist Width Sitting (S):** measure the width across the waist at the widest point on top of the pelvis.
29. **Shoulder Width (T):** measure width across the arm between the left and right shoulder pivot centerlines.
30. **Head Circumference (U):** measure the circumference of the head at the reference location for head circumference (X).
31. **Chest Circumference (V):** measure the circumference of the chest at the reference location for chest circumference (Y).
32. **Waist Circumference (W):** measure the circumference of the waist at the reference location for waist circumference (Z).
33. **Head Reference Line (X):** with head angle set at 27°, measure 81 mm from top of crown of head (see Figure 167); measure head circumference at this location.
34. **Reference Location for Chest Circumference (Y):** measure 246 mm vertically from seat pan to chest; measure chest circumference at this location.
35. **Reference Location for Waist Circumference (Z):** measure 90 mm vertically from seat pan to waist; measure waist circumference at this location.
36. **Head reference Line Angle (BB):** Measure with a protractor and set to 27°.

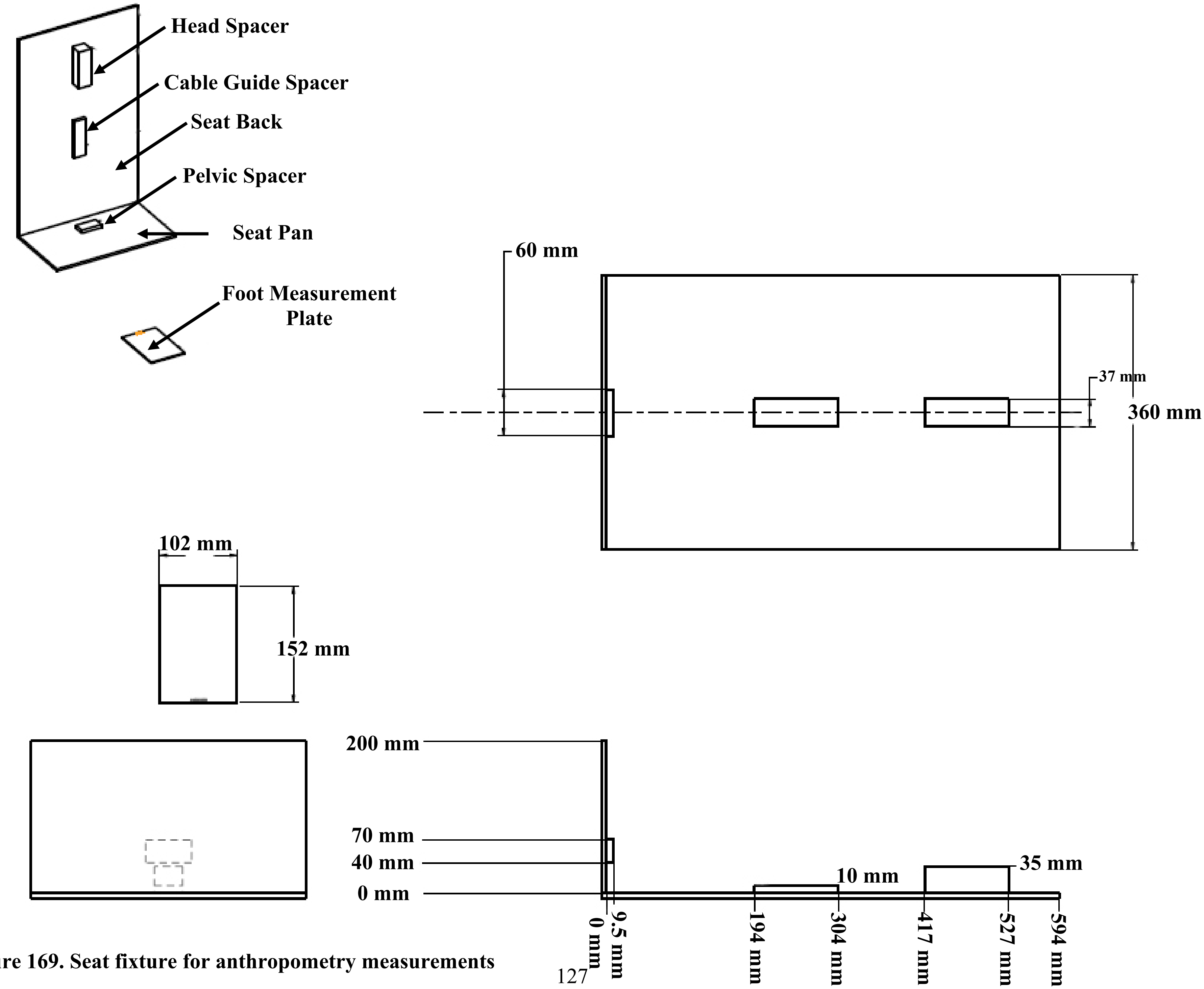


Figure 169. Seat fixture for anthropometry measurements

10 MASS MEASUREMENTS

Check the masses of the various dummy segment assemblies. They should conform to the specifications in Table 26. Consult Table 27 to Table 34 which define the contents of each segment.

Table 26. Q3s Total and Segment Masses

Segment	English (lbs)		Metric (kg)	
	Spec.	Tolerance +/-	Spec.	Tolerance +/-
Head Assembly	6.195	0.220	2.810	0.100
Neck Assembly	0.736	0.055	0.334	0.025
Upper Torso Assembly	5.046	0.220	2.289	0.100
Lower Torso Assembly	8.481	0.220	3.847	0.100
Upper Arm Assembly, Left or Right	0.714	0.110	0.324	0.050
Lower Arm Assembly , Left or Right	0.829	0.055	0.376	0.025
Upper Leg Assembly, Left or Right	2.205	0.055	1.000	0.025
Lower Leg Assembly, Left or Right	1.695	0.055	0.769	0.025
Q3s Suit	0.734	0.331	0.333	0.150
Total Dummy Weight	31.967	1.653	14.500	0.750

Table 27. Head Segment Components

Description	Part Number	Qty
Front Skull Assembly, Q3s	020-1220	1
Rear Skull Cap Assembly	020-1025	1
Screw, BHCS M5-0.8 x12mm	5000654-FT	4
Instrumentation Bracket Assembly	020-1013A	1
Screw, FHCS M5-0.8 x 12mm	5000096-FT	4
Upper Neck Load Cell Structural Replacement	020-2007	1

Table 28. Neck Segment Components

Description	Part Number	Qty
Q3s Molded Neck	020-2401	1
Tension Cable Assembly	020-2415	1
Thrust Bearing Washer (0.032" thick)	9003280-FT	2
Thrust Bearing ½" ID – 15/16" OD	9003279-FT	1
Low Profile Nut, ½-20	9003278-FT	1
Retaining Nut	020-2409	1
Element Spacer	020-2418	1
Screw, SHCS M5-0.8 x 10mm	5000291-FT	4

Table 29. Upper Torso Segment

Part Description	Part Number	Qty
Thoracic spine	020-4001	1
Lower Neck Load Cell Structural Replacement	020-2007	1
Q3s Neck/Torso Interface Plate	020-2017	1
Q3s Rib Cage Assembly with Reinforcement	020-4018	1
Screw, BHCS M5-0.8 x 10mm	5000003-FT	8
Screw, SHCS M5-0.8 x 12mm	5000096-FT	4
Screw, FHCS M5-0.8 x 12mm	5000002-FT	6
IR-TRACC Bracket 1	020-4505	1
Screw, SHCS M5-0.8 x 20mm	5000371-FT	2
ITRTRACC Bracket 2	020-4502	1
Cone Spacer	020-4507	4
Rod End Mount, Base End	020-4508	1
Shoulder Screw (#4-40 1/8 x ½"), Modified	020-4506	2
Screw, SHCS M2-0.4 x 6mm	5000082-FT	1
Molded Shoulder Assembly, Left	020-3510	1
Molded Shoulder Assembly, Right	020-3520	1
Screw, BHCS M4-0.7 x 10mm 8-18 SS	5000010-FT	14
Accelerometer Adapter Assembly	020-4515	1
Screw, BHCS M4-0.7 x 16mm	5000153-FT	2
Screw, BHCS M5-0.8 x 12mm	5000654-FT	4
Q3s Shoulder Cup, Right	020-3535	1
Q3s Shoulder Cup, Left	020-3534	1
Screw, FHCS M5-0.8 x 10mm	5000084-FT	6
Shoulder Shaft	020-3536	2
Screw, SHCS M5-0.8 x 16mm	5000020-FT	2
Shoulder Ball	020-3537	2
Roll Pin, M3 x 20mm	5000188-FT	2
Shoulder Ball Retainer Ring	020-3533	2
Cable Guide	020-4412	1

Screw, FHCS M4-0.7 x 16mm	5000447-FT	2
IR-TRACC Bracket	020-4503	1
Screw, FHCS M4-0.7 x 8mm	5000646-FT	2
Clamp, Nylon loop	9005135-DN	1
Screw, SHCS M4-0.7 x 16mm	5000025-FT	1
Washer, 0.15 I.D. x 0.31 O.D. x 0.062	9003058-FT	6
Shoulder Stringpot Bracket Assembly	020-3539	1
Stringpot Retainer	020-3549	1
Screw, BHCS M3-0.5 x 8mm	50000410-FT	1

Table 30. Lower Torso Segment

Part Description	Part Number	Qty
Lumbar Spine Assembly	020-6000	1
Lumbar Spine Mounting Screw	020-9902	2
Load Cell Structural Replacement	020-2007	1
Screw, SHCS M5-0.8 x 12mm	5000002-FT	4
Screw, FHCS M5-0.8 x 12mm	5000096-FT	4
Q3s Pelvis Assembly	020-7500	1
Abdomen	020-5000	1

Table 31. Left Arm Segment

Part Description	Part Number	Qty
Q3s Upper Arm Molded, Left	020-9750	1
Q3s Lower Arm Assembly, Left	020-9730	1
Stop Screw	020-9901	1
Screw, SSNP M8 x 12	5000725	1
Q3s Elbow Modified Shoulder Screw	020-9913	1

Table 32. Right Arm Segment

Part Description	Part Number	Qty
Q3s Upper Arm Molded, Right	020-9850	1
Q3s Lower Arm Assembly, Right	020-9830	1
Stop Screw	020-9901	1
Screw, SSNP M8 x 12	5000725	1
Q3s Elbow Modified Shoulder Screw	020-9913	1

Table 33. Left Leg Segment

Part Description	Part Number	Qty
Q3s Upper Leg, Molded, Left	020-9516	1
Lower Leg Assembly, Left	020-9102	1
Stop Screw	020-9901	1
Knee Shoulder Screw	020-9908	1

Table 34. Right Leg Segment

Part Description	Part Number	Qty
Q3s Upper Leg, Molded, Right	020-9616	1
Lower Leg Assembly, Right	020-9202	1
Stop Screw	020-9901	1
Knee Shoulder Screw	020-9908	1

Table 35. Q3s Suit

Part Description	Part Number	Qty
Q3s Suit	020-8001	1

APPENDIX A: Flesh Repair

Head Skin Repair

The Q3S head skin can be repaired with a heating iron, however, repairs should not be made in areas that will affect the performance of the head assembly during testing. Therefore, do not attempt to repair flesh damage in the lateral regions of the head.

Typically, a heating iron, similar to a standard electronic soldering iron, is used to make flesh repairs. For best results, a variable power supply set between 60 and 90 watts is suggested to control the amount of heat provided by the iron. When repairing flesh, remove all loose material from the damaged areas and clean the flesh with 99% isopropyl alcohol in a well-ventilated area. Since the alcohol is a flammable liquid, wait until the alcohol-wetted area is dry and remove the alcohol container from the area before attempting to repair the flesh.

Scrapes can be repaired by rubbing the iron over the affected area. If black flakes of burnt flesh start to appear, the iron is either too hot or has been in the same spot too long. Clean the iron tip (flat paddle or "duck bill" suggested) frequently by quickly tapping it on a buffing wheel or rubbing it with a wire brush.

Larger areas of damage may require a patch. The patch should be 10 mm (0.4 in) wider than the damaged area on all sides. One method of patching is to position the iron between the patch and the piece that is damaged. When the patch and flesh take on the appearance of a gel, move the iron to a new point while holding the patch in place until they both cool. For larger areas, it may be desirable to tack it in several places around the patch, then fill in the untacked areas. Moving the iron in a circular motion will eliminate rough, uneven areas.

Other Flesh Repairs

For small cuts or tears occurring in regions which are not expected to contribute significantly to the dummy's response (such as the dummy's extremities), Loctite 406 may be used to repair the damage. If significant damage is sustained, the part should be either replaced or remolded by the manufacturer

APPENDIX B: Joint Torque Adjustments

Throughout this document, reference has been made to the "1G" torque setting for adjusting joint stiffness. The 1G torque setting is defined as the joint torque required to support the weight of the specified segment, yet that which also allows the segment to move when a small force is applied to the unsupported end of the segment. For example, when the dummy's tibia is fully extended forward when seated, the knee joint should be tight enough to support the weight of the tibia, yet loose enough so that the entire tibia will fall slowly when tapped at the ankle.

The 1G torque setting can be difficult to achieve and requires some patience and practice. The following guidelines may be helpful. For the Q3s, "1G" settings should be adjusted for the shoulders, elbows, and knees.

Shoulders

1. Place the dummy in a seated position.
2. Be sure the correct tension is set in the shoulder detent (5.6.3) *prior* to performing the joint torque adjustment.
3. Orient the upper and lower arms so that they are approximately horizontal.
4. First tighten the shoulder screws in succession (screw 1, 2, and 3) by about ¼ turn as shown in Figure B- 1 below.
5. Check to see if the joint torque is sufficient to support the weight of the arm. Tap the arm near the hand with a vertical impact. The arm should fall down slowly. If it does not fall down, loosen the shoulder screws slightly adjusting until the arm falls slowly.
6. If the arm falls too quickly, tighten each screw by about 1/8 turn, checking for the proper 1G joint setting after ***each*** screw is adjusted.
7. Repeat the procedure of tapping at the hand and adjusting each shoulder screw in succession until the 1G torque requirement is met.
8. Repeat steps 3 - 6 on the other shoulder.

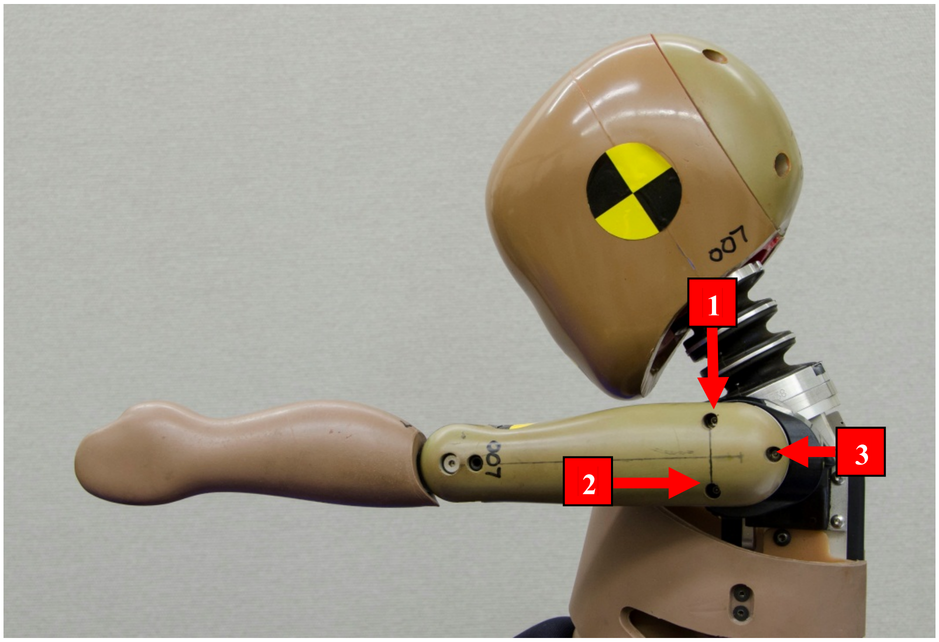


Figure B- 1. Setting shoulder torque

Elbows

1. Place the dummy in a seated position.
2. Orient the upper arm and lower arm so that they form an angle as is Figure B- 2.
3. Slightly tighten the screw at the elbow indicated in Figure B- 2.
4. Check to see if the elbow joint torque is sufficient to support the weight of the lower arm. Tap the arm near the hand with a vertical impact. The lower arm should fall down slowly. If it does not fall down, loosen the adjustment screw at the elbow slightly adjusting until the lower arm falls slowly.
5. If the arm falls too quickly, slightly tighten the screw, checking for the proper 1G joint setting after ***each*** adjustment.
6. Repeat the procedure of tapping at the hand and adjusting the elbow screw until the 1G torque requirement is met.
7. Repeat steps 2 - 6 on the other elbow.

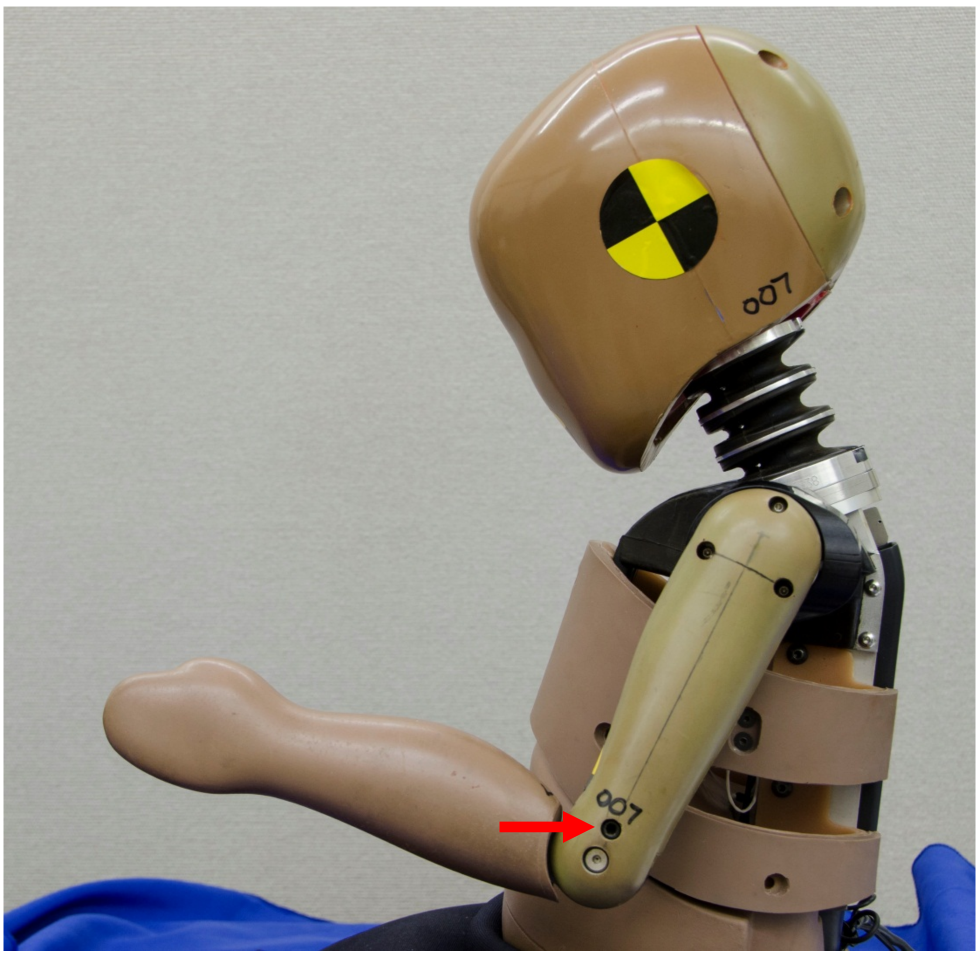


Figure B- 2. Setting elbow torque

Legs

1. Place the dummy in a seated position.
2. Orient the lower leg at approximately 90° relative to the upper leg.
3. Rotate the entire leg assembly to approximately a horizontal position. Adjust the knee torque adjustment screw (located on the inner knee) until the joint torque is sufficient to support the weight of the lower leg (see Figure B- 3). Tap the lower leg near the ankle with a vertical impact. The lower leg should fall down slowly. If it does not fall down, loosen the knee torque adjustment screw. Repeat the procedure of tapping at the ankle and adjusting the knee pivot bolt until the 1G torque requirement is met.
4. Repeat steps 2 - 3 on the other leg.

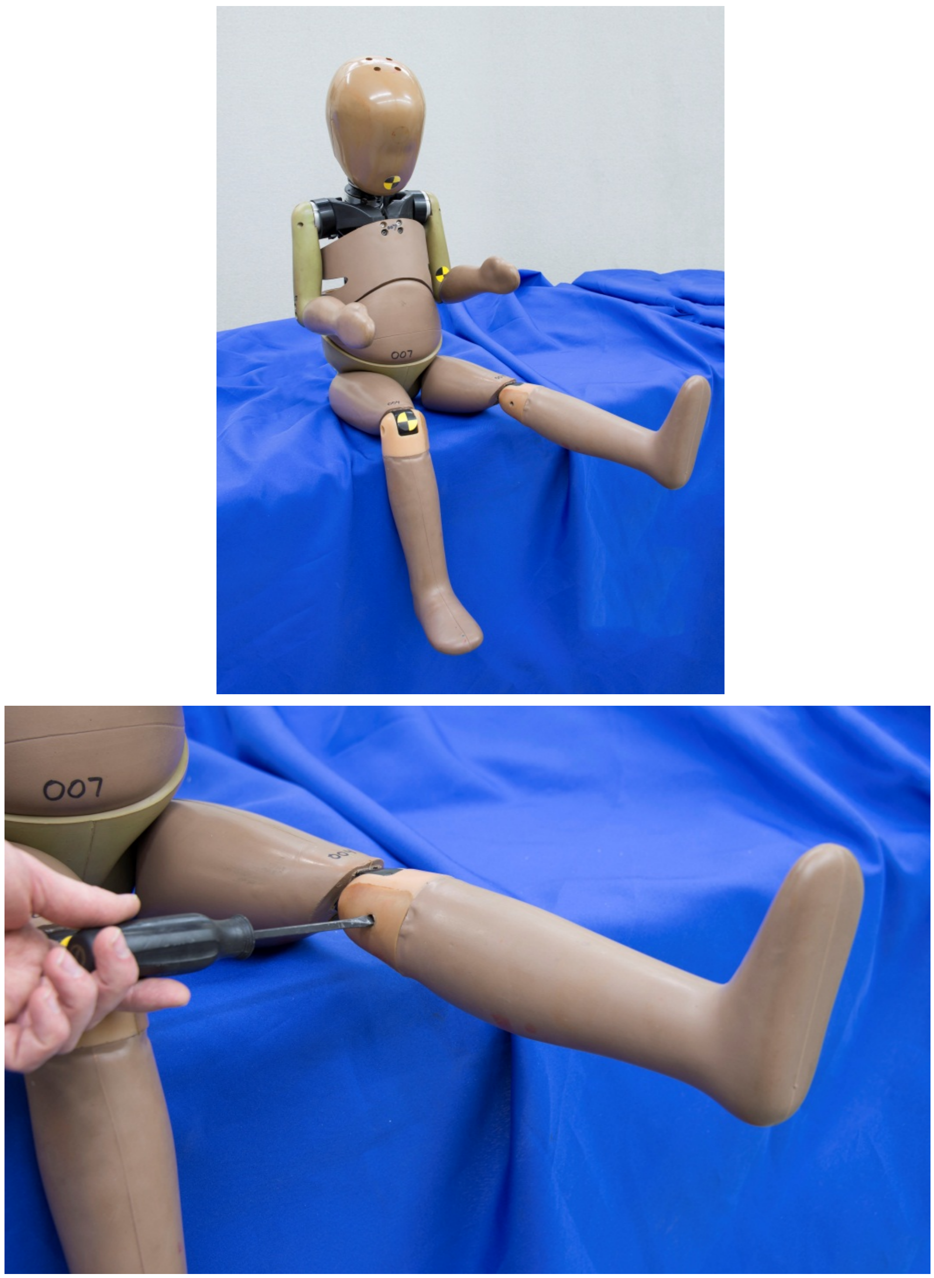


Figure B- 3. Setting knee torque

APPENDIX C: Procedure for Checking Recorded Sensor Polarity

Purpose:

The purpose of this procedure is to provide a practical methodology for checking and documenting the recorded polarity of the data channel for each dummy mounted sensor relative to the NHTSA sign convention. It is intended to be used by the engineer conducting the testing. It is not a fool proof solution to documenting the polarity of channels, but will serve to increase the confidence that polarities have been correctly determined. The sign convention used in this document is the same as that of the SAE J211 and J1733. This procedure is recommended for each and every test conducted for NHTSA.

Background:

Standardized coordinate systems and recorded polarities for various transducer outputs defined relative to positive directions of those coordinate systems are defined for crash test dummies, vehicle structures, and laboratory fixtures in the SAE J211 Recommended Practice. The standardized coordinate system and polarities for data permits comparison of data from different crash test facilities.

There are many ways to affect the polarity of a data channel. NHTSA has required that any given manufacturers' instrumentation be compatible with and recordable in a J211 channel. The channel by definition includes all the instrumentation from the transducer to the data acquisition system output. The channels therefore include a variety of load cells, accelerometers, and deflection measuring sensors (see Table C1) mounted in the dummy connected to a data acquisition system using connectors, wiring, data acquisition software and hardware. The polarity of a data channel for any given dummy may therefore be affected by changing the manufacturer of the sensor, positive and negative pins from the sensor to the wiring in a connector, the polarity assigned in software, and for some sensors by changing the way it is mounted in the dummy.

Since there are many ways to influence the polarity of a data channel it is appropriate to determine the polarity of the assembled channel as it is ready to be tested. So when a test dummy is delivered for a test and connected to the data acquisition system, the polarity of the internal sensors should be established.

In summary, the procedure requires the user to think of the data channel as a black box. The procedure requires manipulating the dummy to determine the polarity of the black box with respect to the sign convention. If the polarity is wrong, then steps must be taken to correct it prior to submitting data to NHTSA, so that data is in accordance with the sign convention. It is recommended to correct and document the channel polarity at the test site so no further modifications to the data are required. If difficulty is experienced in determining the polarity when these procedures are being properly followed, it may indicate that the instrumentation has not been mounted in accordance with the dummy instrumentation assembly drawings.
Although hands-on manipulations are defined for fourteen types of load cells in the SAE J211, they are not provided for all loads cells available or for accelerometers. This procedure expands

manipulations to include accelerometers, load cells, and displacement transducers used by the Q3s Dummy.

PROCEDURE

Table C1 lists the transducers (load cells, accelerometers, and deflection devices) in the Q3s Dummy. A separate procedure is defined for each type of transducer (i.e. accelerometer, load cell, displacement transducer).

Accelerometer Data Channel

The FMVSS 208 test procedure explains that for any dummy component oriented in its standard standing position, blows to the back side, left side, and top will produce positive accelerations relative to its x, y, and z directions, respectively. Apply a blow to the back of the head with a rubber mallet and record the data channel output and time of event. Figure C- 1 is an example of a plot used to document the polarity of the dummy's head x axis accelerometer data channel. The polarity of the dummy channel in Figure C- 1 is positive and no changes are needed to conform to the sign convention. Similarly, to document the polarity of the dummy's head y and z axis accelerometer data channels, apply a blow to the left side and top of the head, respectively, with a rubber mallet (never apply the blow directly to an accelerometer mount) and record the data channel output and time of event as shown in Figure C- 2and Figure C- 3.

An analysis of Figure C- 2and Figure C- 3 for the y and z axes show that the polarities of both the y and z axis accelerometer data channels in the head of this dummy are negative. Therefore these polarities must be inverted to agree with the sign convention. It is possible to document the polarity of each dummy accelerometer data channel by following this approach.

An alternate approach to determine the polarity of the accelerometers mounted in the dummy uses the constant force of gravity as the input. This procedure will yield the same results as the previous procedure. Since the sign convention is fixed with respect to the dummy, this procedure can be conducted outside the test vehicle on the laboratory floor or table, but the dummy must be connected to the data acquisition system. The body coordinate system used for reference is "attached" to the dummy and is x positive pointing forward, y positive pointing to the right, and z positive pointing down.

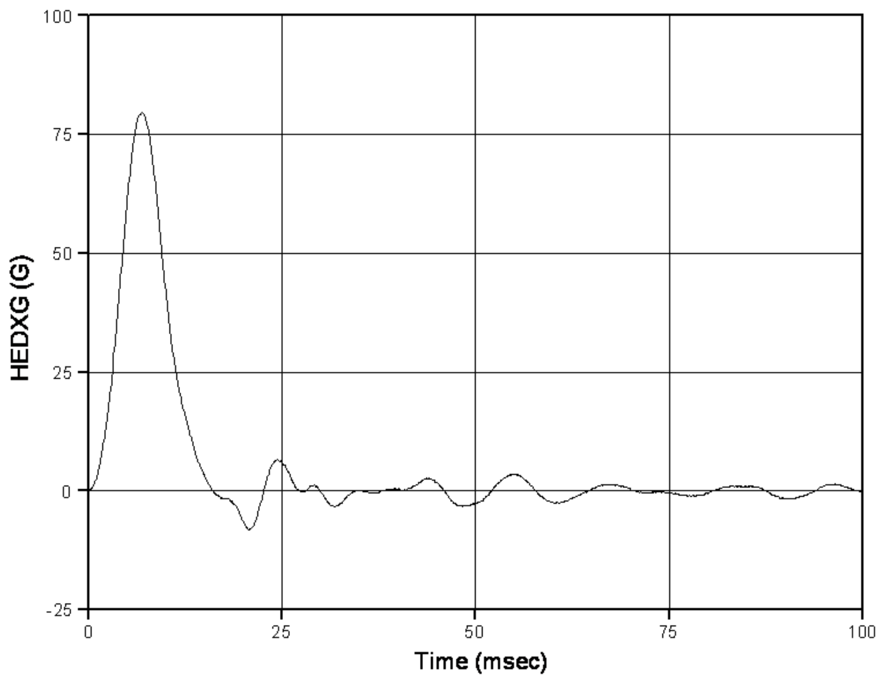


Figure C- 1. Polarity of X axis accelerometer data channel

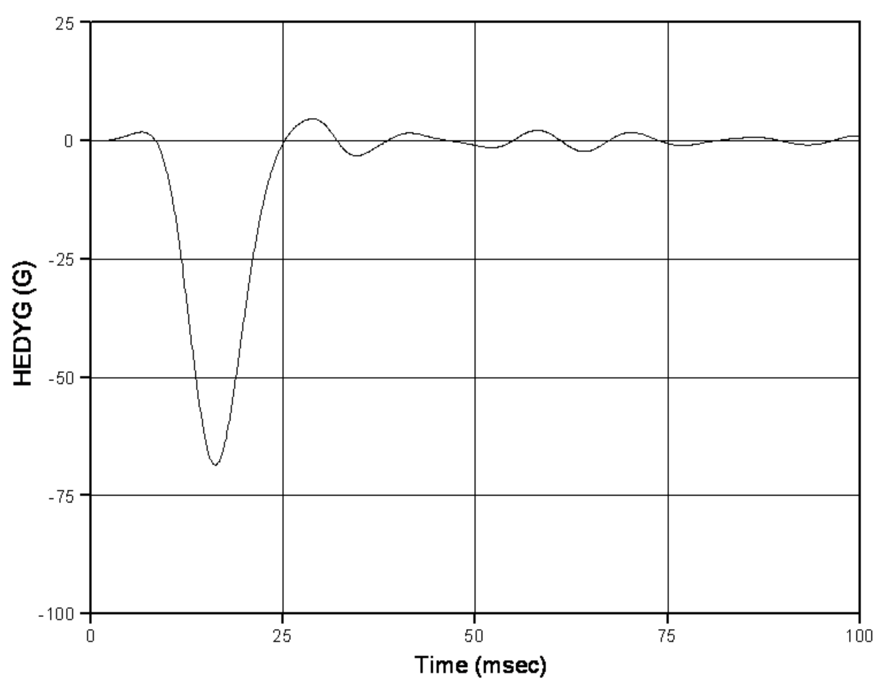


Figure C- 2. Polarity of Y axis accelerometer data channel

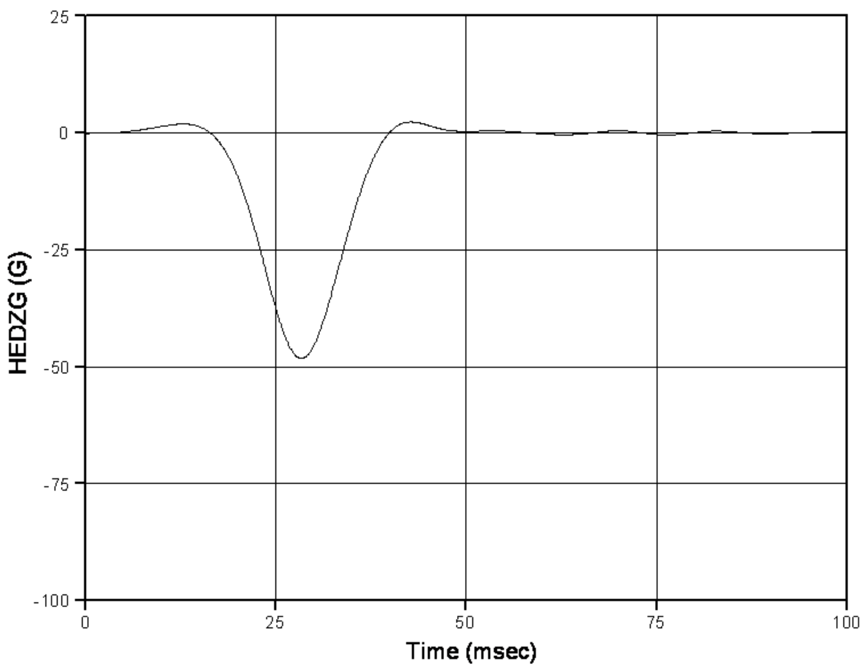


Figure C- 3. Polarity of Z axis accelerometer data channel

The procedure for each axis requires placing the accelerometers to be checked perpendicular to the axis of gravity in two orientations each 180 degrees apart. Then the sign and value of the acceleration channel are recorded for a short period of time. The accelerometer is defined as perpendicular to the axis of gravity when the plane containing both mounting screw holes is perpendicular to the force of gravity. See Figure C- 4.

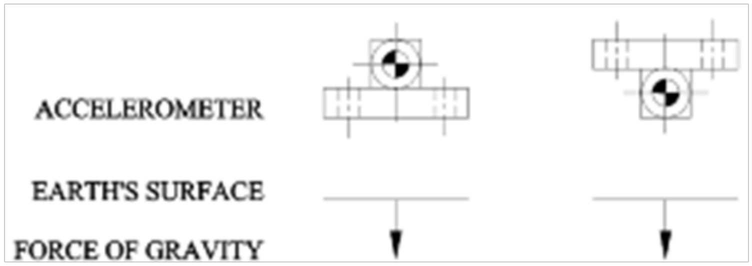


Figure C- 4. Accelerometer perpendicular to gravity in two orientations 180° apart

The orientation of the dummy that is most positive when mounted in a plane perpendicular to the force of gravity will have a positive polarity when moved away from the earth's center. The polarity must agree with the SAE J211 sign convention.

The data collected should be recorded in the Polarity Check Data Sheet for the x, y, and z accelerometers. Samples of these sheets are provided in this Appendix. As an example, refer to the Polarity Check Data Sheet for documenting the x axis polarity. To determine the polarity of the head x-accelerometer, lay the dummy face down (FD) and record the x-accelerometer's channel output in g's in the appropriate column. Now place the dummy face up (FU) and record the channel output in g's in the appropriate column. Note that the difference in FD and FU outputs should be about 2 g's. List the orientation of the most positive value in the next column, either FD or FU, paying attention to the sign from the data acquisition system (-1 is more positive than -2 g's). Next, compare the orientation of the most positive value with the J211orientation for positive sign convention. If the dummy's orientation of the most positive value is consistent with that of the J211 sign convention, then the channel output will be in accordance with the sign convention. If, however, the dummy's orientation of the most positive value is different than that of the J211 sign convention, then the channel's output will have to be reversed in order to be in accordance with the sign convention. Place a check in the column titled "Channels To Be Reversed" for those channels that will require reversal by the data acquisition software.

The channel outputs for all of the x-axis accelerometers can be recorded simultaneously for each orientation. For example, when the dummy is turned face down, the channel outputs for the head, sternum, spine, chest, and pelvis can all be recorded at the same time. Then the dummy can be oriented face up and the corresponding channel outputs can be recorded again.

The procedure for the y-axis accelerometers is very similar to that used for the x-axis and can be accomplished on a floor or bench surface. In this instance, the dummy is placed on its side in two different orientations - one where the right shoulder is down (RSD) and one where the right shoulder is up (RSU). Once again, all of the y-axis channels can be recorded at one time. Then flip the dummy onto its other side and record the values again. At this point, the procedure is similar to that used for the x-axis channels. List the orientation of the most positive value and compare that with that J211 orientation for positive sign convention.

For the z-axis, turning the dummy over and standing it on its head is quite difficult for the larger adult dummies. Thus for the z-axis check it is recommended to secure the dummy in a chair, seat it upright and then rotate the dummy in the chair forward or backward about 60 degrees. The force on the accelerometer varies with the cosine of the angle it makes with respect to tangent to the earth's surface. With the dummy sitting upright (U) in the chair, record the z-axis accelerometer channel outputs in the appropriate column on the Polarity Check Data Sheet. Next, lean the dummy forward or backward approximately 60 degrees and record the z-axis accelerometer outputs in the column labeled "Lean Down." (Note that the symbol "D" for down has been associated with this orientation.) Again, follow the procedure outlined for the x-axis and y-axis accelerometers to complete the z-axis Polarity Check Data Sheet.

Load Cell and Deflection Transducer Data Channels

Polarities of accelerations, velocities, displacements, forces and moments are discussed in SAE J211 Instrumentation for Impact Test - Part 1 - Electronic Instrumentation of 1 Mar 1995. SAE J1733 Dec 94 Sign Convention for Vehicle Crash Testing also lists recorded output polarities for various transducers. The manipulations identified in SAE J211 and those of additional load cells and the deflection sensors are shown in the tables.

Sit the dummy on a bench and secure it so that it does not slip on the bench when performing the manipulation about the load cell or deflection transducer. Manually manipulate the dummy as described in the Polarity Check Data Sheet For Load Cells and Deflection Transducers and record the resulting data channel output from the data acquisition system. If the polarity of the channel output does not agree with that given in the Data Sheet, then invert the polarity of the channel to agree with the sign convention. Typically, this can be accomplished by multiplying the channel by -1 in the data acquisition software. After reversing the polarity, repeat the manipulation to ensure that the channel output is in agreement with the J211 requirements listed in the Data Sheet.

Sample Polarity Check Data Sheets have been included in this appendix (Table C- 1 through Table C- 6) for the various transducers. For example, to document the polarity of the dummy's upper neck x-axis shear force data channel, push the head rearward while simultaneously pushing the chest forward and then record the data channel output and time of event. Record the sign of the output, either positive (+) or negative (-), in the Channel Output column. Next, compare the sign in the Channel Output column with the sign listed in the J211 Polarity column. If the signs are in agreement, then no action needs to be taken. If, however, the signs are not in agreement, then the channel output must be reversed to agree with the J211 sign convention for positive polarity.

Table C- 1. Instrumentation Available for Q3s

Sensor Type	Location in Dummy	Part Number	Measurements	Total # Channels
Accelerometers	Head C.G.	SA572-S4	Ax, Ay, Az	3
	Shoulder	SA572-S4	Ax, Ay, Az	3
	Thorax (T1, top and side of the spine box near neck base)	SA572-S4	Ay	1
	Thorax (upper spine box)	SA572-S4	Ax, Ay, Az	3
	Pelvis	SA572-S4	Ax, Ay, Az	3
IR-TRACC	Thorax	SA572-S37	Dy	1
Potentiometers	Shoulder	SA572-S38 (Left) SA572-39 (Right)	Dy	1
Load Cells	Upper Neck	SA572-S8	Fx, Fy, Fz, Mx, My, Mz	6
	Lower Neck	SA572-S8	Fx, Fy, Fz, Mx, My, Mz	6
	Lumbar	SA572-S8	Fx, Fy, Fz, Mx, My, Mz	6
	Pubic	SA572-S7	Fy	1
Angular Rate Sensors (ARS)	Head	SA572-S58	ω_x, ω_y, ω_z,	3
Tilt Sensors	Thorax	SA572-S44	X°, Y°	2
			TOTAL AVAILABLE INSTRUMENTATION	**36**

Table C- 2. Polarity Check Data Sheet For X - Axis Accelerometers

Dummy Type:_____________ Date:______________				**Serial No.________________**	
Component	**Channel Output (g)**		**Orientation of Most Positive Value (FU or FD)**	**J-211 Orientation for Positive Polarity**	**Data channels to have polarity changed**
	Dummy Orientation				
	Face Down (FD)	**Face Up (FU)**			
Head				FU	
Shoulder				FU	
Upper Spine box				FU	
Pelvis				FU	

Table C- 3. Polarity Check Data Sheet For Y - Axis Accelerometers

Dummy Type:_____________ Date:_____________				**Serial No._______________**	
Component	**Channel Output (g)**		**Orientation of Most Positive Value (FU or FD)**	**J-211 Orientation for Positive Polarity**	**Data channels to have polarity changed**
	Dummy Orientation				
	Right Shoulder Down (RSD)	**Right Shoulder Up (RSU)**			
Head				RSU	
Shoulder				RSU	
Upper Spine Box				RSU	
T1				RSU	
Pelvis				RSU	

Table C- 4. Polarity Check Data Sheet For Z - Axis Accelerometers

Dummy Type:______________ Serial No.________________
Date:______________

Component	**Channel Output (g)**		**Orientation of Most Positive Value (U or D)**	**J-211 Orientation for Positive Polarity**	**Data channels to have polarity changed**
	Dummy Orientation				
	Face Down (D)	**Face Up (U)**			
Head				D	
Shoulder				D	
Upper Spine Box				D	
Pelvis				D	

Table C- 5. Polarity Check Data Sheet For Load Cells

Dummy Part/ Channel	**Dummy Type:** **Dummy Serial No.** **Date:** **Dummy Manipulation for which J211 Polarity is indicated**	**Channel Output**	**J211 Polarity**	**Channels to be Reversed**
Upper Neck (internal load)				
Fx	head rearward, chest forward		+	
Fy	head leftward, chest rightward		+	
Fz	head upward, chest downward		+	
Mx	left ear toward left shoulder		+	
My	chin toward sternum		+	
Mz	chin toward left shoulder		+	
Lower Neck (internal load)				
Fx	head rearward, chest forward		+	
Fy	head leftward, chest rightward		+	
Fz	head upward, chest downward		+	
Mx	left ear toward left shoulder		+	
My	chin toward sternum		+	
Mz	chin toward left shoulder		+	
Lumbar Spine (internal load)				
Fx	chest rearward, pelvis forward		+	
Fy	chest leftward, pelvis rightward		+	
Fz	chest upward, pelvis downward		+	
Mx	left shoulder toward left hip		+	
My	sternum toward front of legs		+	
Mz	right shoulder forward, left shoulder rearward		+	
Pubic Load (internal load)				
Fy	Left femur rightward, right femur leftward		(-)	

Table C- 6. Polarity Check Data Sheet For Deflection Transducers

Dummy Part/ Channel	Dummy Type: Dummy Serial No. Date: Dummy Manipulation for which J211 Polarity is indicated	Channel Output	J211 Polarity	Channels to be Reversed
Left Side Impact: Left Shoulder and Left Ribcage Displacements				
Shldr Δy	left shoulder rightward, ribcage leftward		+	
Thrib Δy	left ribcage rightward, spine box leftward		+	
Right Side Impact: Right Shoulder and Right Ribcage Displacements				
Shldr Δy	right shoulder leftward, ribcage rightward		(-)	
Thrib Δy	right ribcage leftward, spine box rightward		(-)	

APPENDIX D: Procedure for Determining the Moment of Inertia of Probes Used for Dummy Calibration Tests

The impact probes used for calibrating new dummies are less massive than previously used probes for the adult dummies. Experience with these less massive probes provided a lesson learned that a stable trajectory as required by the calibration procedures in the CFR Part 572 can more easily be achieved if the probe meets a minimum moment of inertia requirement in yaw (about z axis) and pitch (about y axis) about the probe's center of gravity.

This appendix to the Procedures for Assembly and Disassembly of the dummy provides a method used by the NHTSA for determining the moment of inertia of the impact probes.

Moment of Inertia of an Unsprung Mass

I = moment of inertia of a probe about a line through its center of gravity and parallel to the z-axis, $lb \cdot in. \cdot sec^2$. Since the probes are symmetrical, the moment of inertia about the y and z axis are equal.

This value can be determined using the classical torsional pendulum method. As shown in Figure D- 1, the probe is suspended freely on two splayed flexible wires. The body of the probe is given a torsional motion of small angular displacement around the vertical axis (z axis), and the period of oscillation is obtained by measuring the time of at least 50 complete oscillations.

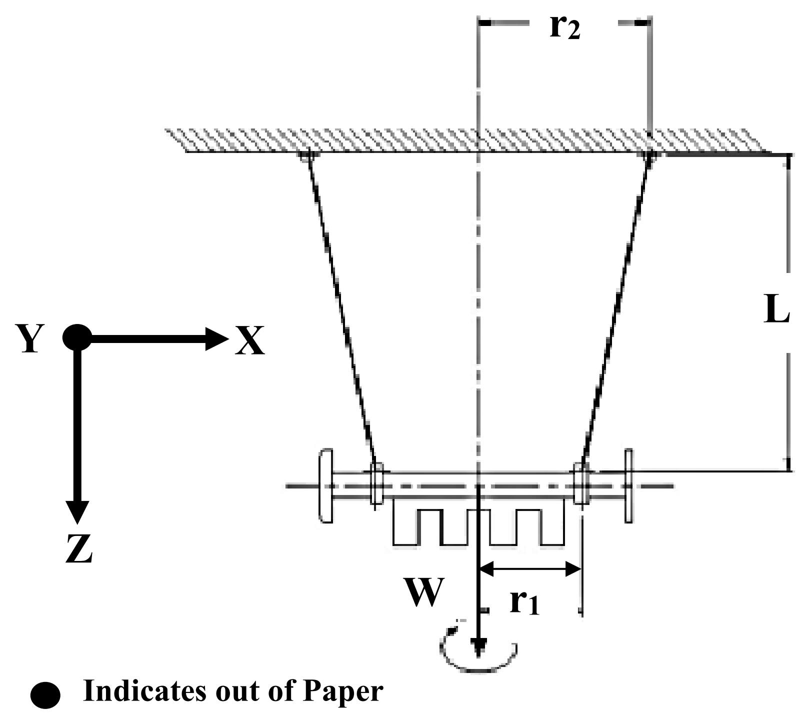


Figure D- 1. Assembly for determining probe moment of inertia

The moment of inertia about the vertical axis (z axis), is equal to that about the y axis (going into the page) since the probe is symmetrical. The moment of inertia is calculated from

$$I_z = I_y = \frac{W r_1 r_2 T^2}{4B^2 L}$$

where W = total weight of body

L = vertical distance between points of suspension and points of attachment to the body

r_1 = radial distance of each attachment point from axis of oscillation

r_2 = radial distance of each suspension point from axis of oscillation

T = period of oscillation.

In order to reduce errors, it is recommended to limit the applied small angular displacement to approximately 20 degrees.

When converting the moment of inertia of a mass from customary units to SI units, keep in mind that the base unit pound used in the derived unit lb · in.· sec^2 is a unit of force (not mass) and, therefore, should be converted into Newtons. We have lb · in.· sec^2 = (4.448 N)(2.54 cm)(1 sec^2) = 11.29792 N cm sec^2 = 1129.792 kg cm^2.

APPENDIX E: Procedure for Determining the Free Air Resonant Frequency of Probes Used for Dummy Calibration Tests

Requirement

Recent Department of Transportation, National Highway Traffic Safety Administration, 49 CFR Part 572, Final Rules For Anthropometric Test Dummies; Occupant Crash Protection specifies in §572.xxx Test conditions and instrumentation, for knee impact test probes and or thoracic impact test probes that:

"The impact probe shall have a free air resonant frequency of not less than 1000 Hz."

Background

This test procedure, developed by the Vehicle Research and Test Center, is used to determine the free air resonant frequency of impact probes employed by the agency in dummy calibration tests. The directionality of the resonant frequency measured by this test procedure is in line with the motion axis of the probe (a longitudinal axis) at the instant of impact with the dummy. While other procedures may be available for this purpose, this procedure is to facilitate those who need to know how the agency conducts this test.

Test Equipment

1. The impact probe
2. Suspension wires
3. An accelerometer
4. Impact hammer (steel - approx. 4 lbs.)
5. Data acquisition equipment

Test Instrumentation

The impact probe has an accelerometer rigidly mounted at the opposite end of the probe on which the impact surface is located. The accelerometer's sensitive axis is in collinear alignment with the longitudinal axis of the impact probe.

Test Set-up and Test Procedure

Suspend the impact probe by its suspension system along with all equipment that is attached to the probe for a typical calibration impact, including the accelerometer, velocity vane, etc. as shown in Figure E- 1. Tap the probe with a hammer (a 4 lb. engineers' hammer works fine) on the impact surface sufficiently hard to excite the resonant frequency, but not hard enough to damage the accelerometer.

Data recording

Record the data using a sampling rate at 50 kHz and anti-aliasing filter at 20 kHz. Typical responses are shown in Figure E- 2 and Figure E- 3.

Data analysis

The resonant frequency can be determined from the data plots by a variety of techniques, such as counting peaks during selected time periods, calculating the average frequency, spectral analysis, etc. A sample calculation based on counting the peaks over a period of time after the transient response has decayed is shown in Figure E- 3.

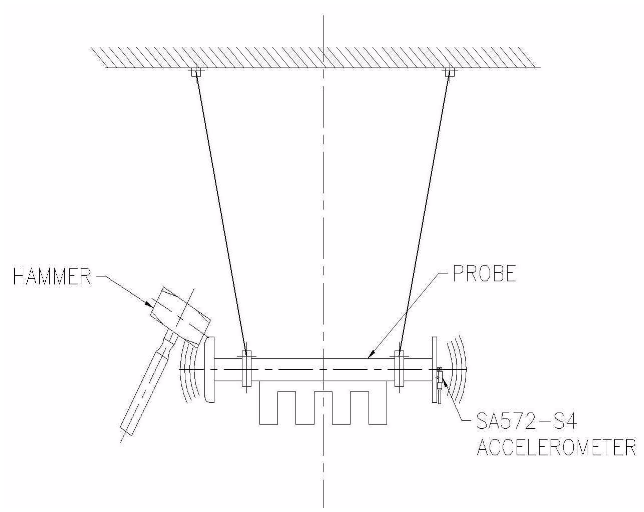


Figure E- 1. Probe impacted with hammer to excite resonance

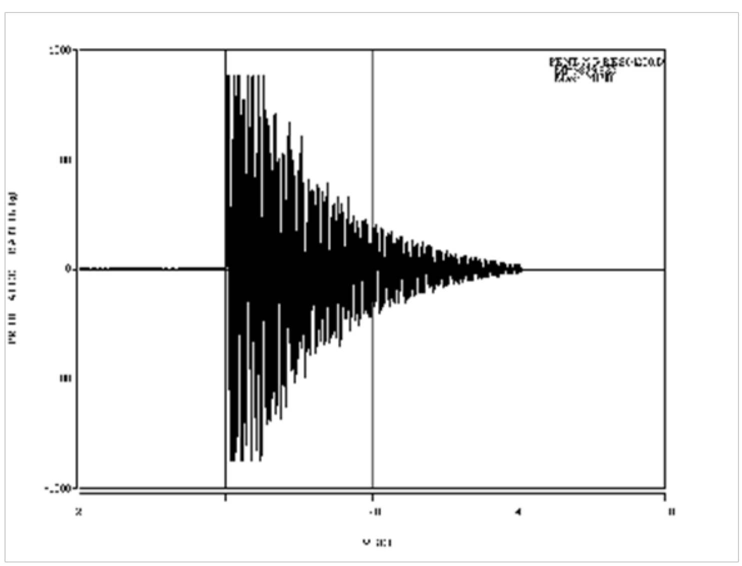


Figure E- 2. Probe acceleration response (longitudinal axis) versus time

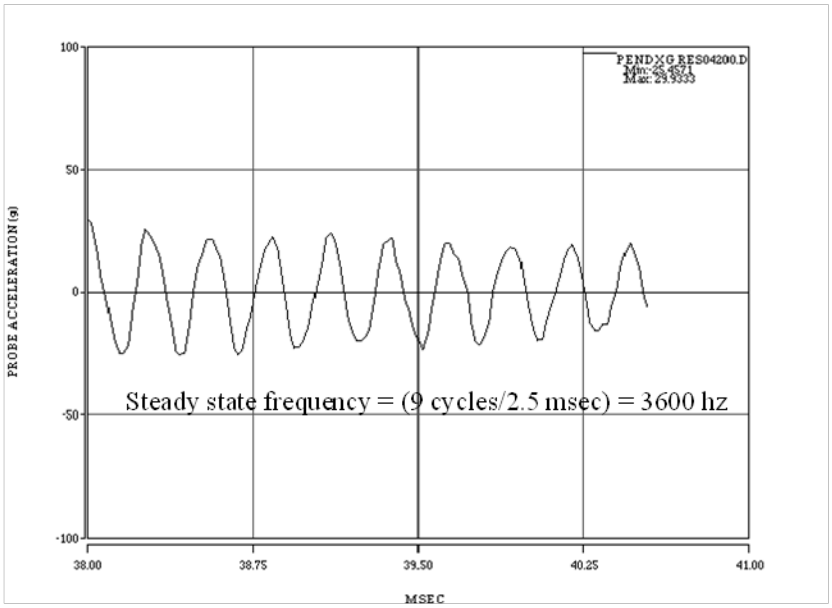


Figure E- 3. Probe acceleration response (longitudinal axis) between 38 and 41 milliseconds

APPENDIX F: IR-TRACC Data Collection/Processing

Since the IR-TRACC is a non-linear transducer, there are special requirements for recording and processing IR-TRACC displacement measurements. The data acquisition system (DAS) input channel should be configured to record the un-scaled voltage output of the IR-TRACC. This can be accomplished by setting the DAS input channel to an amplifier gain of one. Also, the DAS input channel must be configured so that no hardware or software offsetting is applied to the IR-TRACC output voltage. After the IR-TRACC voltage is recorded, the data can be linearized and converted to displacement units using post-processing software as shown below.
First, the IR-TRACC voltage must be linearized as follows:

$$V_{linear} = (V_{meas})^{linexp}$$

Where:

V_{linear} = linearized voltage in volts
V_{meas} = un-scaled voltage recorded by the DAS in volts
Linexp = linearization exponent from calibration sheet

Then the IR-TRACC compression can be found as follows:

$$X_{IR}(t) = \frac{(1000 * V_{linear})}{S_{cal}}$$

$$X(t) = X_{IR}(t) - X_{IR}(0)$$

Where:

S_{cal} = Sensitivity / calibration factor (in mV/mm)
$X_{IR}(t)$ = time-history of change in length of the IR-TRACC (in mm)
$X_{IR}(0)$ = value of $X_{IR}(t)$ at time zero (in mm)
$X(t)$ = time-history of IR-TRACC compression (in mm)

Some data acquisition systems provide options for configuring IR-TRACC transducers in their test configuration software. This software allows the user to enter the IR-TRACC linearization exponent and the sensitivity into the transducer information file. The software will automatically configure the DAS channel and perform the post-processing linearization and scaling. Note that this processing method is only valid when the user is interested in the IR-TRACC's change in length as is the case with the Q3s dummy; i.e. this method should not be used with the THOR or WorldSID dummies where the absolute position of the IR-TRACC is of interest.

APPENDIX G: Proper Storage of the Q3s

Proper storage of the dummy promotes a longer service life. The proper storage method minimizes the amount of stress placed on sensitive features of the dummy and reduces the chance of imparting a permanent deformation to the dummy's compliant components. There are many ways to achieve proper dummy storage and the following section provides one example and is intended as a reference.

The Q3s is stored in an environment between 55 - 85°F (12.8 – 29.4°C) and relative humidity of 10 - 70%.

Store the seated dummy in a chair or similar device which supports the thorax without putting tension on the neck (Figure G- 1). In the example chair design shown in Figure G- 1 through Figure G- 3, the thorax is supported on either side by rails which splay outwards. A seat belt with buckle keeps the dummy from falling forward. To prevent buttocks deformation, the seat is cushioned with foam padding so that the dummy is not directly seated on a hard surface.

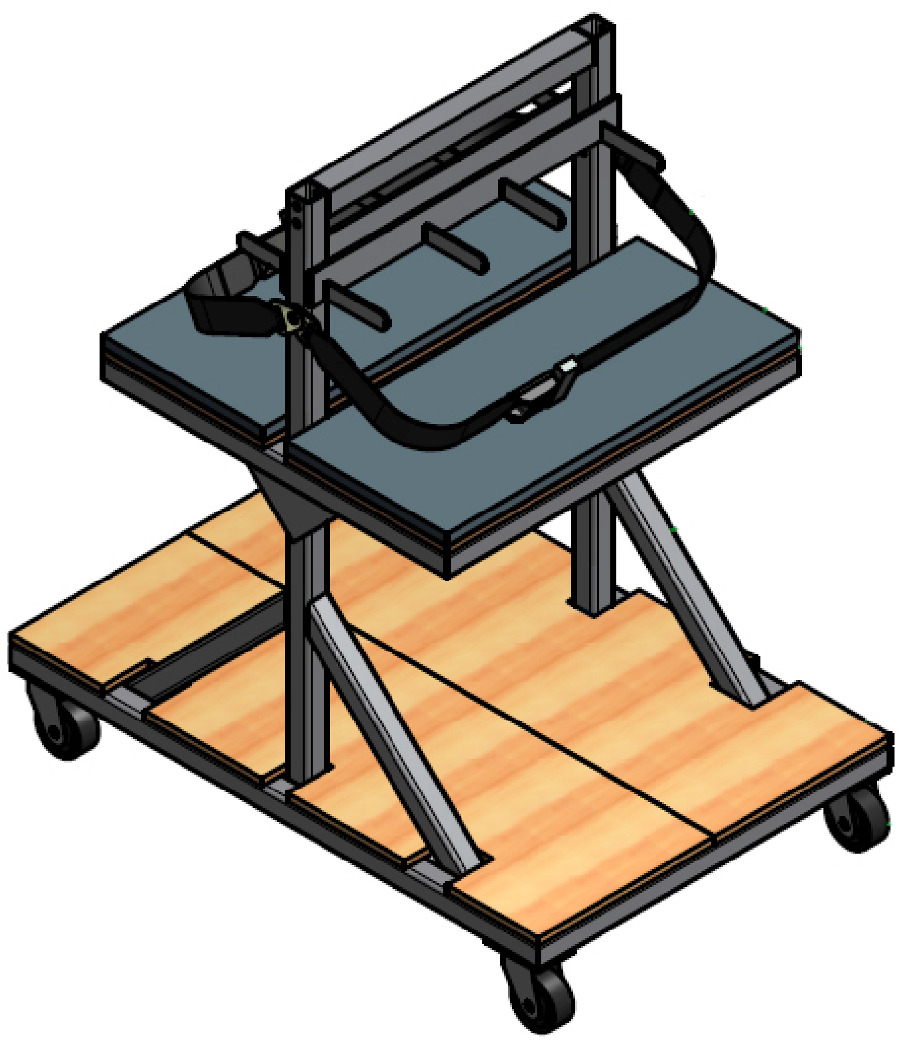


Figure G- 1. Example of Q3s storage chair

Figure G- 2. Q3s positioned in storage chair

(NOTE: Arm is raised to illustrate support rails; Q3s is not required to be stored in this position)

Figure G- 3. Q3s storage chair showing details of thorax support rails