INTERNATIONAL STANDARD

ISO 15830-4

Second edition
2013-05-15

Road vehicles — Design and performance specifications for the WorldSID 50th percentile male side impact dummy —

Part 4: User's manual

Véhicules routiers — Conception et spécifications de performance pour le mannequin mondial (WorldSID), 50e percentile homme, de choc latéral —

Partie 4: Manuel de l'utilisateur

Reference number
ISO 15830-4:2013(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Passive safety crash protection systems*.

This second edition cancels and replaces the first edition (ISO 15830-1:2005) which has been technically revised. Technical amendments have been incorporated throughout all four parts, resulting from extensive experience with the standard and design changes.

ISO 15830 consists of the following parts, under the general title *Road vehicles — Design and performance specifications for the WorldSID 50th percentile male side impact dummy*:

— *Part 1: Terminology and rationale*

— *Part 2: Mechanical subsystems*

— *Part 3: Electronic subsystems*

— *Part 4: User's manual*

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Introduction

This second edition of ISO 15830 has been prepared on the basis of the existing design, specifications, and performance of the WorldSID 50th percentile adult male side impact dummy. The purpose of the ISO 15830 series is to document the design and specifications of this side impact dummy in a form suitable and intended for worldwide regulatory use.

In 1997, ISO/TC22/SC12 initiated the WorldSID 50th percentile adult male dummy development, with the aims of defining a global-consensus side impact dummy, having a wider range of human-like anthropometry, biofidelity, and injury monitoring capabilities, suitable for regulatory use. Participating in the development were research institutes, dummy and instrumentation manufacturers, governments, and vehicle manufacturers from around the world.

With regard to potential regulatory, consumer information, or research and development use of ISO 15830, users will need to identify which of the permissive (i.e. optional) sensors and other elements defined in ISO 15830-3 are to be used in a given application.

WorldSID drawings in electronic format are being made available. Details are given in ISO 15830-2:2013, Annex B.

In order to apply ISO 15830 properly, it is important that all four parts be used together.

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Road vehicles — Design and performance specifications for the WorldSID 50th percentile male side impact dummy —

Part 4:
User's manual

1 Scope

This part of ISO 15830 specifies requirements for assembling and disassembling of the WorldSID 50th percentile side impact dummy, a standardized anthropomorphic dummy for side impact testing of road vehicles.

It is applicable to impact tests involving

— passenger vehicles of categories M1 and goods vehicles of categories N1,

— impacts to the side of the vehicle structure,

— impact tests involving the use of an anthropometric dummy as a human surrogate for the purpose of evaluating compliance with vehicle safety standards.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15830-1, *Design and performance specifications for the WorldSID 50th percentile adult male side impact dummy — Part 1: Terminology and rationale*

ISO 15830-3:2013, *Design and performance specifications for the WorldSID 50th percentile adult male side impact dummy — Part 3: Electronic subsystems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15830-1 apply.

4 Requirements

4.1 Disassembly and assembly

The WorldSID shall be disassembled and assembled according to the procedures in Annex A.

Unless noted otherwise, all fasteners shall be installed using the torques in Annex C.

4.2 Full arm changeover

If a full arm is to be relocated from the left side of the dummy to the right side or from the right side of the dummy to the left side, then this shall be done using the procedures given in A.4.5.

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Annex A
(normative)

Procedures for disassembling and assembling the WorldSID

A.1 Head

A.1.1 Parts list for head

Note that Table A.1 lists the parts required for assembling the WorldSID head, which are illustrated in Figure A.1. Note that part numbers correspond to those on electronic drawing W50-10000.

Table A.1 — Parts list for WorldSID head

Item number	Description	Quantity	Part number
1	Head core	1	W50-10007
2	Moulded head	1	W50-14014
3	Rotational accelerometer, Endevco 7302BM4[a]	3	ISO 15830-3:2013, 4.1.3.3
4	Dual-axis tilt sensor	1	ISO 15830-3:2013, 4.1.3.4.1
5	Linear triaxial accelerometer	1	ISO 15830-3:2013, 4.1.3.2
6	Neck load cell structural replacement	1	W50-71003
7	SHCS M3 x 0,5 x 6	6	5000393
8	Cheese screw, M2 x 16	1	5000254
9	SHCS M4 x 0,7 x 10	1	5000151
10	SHCS M6 x 1 x 16	4	5000081
11	Flat washer M8 (8,9 ID x 18,8 OD x 2,3 thick)	1	5000123
12	BHCS M8 x 1,25 x 25	1	5000255
13	Neck shroud assembly	1	W50-24103
14	SHCS M6 x 12	4	5000281
15	BHCS M4 x 0,7 x 10	5	5000010
Not shown	Rotational accelerometer mass replacement	3	W50-10010
Not shown	Linear triaxial accelerometer mass replacement	1	W50-61063
Not shown	Dual-axis tilt sensor mass replacement	1	W50-10011
Not shown	Universal neck load cell	1	W50-71000

[a] Accelerometer model 7302BM4 is a product supplied by Endevco Corp. San Juan Capistrano, California, USA. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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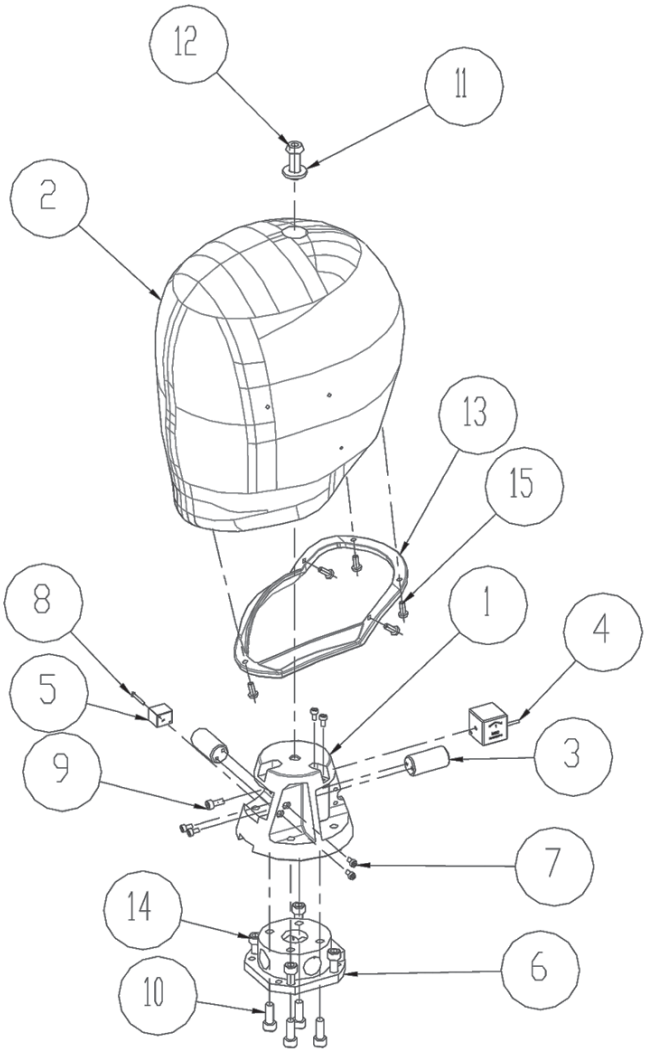

Figure A.1 — WorldSID head components

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A.1.2 Disassembling

As shown in Figure A.2, remove the BHCS M8 × 25 fastener (Figure A.1, Item 12) and M8 flat washer (Figure A.1, Item 11) from the top of the head. Lift the moulded head (Figure A.1, Item 2) off the head core assembly. If the head sticks to the core, tap the bottom edge of the head lightly with a plastic hammer. Detach the neck shroud assembly (Figure A.1, Item 13) from the head by removing five screws, BHCS M4 × 10.

Figure A.2 — Removal of moulded head

Remove the four SHCS M6 × 12 (Figure A.1, Item 14) that connect the head core assembly to the neck assembly (see Figure A.3).

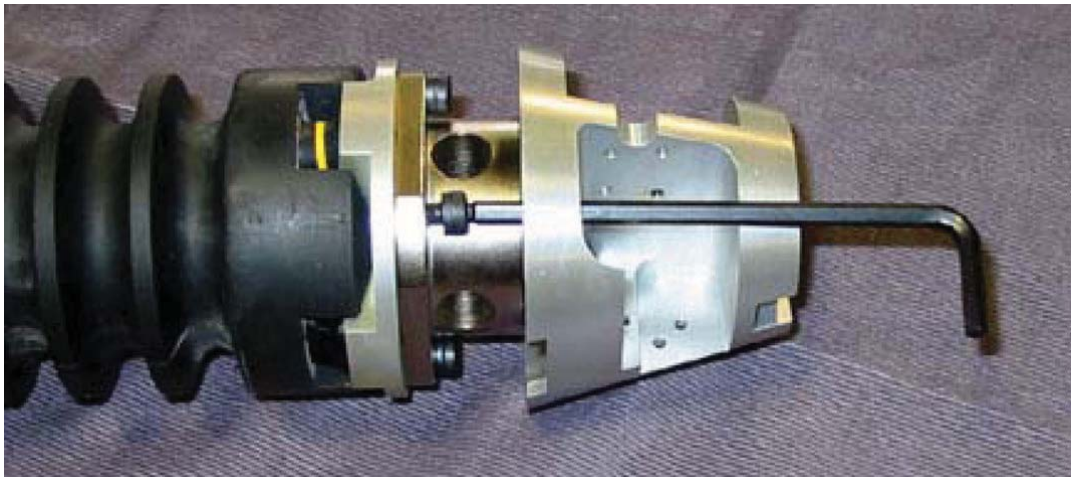

Figure A.3 — Separating the head core from the neck

Remove the four SHCS M6 × 16 (Figure A.1, Item 10) from the bottom of the upper neck load cell structural replacement (Figure A.1, Item 6) that attach it to the bottom of the head core (see Figure A.4).

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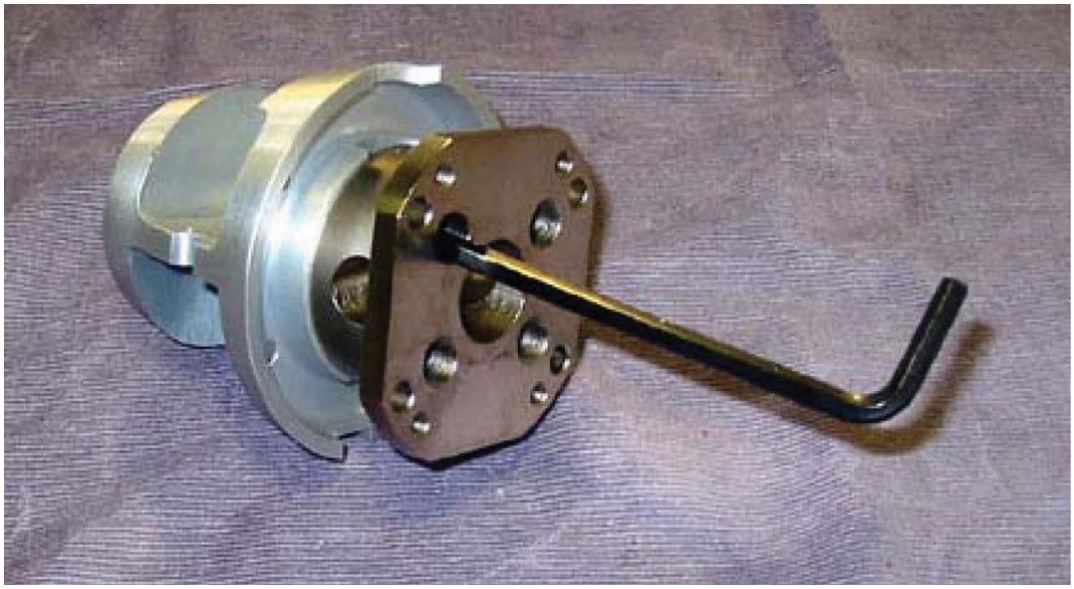

Figure A.4 — Removing upper neck load cell from instrumented head core

A.1.3 Assembling

Install the head instrumentation as described in A.1.4. Use four SHCS M6 × 16 (Figure A.1, Item 10) to attach the upper neck load cell to the bottom of the head core (Figure A.1, Item 1). Make sure the slot at the top front of the head core is lined up with the connector for the upper neck load cell. Torque the screws to 6 Nm. Attach the head core assembly to the neck assembly using four SHCS M6 × 12 (Figure A.1, Item 14). Torque the screws to 6 Nm.

Mount the neck shroud assembly (Table A.1, Item 13) to the moulded head (Figure A.1, Item 2) using five BHCS M4 × 10. Place the head/neck shroud assembly over the instrumented core, making sure that all wires are free. Place the M8 flat washer into the recess at the top of the head and connect the head to the instrumented core using the BHCS M8 × 25 (Figure A.1, Item 12). Tighten the screw 1/4 - 1/2 turn after engagement of the screw head and the skull.

As shown in Figure A.5, bundle the wires from the head instrumentation together at the rear with cable ties and route down the back of the neck over to the non-struck side of the dummy. Pass the cables between the shoulder rib and first thoracic rib. As shown in Figure A.5, make sure that the cable has some slack. See Annex G for more detailed wiring information.

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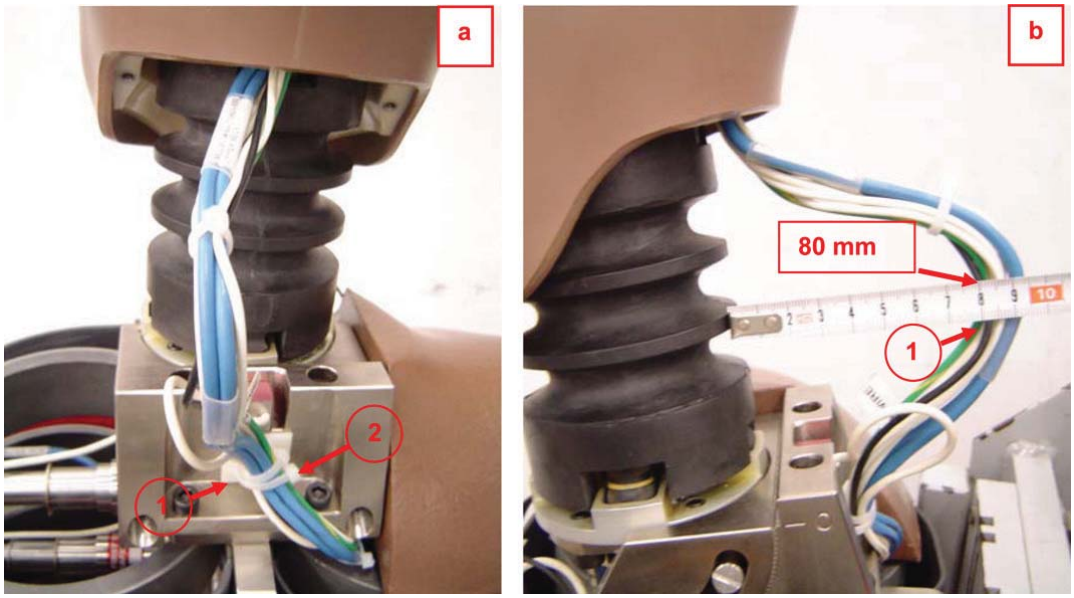

Figure A.5 — Wire routing for head instrumentation

A.1.4 Instrumentation mounting

Note that, as shown in Figure A.6, the head core can be instrumented with three rotational accelerometers (Figure A.6, Item 3), one linear triaxial accelerometer (Figure A.6, Item 5), and one dual-axis tilt sensor (Figure A.6, Item 4). Note that each rotational accelerometer is secured with two SHCS M3 × 6 (Figure A.6, Item 7) and that the y-axis rotational accelerometer is mounted in the right-front chamber with screws accessed from the left-front chamber. Mount the z-axis rotational accelerometer in the left-rear chamber with screws accessed from the top. Mount the x-axis rotational accelerometer in the right-rear chamber with screws accessed from the right-front chamber. Note that the linear triaxial accelerometer is mounted in the right-front chamber with one cheese screw M2 × 16 (Figure A.6, Item 8) that is accessed from the right. Mount the tilt sensor in the right-rear chamber with one SHCS M4 × 10 (Figure A.6, Item 9) accessed from the right-front chamber. Note that the instrumentation in the right-rear chamber shall be installed before the instrumentation in the right-front chamber. Note that the upper neck load cell is also considered part of the head assembly instrumentation.

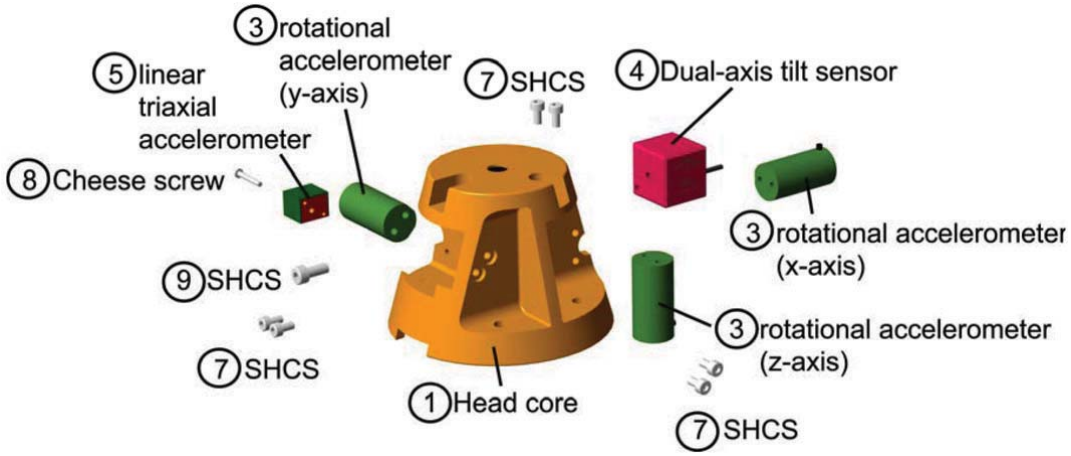

Figure A.6 — WorldSID head instrumentation

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A.2 Neck

A.2.1 Parts lists for neck

Note that Table A.2 lists the parts required for assembling the WorldSID neck, which are shown in Figure A.7. Note that part numbers correspond to those found on drawing W50-20000.

Table A.2 — Parts list for WorldSID neck

Item number	Description	Quantity	Part number
1	Lower neck bracket	1	W50-20101
2	Upper neck bracket	1	W50-20102
3	Neck assembly, tested and certified	1	W50-21001
4	SHCS M6 x 12	8	5000281
5	Neck spacer	2	W50-20103
6	Screw, SHCS M6 x 1 x 30	2	5000008
7	Cable tie mount, #4 screw	1	6002036
8	Screw, BHCS M3 x 0,5 x 6	1	5000399
9	Neck load cell replacement	1	W50-71003

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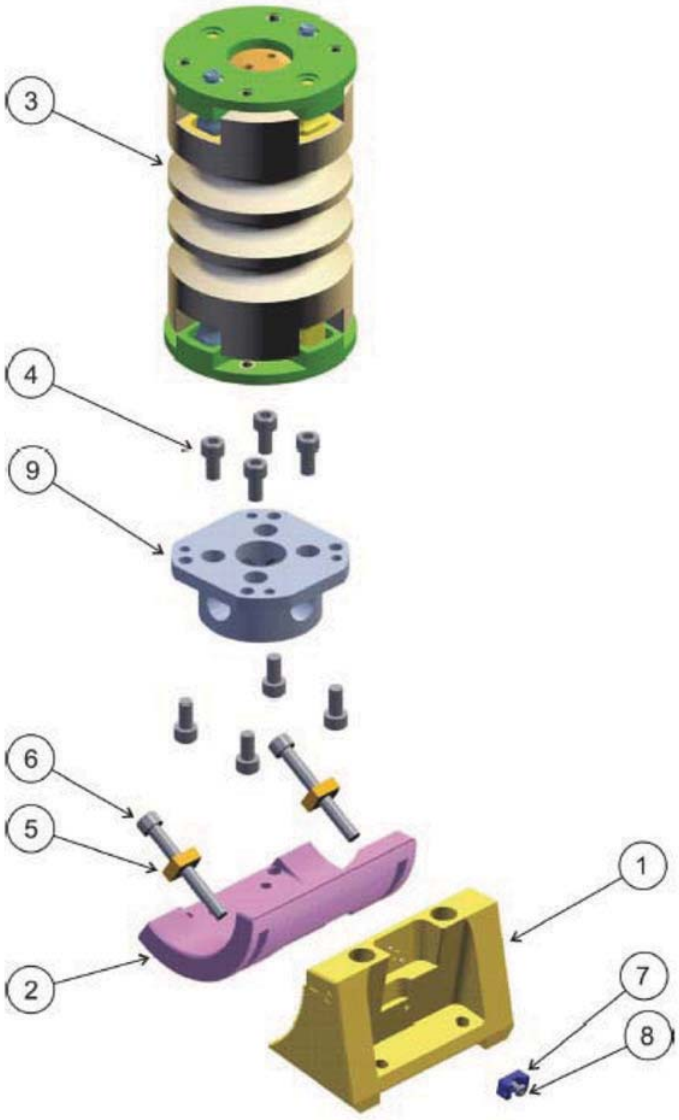

Figure A.7 — WorldSID neck components

A.2.2 Disassembling

Separate the upper (Figure A.7, Item 2) and lower (Figure A.7, Item 1) neck brackets by removing two SHCS M6 x 30 (Figure A.7, Item 6) accessed from the rear of the dummy (see Figure A.8). Two spacers (Figure A.7, Item 5), accessed from either side, will be free to be removed.

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Figure A.8 — Removing lower neck bracket

Remove the upper part of the neck bracket and lower neck load cell structural replacement from the neck assembly by removing four SHCS M6 x 12 (Figure A.7, Item 4) accessed from the bottom (Figure A.9). The lower neck load cell is removed from the upper neck bracket by removing four SHCS M6 x 12 (Figure A.7, Item 4).

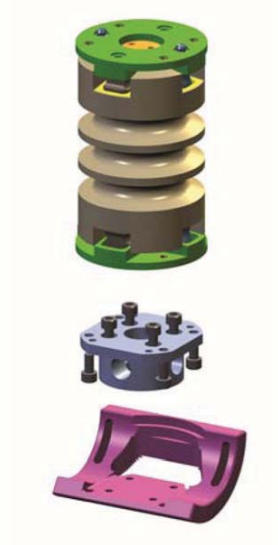

Figure A.9 — Removing upper neck bracket

To take apart the neck assembly, use the neck compression wrench to remove the half-spherical screw from the neck (Figure A.10). The interface plates will come off, and the four dampers can be removed by pulling them out (see Figure A.11).

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Figure A.10 — Using clamp to remove neck interface plate

Figure A.11 — Neck dampers are free to be removed when interface plates are removed

A.2.3 Assembling

When assembling the neck, mount the neck buffers with the circular cross-sections on the lateral sides of the neck, and mount the neck buffers with the square cross-sections on the front and rear of the neck. As shown in Figure A.12, note that the lateral locations for the buffers in the interface plates are farthest from the holes for mounting the neck to the head and torso.

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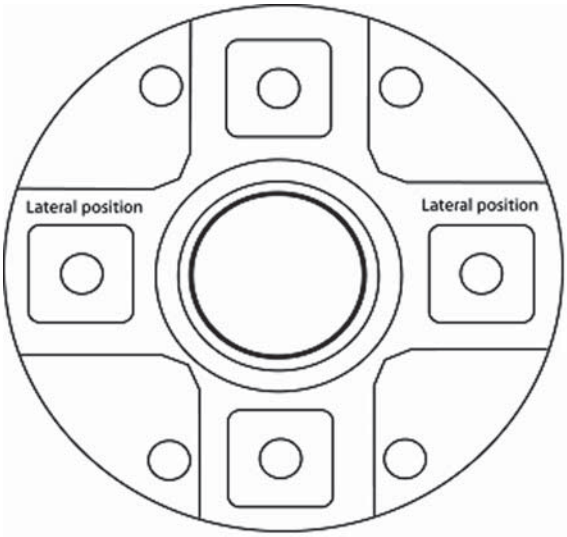

Figure A.12 — Lateral positions for neck buffers

Note that the circular cross-section buffers have a cylindrical end and a mushroom-shaped end. Press the mushroom ends firmly into the top and bottom interface plates so that the mushroom cap protrudes into the counterbore on the flat face of the interface plate. Note that a turning action during assembly helps to get the circular buffers positioned correctly. Tune the correct response of the neck in lateral bending by using three different hardnesses of lateral circular cross-section buffers. When installing the flexion/extension buffers in the interface plates, position them as shown in Figure A.13 so the end that sticks out farther is facing the moulded neck.

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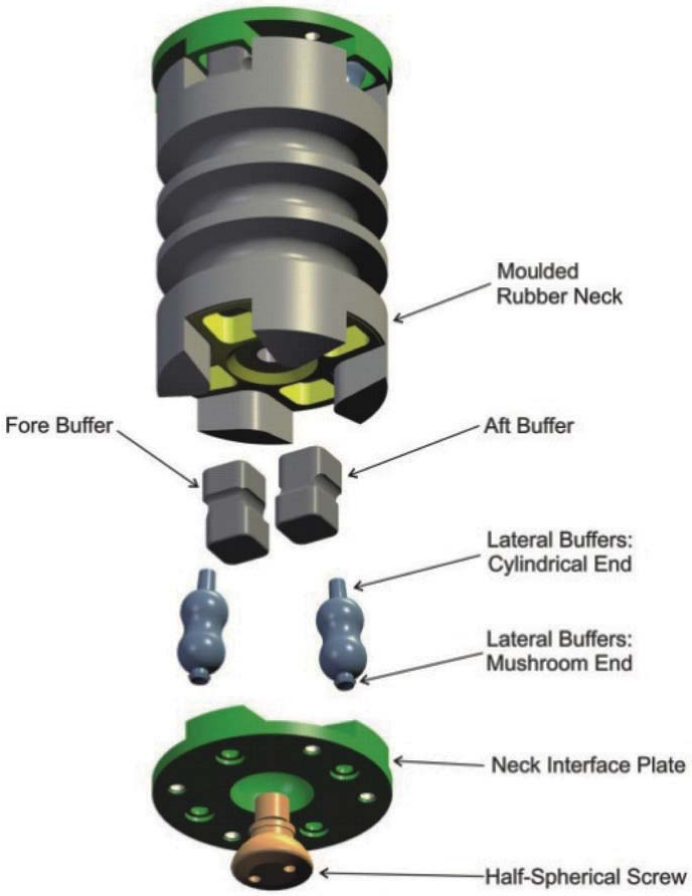

Figure A.13 — Assembling of neck buffers

Position the interface plate with the installed buffers over one end of the neck. Lubricate the surface of the half-spherical screw with "Never Seez"[1)] high-pressure grease. Attach the interface plate to the neck by tightening the half-spherical screws to 10 Nm using the neck compression tool. Repeat for the other end of the neck.

Place the upper neck bracket (Figure A.7, Item 2) over the lower neck bracket (Figure A.7, Item 1) and engage the teeth in the desired orientation. Insert the neck spacer (Figure A.7, Item 5) into the slot on one side and orient it so the hole in the nut lines up with the hole accessed from the back of the lower neck bracket. Insert the SHCS M6 x 30 (Figure A.7, Item 6) to secure the brackets together. Repeat with the second neck bracket nut and SHCS on the other side.

Mount the neck load cell or its structural replacement (Figure A.7, Item 9) to the neck bracket with four SHCS M6 x 12 (Figure A.7, Item 4). Tighten the screws to 6 Nm. Attach the neck assembly (Figure A.7, Item 3) to the neck bracket/load cell assembly with four SHCS M6 × 12 (Figure A.7, Item 4) accessed from the bottom. Tighten the screws to 6 Nm.

A.2.4 Instrumentation mounting

Note that the neck assembly includes a lower neck load cell (the upper neck load cell is considered part of the head assembly). Note that a triaxial accelerometer can be mounted in a recess in the back of the

1) "Never Seez" is a commercial product. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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lower neck bracket. Attach the triaxial accelerometer or its mass replacement to the upper neck bracket using a cheese screw M2 × 16 (see Figure A.14).

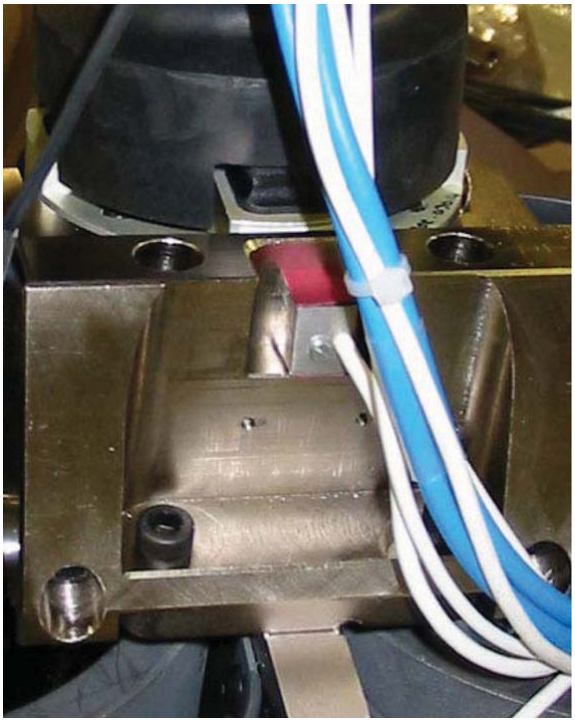

Figure A.14 — Neck triaxial accelerometer installation

A.3 Thorax, abdomen, and shoulder

A.3.1 Parts list

A.3.1.1 Parts list for thorax, abdomen, and shoulder assembly

Note that Table A.3 lists the parts required for assembling the WorldSID thorax, abdomen, and shoulder, which are illustrated in Figure A.15. Note that part numbers correspond to those on drawing W50-30000.

Table A.3 — Parts list for the WorldSID thorax, abdomen, and shoulder

Item number	Description	Quantity	Part number
1	Spine box assembly	1	W50-31000
2	IRTRACC displacement sensor assembly, ribs 1-6 (ref)	6	IF-363
3	Thorax rib assembly 1, WorldSID	2	W50-32111
4	Thorax rib assembly 2 & 3, WorldSID	8	W50-32131
5	Sternum, thorax rib	1	W50-35022
6	Rib coupler, abdominal, WorldSID	1	W50-35021
7	Shoulder rib sternum mounting strip	2	W50-32177
8	Thorax and abdominal rib sternum mounting strip	10	W50-32178
9	Thorax and abdominal rib mounting strip, threaded	10	W50-32176
10	Screw, BHCS M5 X 0,8 X 10	24	5000003

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Table A.3 *(continued)*

Item number	Description	Quantity	Part number
11	Shoulder rib assembly, inner band, WorldSID	2	W50-32160-2
12	Thorax rib assembly, inner band, WorldSID	6	W50-32150-2
13	Abdomen rib assembly, inner band, WorldSID	4	W50-32155-2
14	Shoulder rib mounting bracket, WorldSID	2	W50-32171
15	Thorax and abdominal rib accelerometer mounting bracket, WorldSID	10	W50-32172
16	Accelerometer, linear triaxial, Endevco 7268C-M1 (ref)	6	7268C-M1
17	Rib assembly, shoulder	2	W50-32001
not shown	Shoulder rib sternum mounting strip, threaded	2	W50-32175
19	Thorax and abdominal rib clamping bracket, WorldSID	10	W50-32173
20	Screw, FHCS M5 X 0,8 X 16	8	5000467
21	Screw, rib IRTRACC mount	6	W50-32179
22	Rib doubler, shoulder	2	W50-32010
23	Shoulder assembly, l.c. structural replacement	2	W50-61053
24	Clamp, damping	24	W50-32180
25	Screw, FHCS M5 X 0,8 X 10	48	5000084
26	Screw, BHCS M5 X 0,8 X 6	24	5000214
27	Shoulder pad, left, WorldSID	1	W50-35023-1
28	Shoulder pad, right, WorldSID	1	W50-35023-2
29	Screw, BHCS M2,5 X 0,45 X 10	10	5000208
30	Nut, locknut M12 X 1,75	2	5000462
31	Thorax pad	2	W50-35024
32	Screw, SHCS M6 X 1 X 16	4	5000081
33	Screw, cheese M2 X 16	6	5000254
34	Cable tie mount, ,50 x ,50, nylon, adhesive backed	10	6002035
35	Cable tie mount, #4 screw, nylon	1	6002036
36	Screw, BHCS M3 X 0,5 X 6	1	5000399
37	Cable tie, hook & loop, 11 inch (not shown)	8	6002055
38	Temperature logger assy (ref)	1	734-0808
39	Battery mounting bracket	1	W50-37013
40	Spine ballast stand offs	2	W50-37014
41	G5 mounting bracket, WorldSID thorax	1	W50-37015
42	G5 structural replacement	1	W50-74307
43	Screw, SHCS M5 X 0,8 X 30	2	5000471
44	Screw, BHCS M5 X 0,8 X 12	40	5000654
45	Screw, BHCS #6-32 X 1-1/4	4	9003044
46	Screw, SHCS M3 X 0,5 X 12	6	5000568
47	Structural replacement cover	1	556-5125-2

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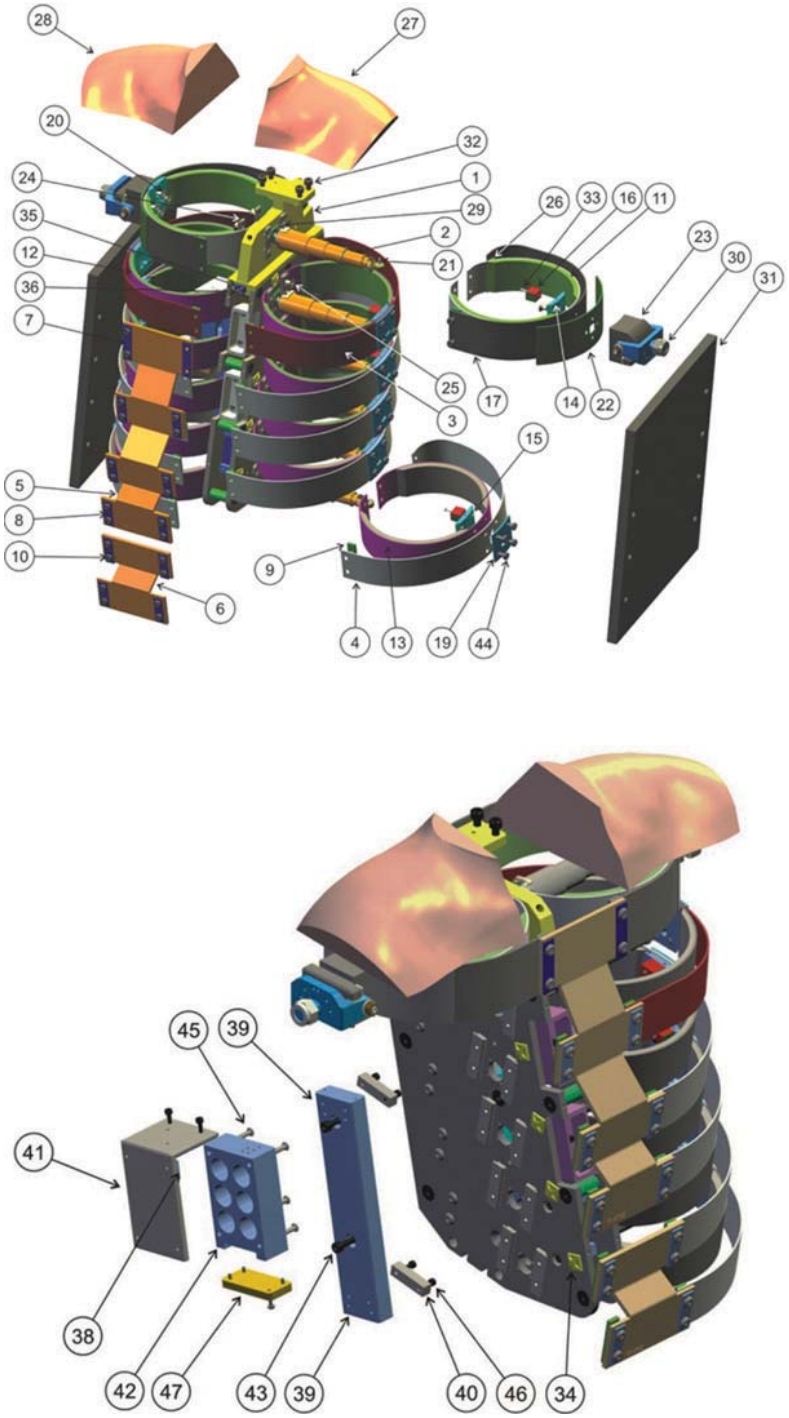

Figure A.15 — Components of WorldSID thorax and abdomen

A.3.1.2 Parts list for shoulder

Note that Table A.4 lists the parts required for assembling the WorldSID shoulder (electronic drawing W50-61053), which is illustrated in Figure A.16.

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Table A.4 — Parts list for shoulder assembly

Item number	Description	Quantity	Part number
1	Shoulder load cell structural replacement	1	W50-71092
2	Shoulder pivot shaft	1	W50-61049
3	Shoulder pivot washer	2	W50-61050
4	Shoulder clevis assembly	1	W50-61117
5	M6 hex locknut	1	5000143
6	SSNT M4 x 0,7 x 4 mm	2	5000201
Not shown	Shoulder load cell	1	W50-71090
Not shown	SSFP M4 x 0,7 x 4 mm	2	5000618
Not shown	SSFT M6 x 10	1	5000226

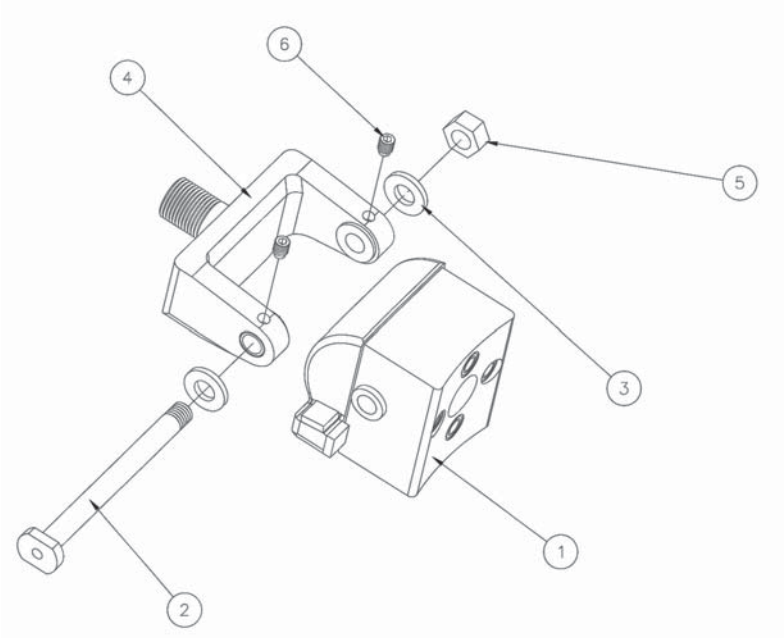

Figure A.16 — Shoulder

A.3.1.3 Parts list for spine box assembly

Note that Table A.5 list the parts required for assembling the WorldSID spine box. Note that part numbers correspond to those on drawing W50-31000 and shown in Figure A.17.

Table A.5 — Parts list for WorldSID spine box

Item number	Description	Quantity	Part number
1	Mounting bracket #1	2	W50-31042
2	Upper bracket weldment, spine box, WorldSID	1	W50-31010
3	Interposer replacement	2	W50-75001
4	Side plate, left WorldSID	1	W50-31020
5	SHCS M3 x 0,5 x 10	7	5000119
6	Spacer, WorldSID	6	W50-31041

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Table A.5 *(continued)*

Item number	Description	Quantity	Part number
7	T12 accelerometer mount, WorldSID	1	W60-37024
8	Side plate, right WorldSID	1	W50-31030
9	SHCS M3 x 0,5 x 8	8	5000388
10	Connector housing mass replacement	2	W50-75002
11	Backup plate mounting bracket	2	W50-37022
12	SHCS M4 x 0,7 x 10	4	5000151
13	FHCS M2,5 x 0,45 x 6	24	5000202
14	Ball joint assembly, IRTRACC	6	W50-31050
15	FHCS M6 x 1 x 10	18	5000204
16	Accelerometer, linear triaxial	2	ISO 15830-3:2013, 4.1.3.2
17	SHCS M2 x 0,4 x 12,0 12,9 alloy steel	8	5000382
18	Cheese screw M2 x 16	2	5000254
19	BHCS M6 x 1 x 18	4	5000465
20	Rotational accelerometer/tilt sensor mount bracket	1	W50-37023
21	Mounting bracket #2	2	W50-31043
22	G5 mass replacement	3	W50-74307
23	Cover plate spine box	2	W50-31045
24	Accelerometer, rotational	2	ISO 15830-3:2013, 4.1.3.3
25	SHCS M4 x 0,7 x 25	8	5000461
26	Bracket, rotational accelerometer mount	1	W50-37029
27	Tilt sensor, dual axis (ref)	1	ISO 15830-3:2013, 4.1.2.4.3
28	FHCS M3 x 0,5 x 10	2	5000203
29	SHCS M4 x 0,7 x 8	1	5000024
30	Pin, dowel M4 x 14	2	5000053
Not shown	Linear accelerometer mass replacement	2	W50-61063
Not shown	Rotational accelerometer mass replacement	2	W50-10010
Not shown	Dual axis tilt sensor mass replacement	1	W50-10011

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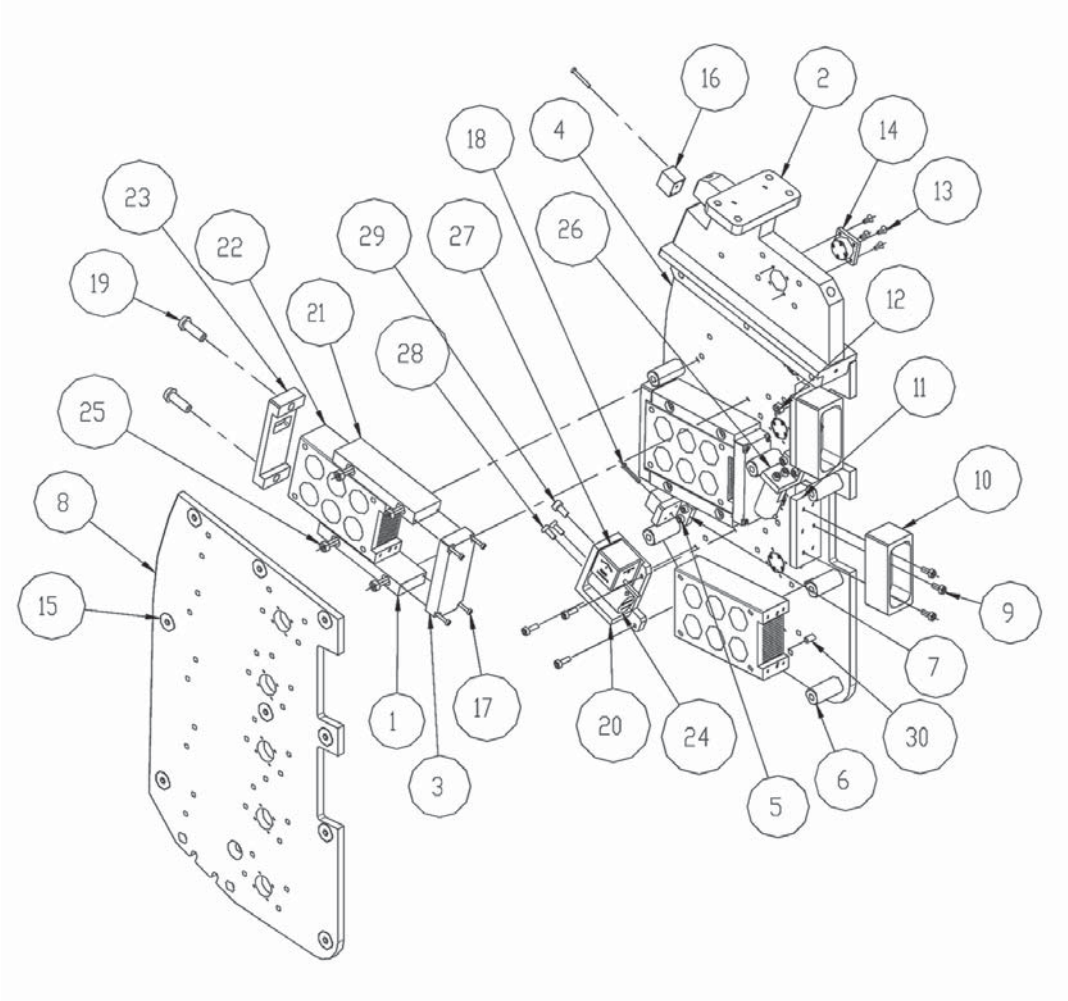

Figure A.17 — WorldSID spine box assembly

A.3.2 Disassembling

A.3.2.1 Separation of upper and lower torso

To separate the upper and lower torso, first make sure all cables running between the upper and lower torso are detached. These would normally include sensor cables that were routed to the DAS in the thorax, and a ground cable. This step may require disassembly of the sternum to access the sensor collector. Thereafter, remove the four SHCS M8, two on each side of the bottom of the spine box, to separate the upper and lower torsos.

A.3.2.2 Shoulder

As shown in Figure A.18, remove the shoulder assembly (Figure A.15, Item 23) by removing the four FHCS M5 x 16 (Figure A.15, Item 20) that hold each in place.

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Figure A.18 — Removing shoulder load cell assembly

To remove the clevis assembly (Figure A.16, Item 4), take off the M6 hex nut (Figure A.16, Item 5) with the nylon washer (Figure A.16, Item 3) at the threaded end. Next, loosen the two SSNT M4 × 0,7 × 4 (Figure A.16, Item 6) in the clevis assembly that hold the pivot shaft (Figure A.16, Item 2) and the SSFT M6 × 10 mm (in the load cell behind the clevis securing the pivot shaft) from the load cell structural replacement then pull the shaft out of the assembly.

NOTE The shoulder load cell has two SSFP M4 × 4 mm securing the pivot shaft instead of the one SSFT M6 × 10 in the load cell structural replacement.

A.3.2.3 Thorax and abdomen

Remove the thorax pad (Figure A.15, Item 31) by removing it from the Velcro® that holds it in place. Remove the shoulder pads (Figure A.15, Items 27 and 28) by lifting them off of the dummy. Remove the lower neck bracket from the spine box by removing four SHCS M6 × 16 (Figure A.15, Item 32).

Remove the shoulder rib mounting brackets (Figure A.15, Item 14). Detach the shoulder rib IR-TRACC (Figure A.15, Item 2) from the shoulder rib mounting bracket by removing the IR-TRACC rib mount screw (Figure A.15, Item 21), accessed from the bottom of the shoulder rib mounting bracket.

Remove the linear triaxial accelerometer (Figure A.15, Item 16) from the shoulder rib mounting bracket by removing the cheese screw M2 × 16 (Figure A.15, Item 33). Detach the shoulder IR-TRACC assembly from the spine box by removing the BHCS M2,5 × 10 (Figure A.15, Item 29).

As shown in Figure A.19, disconnect the shoulder rib (Figure A.19, Item 17) at the front by removing the two BHCS M5 × 10 (Figure A.15, Item 10) that attach the left and right shoulder ribs to the sternum thorax rib (Figure A.15, Item 5). Remove a shoulder rib sternum mounting strip (Figure A.15, Item 7) and a threaded shoulder rib sternum mounting strip (Figure A.15, Item 18) which are removed from each side.

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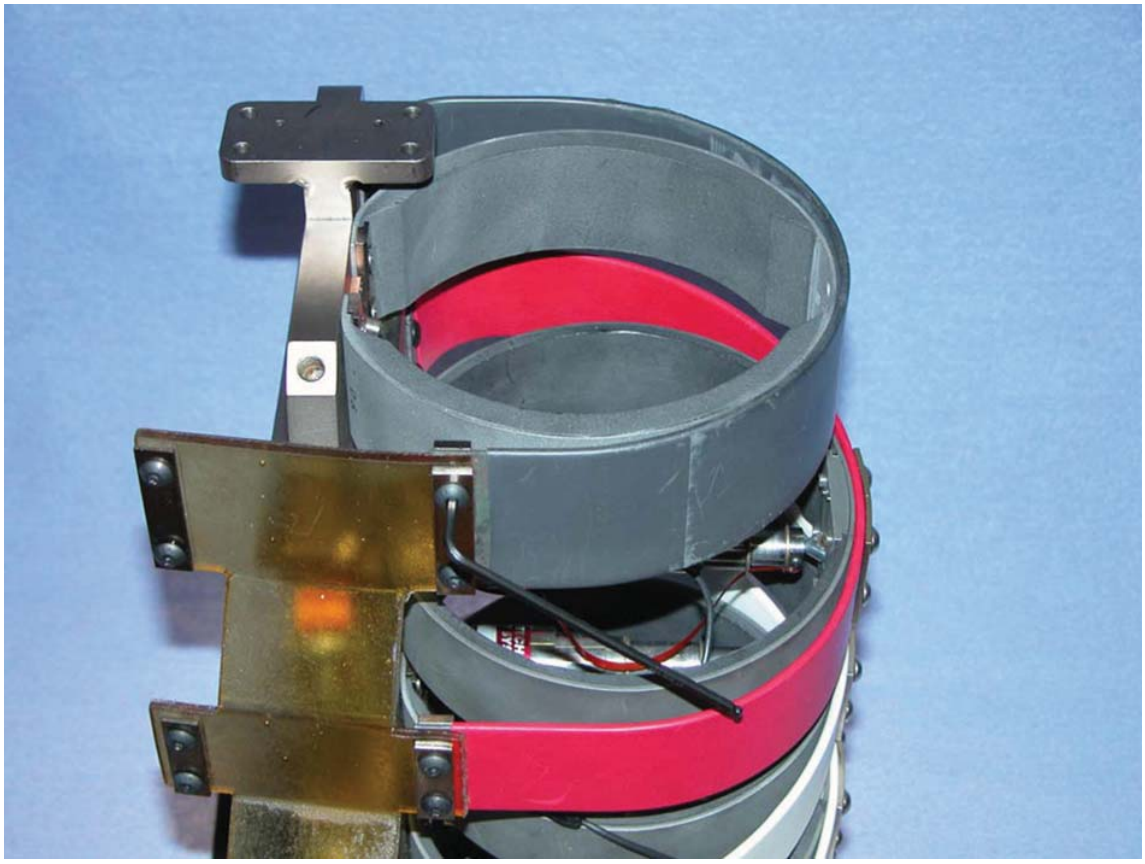

Figure A.19 — Detaching shoulder rib at front from sternum

Detach the left and right shoulder ribs from the spine box at the rear by removing two BHCS M5 × 6 (Figure A.15, Item 26) that hold each in place (see Figure A.20). On the non-struck side, remove the two damping clamps (Figure A.15, Item 24).

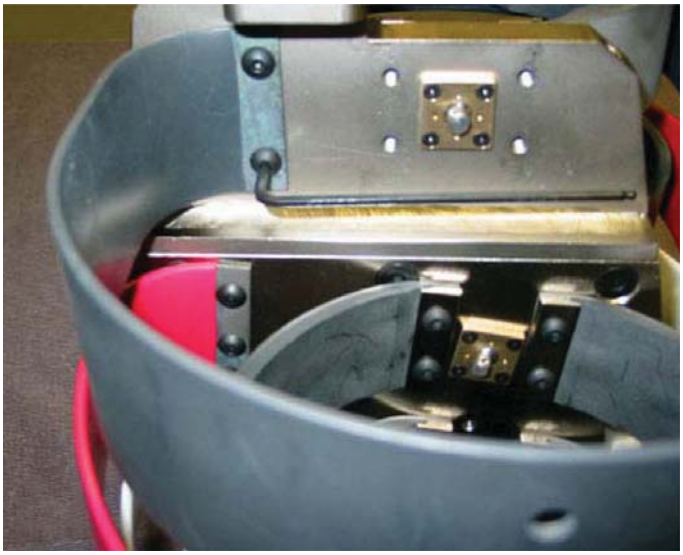

Figure A.20 — Detaching the rib from the spine box at the rear

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Note that the procedures for disassembling the remaining ribs are similar to those for the shoulder rib, but details for the first thoracic rib are included here in order to include references to the correct item numbers. Detach the rib clamping bracket (Figure A.15, Item 19) and the rib accelerometer mounting bracket (Figure A.15, Item 15) by removing the four BHCS M5 × 10 (Figure A.15, Item 10). Remove the triaxial accelerometer (Figure A.15, Item 16) from the rib accelerometer mounting bracket (Figure A.15, Item 15) by removing the cheese screw M2 × 16 (Figure A.15, Item 33).

Remove the IR-TRACC (Figure A.15, Item 2) by removing the BHCS M2,5 × 10 (Figure A.15, Item 29) that secures it to the spine box. Detach it from the rib accelerometer bracket by removing the IR-TRACC mount screw (Figure A.15, Item 21), which is accessed from the bottom of the rib accelerometer bracket.

Detach the thorax rib at the front by removing the four BHCS M5 × 10 (Figure A.15, Item 10) that connect it to the sternum (Figure A.15, Item 5). Remove the two sternum rib mounting strips (Figure A.15, Item 8) and the two threaded rib mounting strips (Figure A.15, Item 9). Detach the inner band of the thorax rib (Figure A.15, Item 12) by removing the four BHCS M5 × 10 (Figure A.15, Item 10) that hold them in place. Remove the two damping clamps (Figure A.15, Item 24). Detach the rib from the spine box at the rear by removing two BHCS M5 × 6 (Figure A.15, Item 26) that hold them in place.

Repeat this procedure for the second and third thorax ribs and the two abdominal ribs with the few differences in parts described here. Note that the two abdominal ribs are attached at the front to the abdominal rib coupler (Figure A.15, Item 6), and that the inner rib bands of the two abdomen ribs (Figure A.15, Item 13) are different than the inner bands of the three thorax ribs (Figure A.15, Item 12). Note that the damping material on the abdominal ribs is thicker than that on the thoracic ribs. Note that the first thorax outer rib (Figure A.15, Item 3) is different from the thorax ribs 2 and 3 and the abdominal ribs (Figure A.15, Item 4), which are the same.

After the ribs are removed, detach the G5 mounting bracket (Figure A.21) from the non-struck side by removing two SHCS M3 x 12. Then, detach the G5 structural replacement by removing the four #6-32 × 1-1/4 BHCS. Detach the cover by removing the four BHCS M2.5 x 10. Next, remove the battery mounting bracket by detaching the two M5 x 30 SHCS that secure it to the spine box. Detach the spine ballast stand offs from the battery mounting bracket by removing the SHCS M3 x 12.

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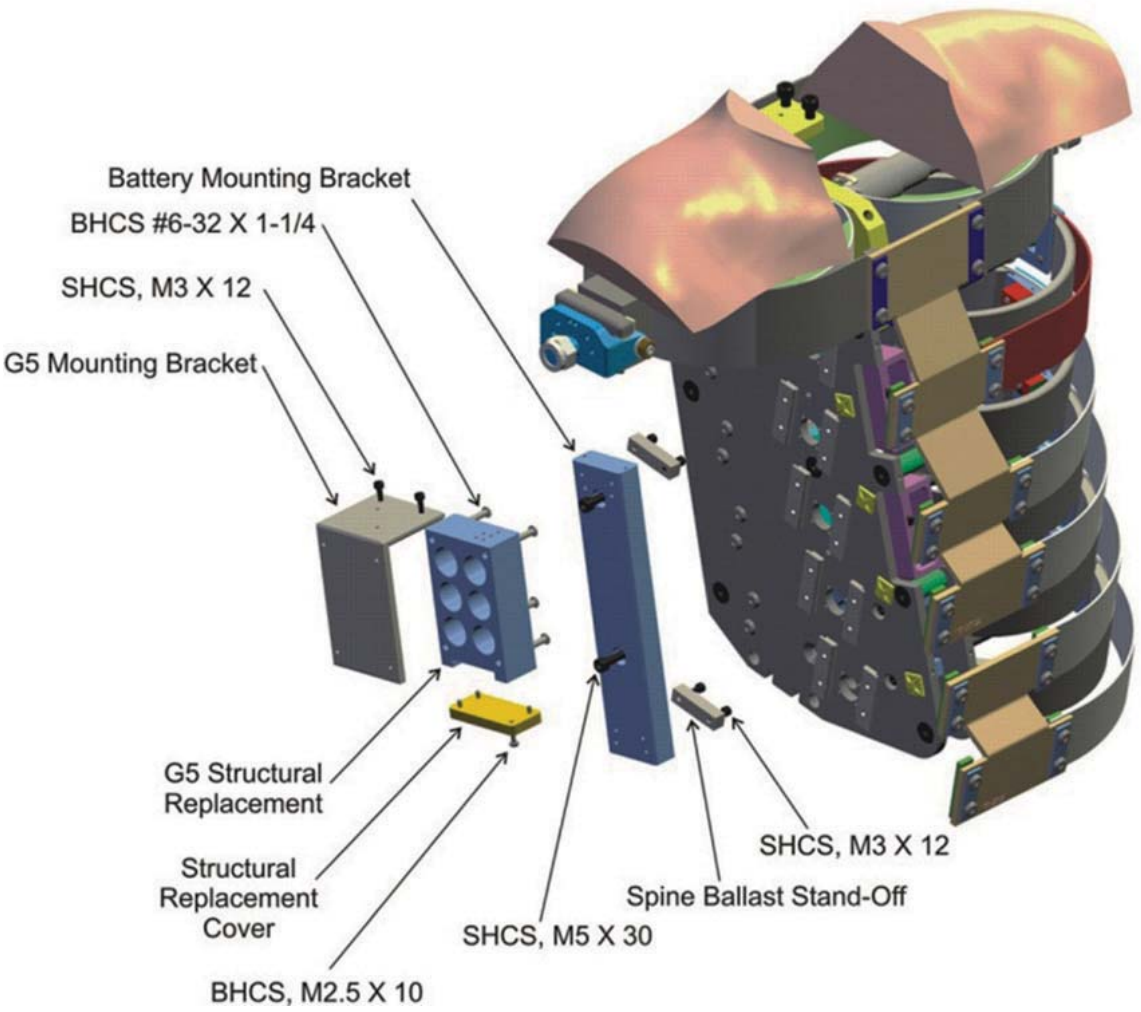

Figure A.21 — Non-impact side G5 assembly

A.3.2.4 Spine box disassembling

Detach the right side plate (Figure A.17, Item 8) from the spine box by removing 10 FHCS M6 × 10 (Figure A.17, Item 15). Note that the internal components of the spine box will now be visible (see Figure A.23).

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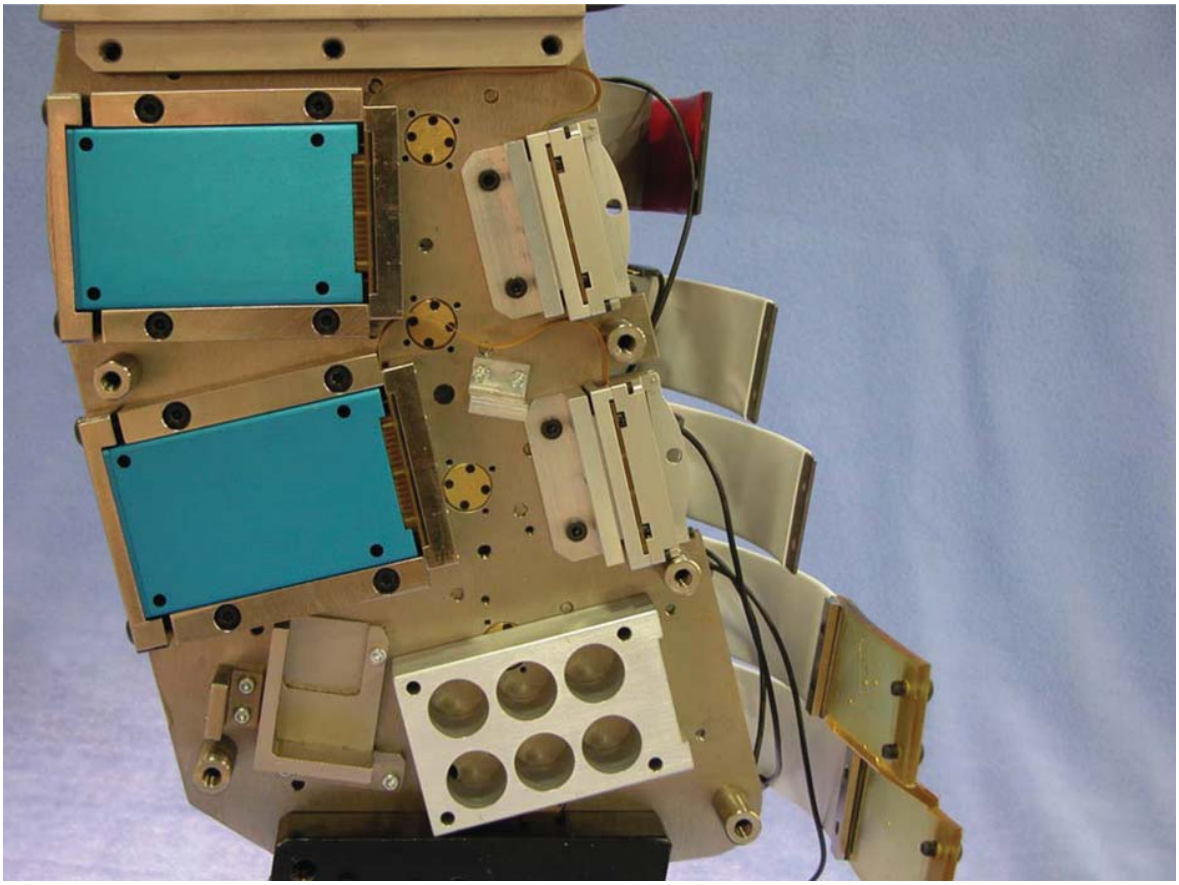

Figure A.22 — Internal spine box assembly

Note the rotational and linear accelerometer assembly shown in Figure A.23. To detach the rotational accelerometer assembly from the spine box, remove the three SHCS M3 × 10 (Figure A.17, Item 5) that secure it to the spine box. Remove the dual-axis tilt sensor (Figure A.17, Item 27) from the rotational accelerometer bracket by removing the SHCS from the back of the bracket. Detach the two rotational accelerometers by removing the two FHCS that secure each to the bracket.

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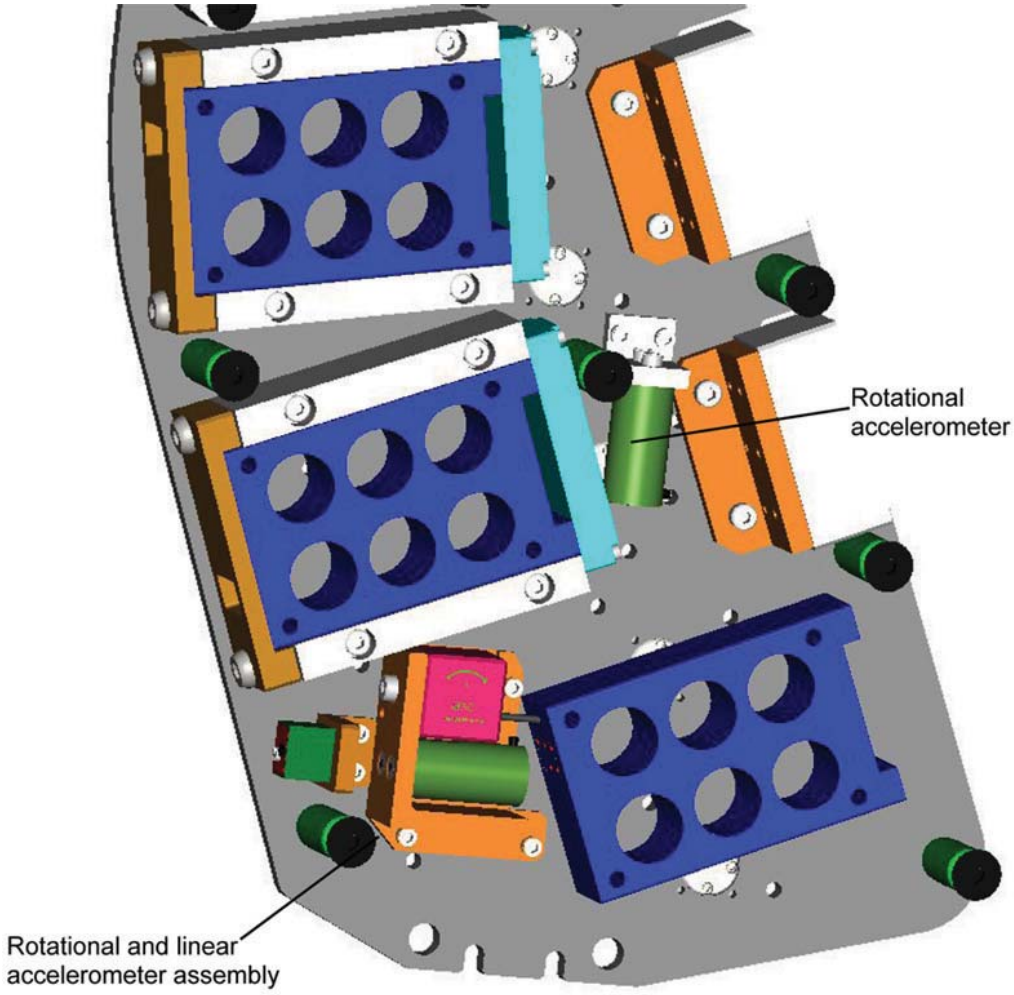

Figure A.23 — Angular accelerometer assembling

Begin removal of the upper or middle G5 module mass replacements (Figure A.17, Item 22) by removing two SHCS M4 × 25 (Figure A.17, Item 25) that secure the Number 2 mounting brackets (Figure A.17, Item 21) to the upper bracket weldment, spine box (Figure A.17, Item 2). Remove two more SHCS M4 × 25 (Figure A.17, Item 25) that secure the Number 1 mounting brackets (Figure A.17, Item 1) to the spine box. Remove the middle or upper G5 module mass replacement assembly (Figure A.17, Item 22). Detach the spine box cover plate (Figure A.17, Item 23) from the back of each G5 module mass replacement (Figure A.17, Item 22) by removing two BHCS M6 × 18 (Figure A.17, Item 19). Slide the G5 module mass replacement (Figure A.17, Item 22) from between the two mounting brackets (Figure A.17, Item 1 and 21). Detach each interposer mass replacement (Figure A.17, Item 3) from the mounting brackets by removing the four SHCS M2 × 12 (Figure A.17, Item 17). Remove the two backup plate mounting brackets (Figure A.17, Item 11) from the spine box by removing the two SHCS M4 × 10 (Figure A.17, Item 12) that hold each in place. Remove each connector housing mass replacement (Figure A.17, Item 10) from its backup plate mounting bracket (Figure A.17, Item 11) by removing three SHCS M3 × 8 (Figure A.17, Item 9). Remove the lower G5 module mass replacement (Figure A.17, Item 22) from the spine box by detaching two pin dowel M4 × 14 (Figure A.17, Item 30).

Turn the spine box over and remove seven FHCS M6 × 10 (Figure A.17, Item 15) to remove the seven spacers (Figure A.17, Item 6) from the left side plate (Figure A.17, Item 4). Remove three more of the FHCS M6 × 10 (Figure A.17, Item 15) to separate the upper spine box bracket weldment from the left-side plate (Figure A.17, Item 4).

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As shown in Figure A.24, note that six IR-TRACC ball joint assemblies (Figure A.17, Item 14) are secured to the struck-side plate, each with four FHCS M2,5 × 6 (Figure A.17, Item 13).

Figure A.24 — IR-TRACC ball joint assemblies are mounted to the struck-side plate of the spine box

A.3.3 Assembling

A.3.3.1 Assembling thorax and abdomen

Note that Figure A.25 shows the colour coding scheme for the WorldSID ribs and that the shoulder rib is grey, the first thoracic rib is red, and the remaining ribs (thorax number two and three, both abdominal) are white.

Note that the inner bands of the two abdominal ribs (Figure A.15, Item 13) have a thicker layer of damping material than the inner bands of the thoracic ribs (Figure A.15, Item 12), and that the inner band of the shoulder rib (Figure A.15, Item 11) is different from the other inner bands.

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Figure A.25 — Shoulder rib is grey, the first thoracic rib is red, and the second and third thoracic ribs and abdominal ribs are white

Begin assembly of the thorax by attaching the two spine ballast stand offs (Figure A.15, Item 40) to the battery mounting bracket (Figure A.15, Item 39) with SHCS M3 × 12 (Figure A.15, Item 46). Then attach the battery mounting bracket (Figure A.15, Item 39) with two SHCS M5x30 (Figure A.15, Item 43) that secure it to the spine box on the non-struck side. Attach the G5 structural replacement (Figure A.15, Item 42) with four BHCS #6-32 × 1-1/4 to the G5 mounting bracket (Figure A.15, Item 41). Attach the G5 cover (Figure A.15, Item 47) to the G5 replacement with BHCS M2.5 × 10 (Figure A.15, Item 29). Then attach the G5 mounting bracket (Figure A.15, Item 41) to the battery mounting bracket (Figure A.15, Item 39).

Begin assembly of the ribs from the bottom. Attach the lower abdominal rib (Figure A.15, Item 13) to the spine box at the rear using two BHCS M5 × 6 (Figure A.15, Item 26). Secure the inner band of the abdomen (Figure A.15, Item 13) with two damping clamps (Figure A.15, Item 24) and four BHCS M5 × 10 (Figure A.15, Item 10). To permit easier access to the connector boxes in the spine box, install the instrumentation before attaching the ribs to the rib and abdominal couplers.

Attach the IR-TRACC to the spine box with a BHCS M2,5 × 10 (Figure A.15, Item 29). Connect it to the rib accelerometer bracket (Figure A.15, Item 15) with the IR-TRACC mount screw (Figure A.15, Item 21), accessed from the bottom of the rib accelerometer bracket (Figure A.15, Item 15). Connect the rib clamping bracket (Figure A.15, Item 19) and the rib accelerometer mounting bracket (Figure A.15, Item 15) to the inner band and rib with four BHCS M5 × 10 (Figure A.15, Item 10). Secure the triaxial accelerometer (Figure A.15, Item 16) to the rib accelerometer mounting bracket (Figure A.15, Item 15) with a cheese screw M2 × 16 (Figure A.15, Item 33).

As each IR-TRACC assembly and accelerometer is installed, route the cables toward the centre front (Figure A.28 and Figure A.29) of the dummy and plug them into the G5 module connectors. See Annex G for more detailed wiring information.

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Note that Figure A.26 shows the arrangement of the components in the first thoracic WorldSID rib and that all of the ribs have a similar general assembly. Note that the inner band of the rib (Figure A.26, Item 33) is attached to the spine box with damping clamps (Figure A.26, Item 10) and FHCS. Note that the rib (Figure A.26, Item 28) is attached to the spine box (Figure A.26, Item 13) at the rear with BHCS, and to the thorax rib sternum (Figure A.26, Item 3) at the front using BHCS and the sternum mounting strip (Figure A.26, Item 4) and threaded sternum mounting strip (Figure A.26, Item 7). Attach the IR-TRACC assembly (Figure A.26, Item 14) with a BHCS to the ball joint components which are attached to the spine box. Secure the IR-TRACC to the rib accelerometer mounting bracket (Figure A.26, Item 32) with a special mounting screw accessed from the bottom. Note that a linear triaxial accelerometer (Figure A.26, Item 15) is attached to the rib accelerometer mounting bracket (Figure A.26, Item 32), which is then secured to the inner rib, rib, and rib clamping bracket (Figure A.26, Item 31) with a BHCS.

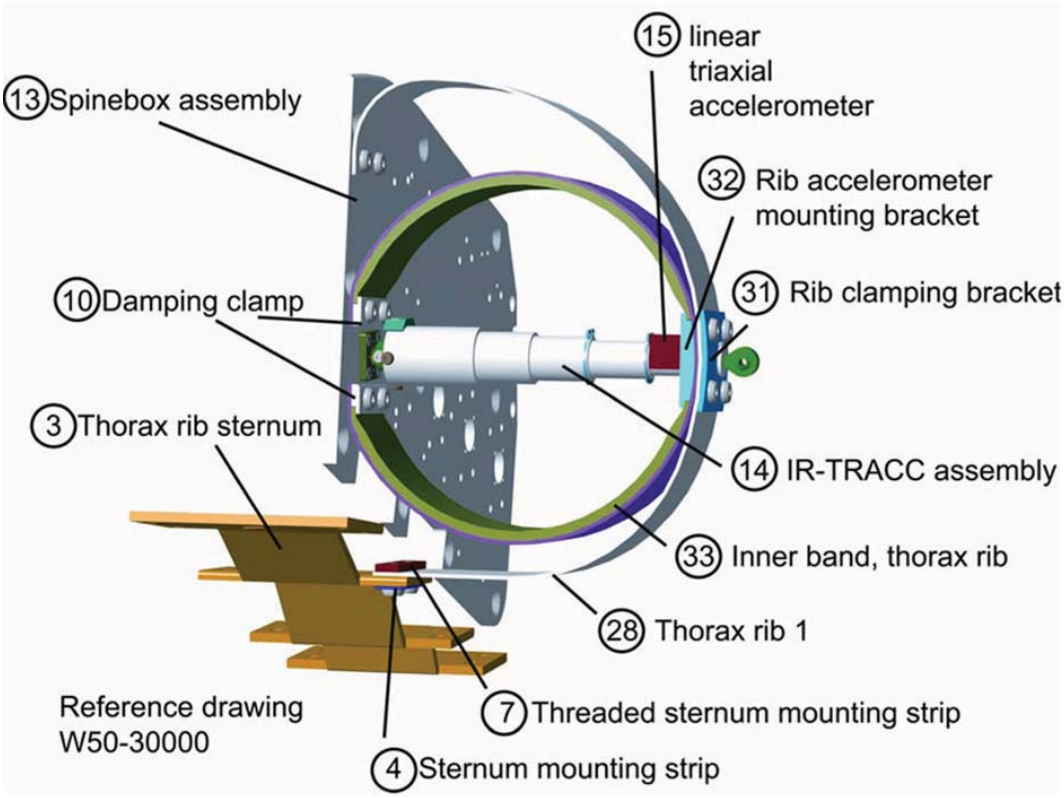

Figure A.26 — Components of thorax rib

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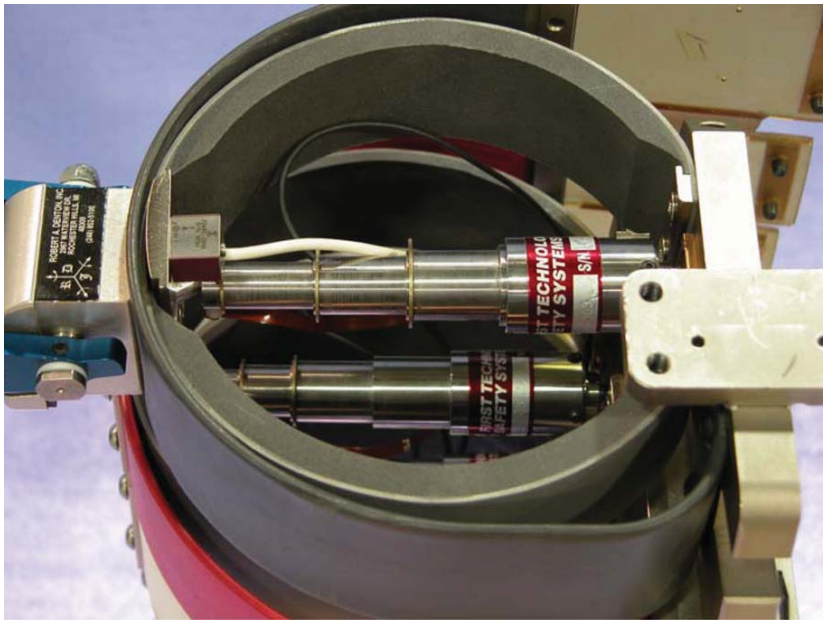

Figure A.27 — Wire routing for rib instrumentation

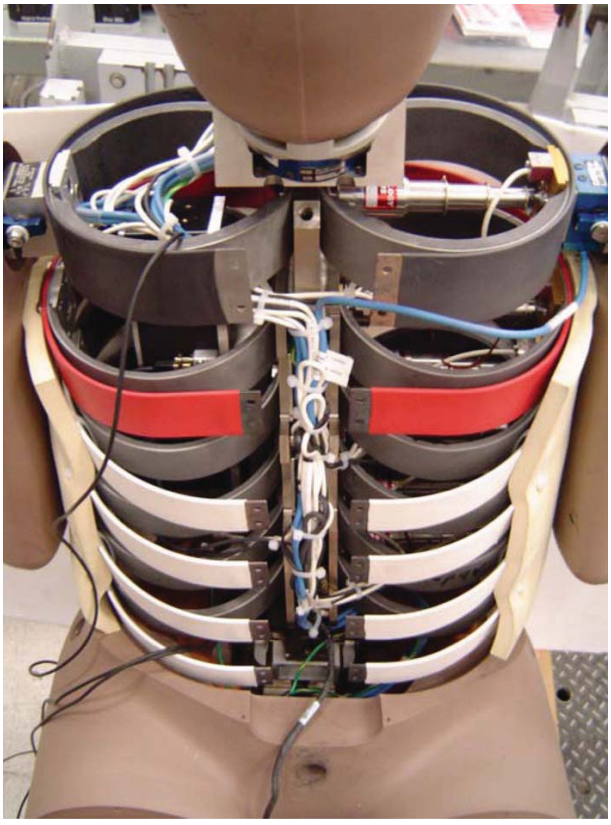

Figure A.28 — Plugging rib instrumentation cables into the front of the G5 modules mounted in the spine box

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Continue installing the ribs with the preceding procedure. Attach the shoulder rib mounting bracket (Figure A.15, Item 14) to the shoulder rib and shoulder load cell structural replacement (Table A.3, Item 23) with four FHCS M5 × 0,8 × 16 (Figure A.15, Item 20).

After the instrumentation is plugged into the connectors, position a threaded rib mounting strip (Figure A.15, Item 9) behind the front holes on each abdominal rib, and place the abdominal rib coupler (Figure A.15, Item 6) over it. Put the rib mounting strip (Figure A.26, Item 4) over the rib coupler and secure the rib at the front with two BHCS M5 × 10 (Figure A.15, Item 10). Note that the installed rib couplers are shown in Figure A.29.

Attach the lower neck bracket to the spine box with four SHCS M6 × 16 (Table A.3, Item 32). Attach the thorax pad (Figure A.15, Item 31) with Velcro®. Place the shoulder pads (Figure A.15, Items 27 and 28) in position.

To install the thorax pads, check the fit of the pad against the dummy to make sure the pad covers the ribs and press into place, engaging the Velcro® with light pressure.

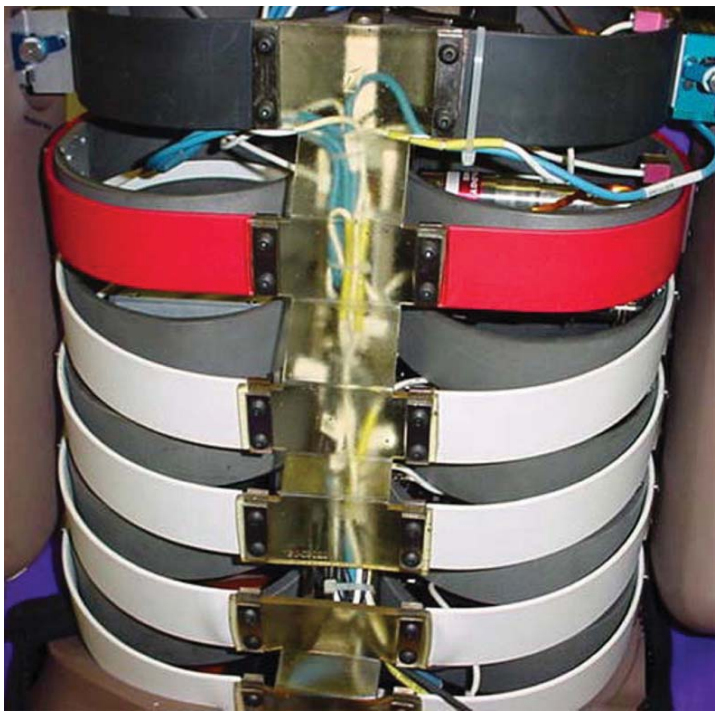

Figure A.29 — The rib and abdominal couplers are attached to the ribs after instrumentation is plugged in

A.3.3.2 Assembling spine box

Begin assembly of the spine box by mounting the ball joints for the IR-TRACC assemblies to the side plate so they face the struck-side of the dummy. Secure each ball joint (Figure A.17, Item 14) with four FHCS M2,5 × 6 (Figure A.17, Item 13). Attach the seven spacers (Figure A.17, Item 6) to the struck-side plate (Figure A.17, Item 4 or Item 8) using seven FHCS M6 × 10 (Figure A.17, Item 19). Attach the upper spine box bracket weldment (Figure A.17, Item 2) to the struck-side plate with three more FHCS M6 × 10 (Figure A.17, Item 19).

As shown in Figure A.30, attach the lower G5 module or its mass replacement (Table A.5, Item 22) to the spine box. Attach each backup plate mounting bracket (Figure A.17, Item 11) to the spine box with two M4 × 14 pin dowels (Figure A.17, Item 30). Connect each interposer or its mass replacement (Figure A.17, Item 3) to the mounting brackets Number 1 (Figure A.17, Item 1) and Number 2 (Figure A.17, Item 21) with four SHCS M2 × 12 (Figure A.17, Item 17). Secure the mounting brackets/interposers to the spine box with four SHCS M4 × 25 (Figure A.17, Item 25). Slide the G5 modules or their mass replacements (Figure A.17,

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Item 22) into the mounting brackets and connect them to the interposers. Attach the spine box cover plate (Figure A.17, Item 23) to the back of each G5 module or its mass replacement with two BHCS M6 × 18 (Figure A.17, Item 19). Attach each connector housing or its mass replacement (Figure A.17, Item 10) to its backup plate mounting bracket (Figure A.17, Item 11) with three SHCS M3 × 8 (Figure A.17, Item 9).

Next, assemble the angular accelerometer assembly. Attach the z-axis angular accelerometer to the bottom of the bracket with two FHCS. Attach the x-axis rotational accelerometer to the back of the bracket with two FHCS so it is parallel to the bottom of the bracket. Attach the dual-axis tilt sensor (Figure A.17, Item 27) to the back of the bracket with a SHCS. Position the rotational accelerometer assembly on the spine box and secure it with three SHCS M3 × 10 (Figure A.17, Item 5). Plug the cables for the rotational accelerometers sensors into a G5 module, but leave the connectors for the dual-axis tilt sensor free to be plugged into the off-board readout during dummy setup.

Attach the T12 accelerometer mount (Figure A.17, Item 7) to the spine box with two SHCS M3 × 10 (Figure A.17, Item 5). Attach the accelerometer (Figure A.17, Item 16) to the mount with a cheese screw M2 × 16 (Figure A.17, Item 18). Orient the accelerometer so that the cable points upward and can be routed between the middle G5 module and angular accelerometer assembly to be plugged into the G5 module. Attach the linear triaxial accelerometer (Figure A.17, Item 16) to the top of the spine box weldment with a cheese screw M2 × 16 (Figure A.17, Item 18). Plug the cable for the upper accelerometer into the G5 module after the ribs are installed.

Attach the other side plate (Figure A.17, Item 4 or 8) to the spine box with 10 FHCS M6 × 10 (Figure A.17, Item 15). Make sure the cables from the T12 or angular accelerometer assembly are not pinched by the side plate.

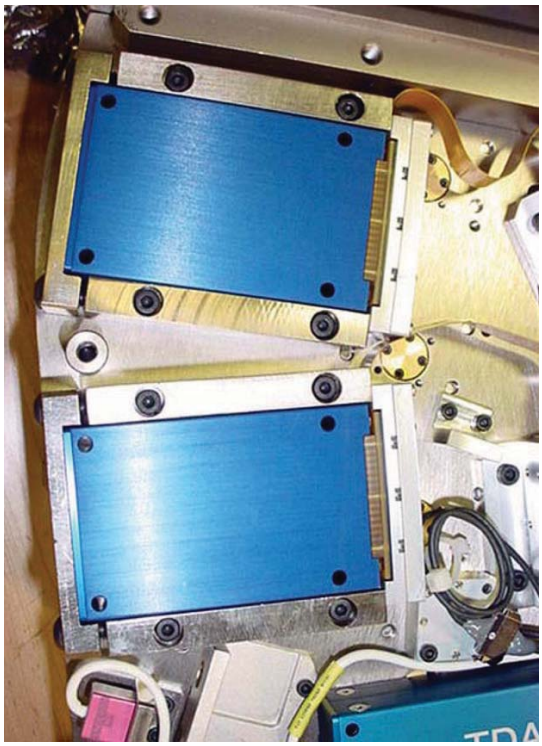

Figure A.30 — Installation of G5 modules

A.3.4 Instrumentation mounting

A.3.4.1 Thorax instrumentation

Note that the thorax instrumentation for the WorldSID includes an IR-TRACC deflection measurement assembly for each struck-side rib, plus a triaxial accelerometer attached to the inner struck side of each

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rib. Note that Figure A.31 illustrates the configuration for the assembly of the rib with instrumentation. Note that the IR-TRACC assembly (Figure A.31, Item 14) is attached to the spine box with a BHCS M2,5 (Figure A.31, Item 11), and that the other end of the IR-TRACC assembly is attached to the rib accelerometer mounting bracket (Figure A.31, Item 32) with an IR-TRACC rib mount screw (Figure A.31, Item 19) accessed from the bottom of the rib. Note that a linear triaxial accelerometer (Figure A.31, Item 15) is secured to the rib accelerometer mounting bracket (Figure A.31, Item 32) with a cheese screw M2 × 16 (Figure A.31, Item 37), and that the rib accelerometer mounting bracket (Figure A.31, Item 32) is secured to the inner band of the rib (Figure A.31, Item 33), the thorax rib (Figure A.31, Item 28), and the rib clamping bracket (Figure A.31, Item 31) with four BHCS M5 × 10 (Figure A.31, Item 1).

Note that a battery to power the G5 modules is part of the thorax assembly and that additional instrumentation attached to the spine box is described in the disassembly/assembly section for the spine box. Note that a shoulder load cell is also available for use with the WorldSID.

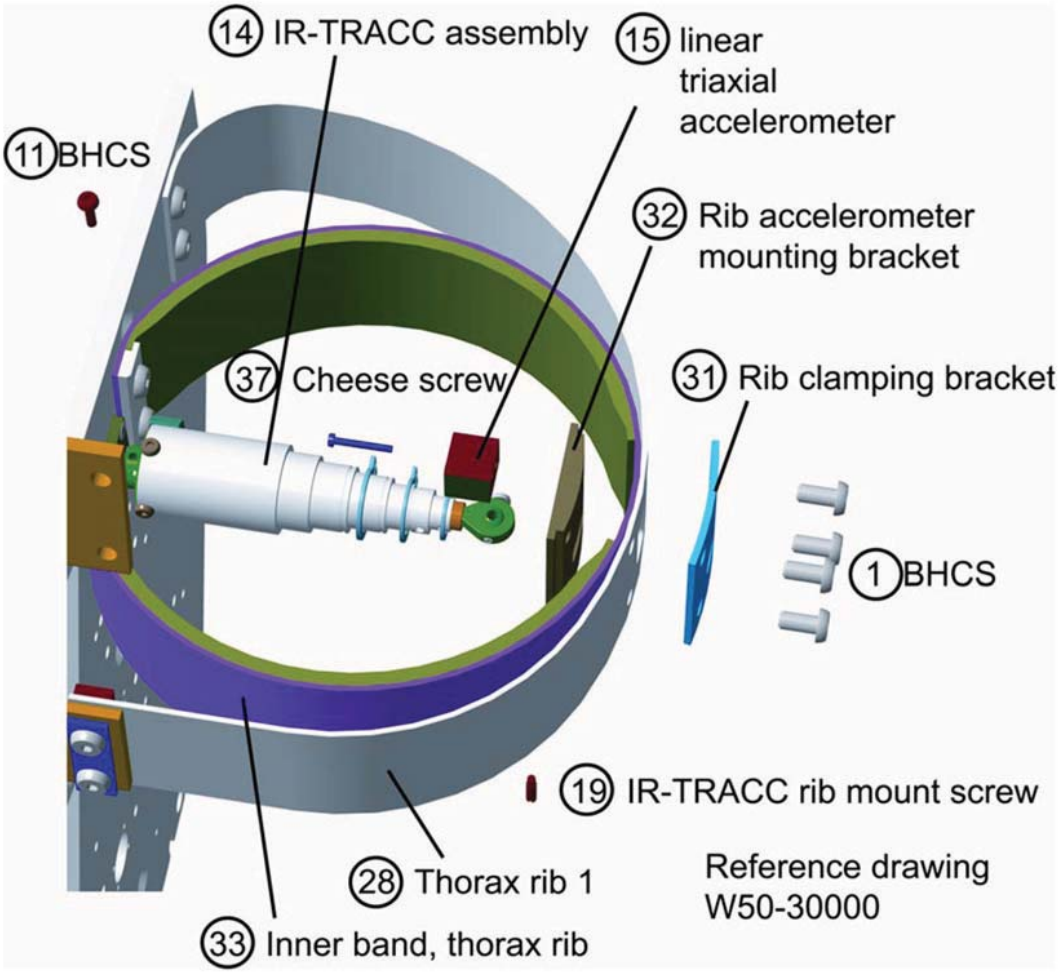

Figure A.31 — WorldSID rib instrumentation

A.3.4.2 Spine box instrumentation

Note that the spine box includes mounting positions for two G5 DAS modules, one of which is shown in Figure A.32. Note that for both of these, an interposer connector (see Figure A.33) is attached to the mounting brackets, and the DAS module is plugged into this connector. Note that the connector for each DAS (see Figure A.34), which is linked to the interposer connector, is secured to a bracket mounted to the spine box. Note that the arrangement of the DAS and connectors is shown in Figure A.35. Note

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that for the lower G5 module, the connector is mounted adjacent to the module, so the module plugs in directly to the connector and no interposer is used.

Figure A.32 — G5 DAS module

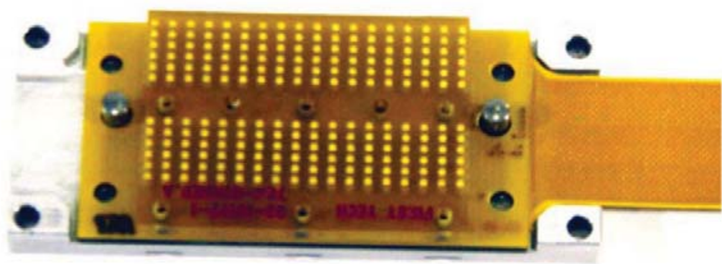

Figure A.33 — Interposer connector

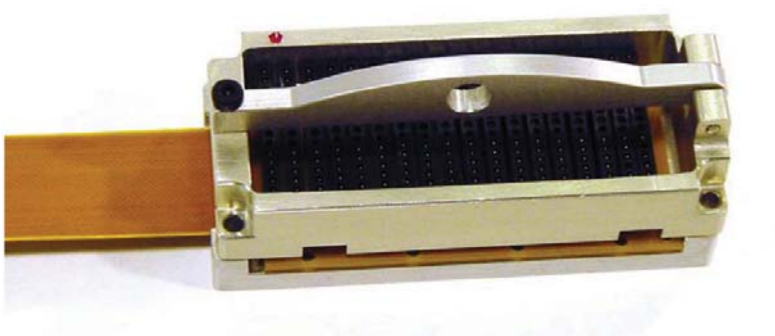

Figure A.34 — DAS connector

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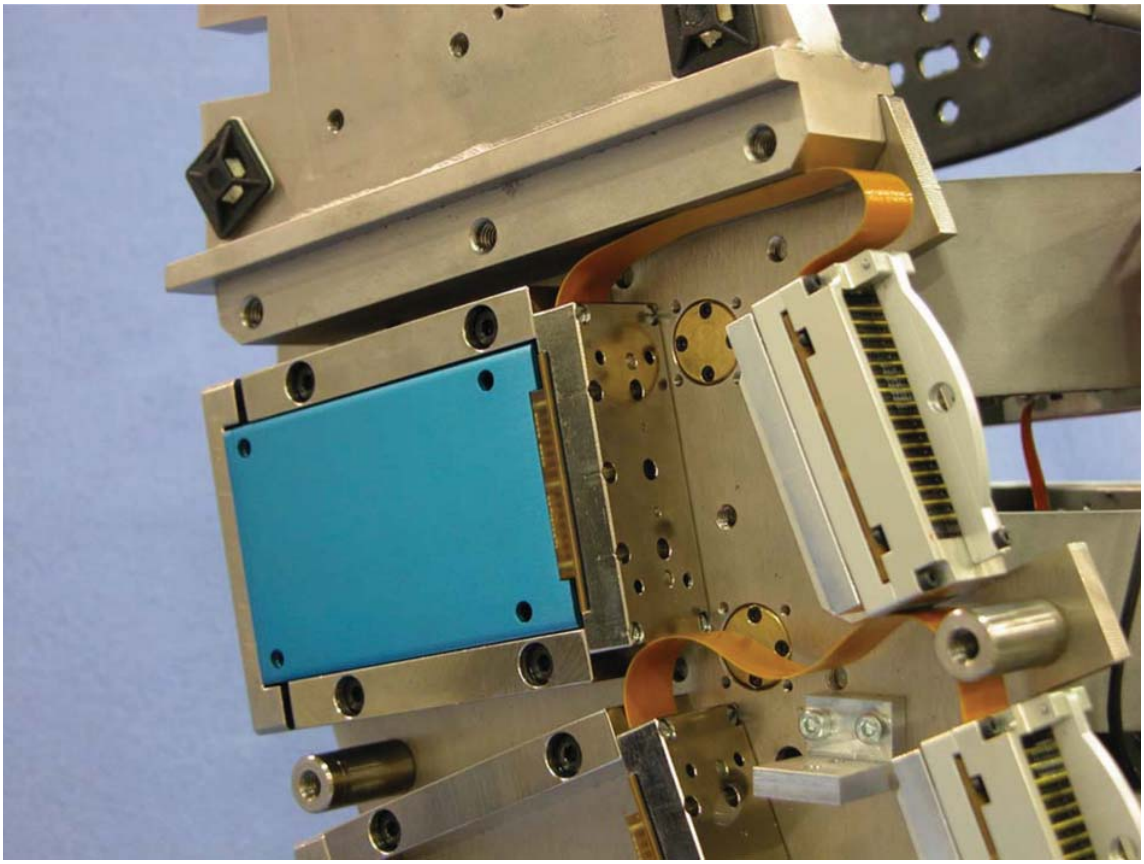

Figure A.35 — Arrangement of DAS, interposer connector, and connector

Note that other instrumentation in the spine box includes a linear triaxial accelerometer mounted directly to the spine box near the top, and that a second linear triaxial accelerometer is mounted to a bracket attached to the spine box near the location of the T12 thoracic vertebra. Note that an angular accelerometer assembly, which includes rotational accelerometers to measure x- and z-axis angular acceleration, plus a dual-axis tilt sensor, is mounted near the bottom of the spine box, and that in addition, the ball joint portions of six IR-TRACC assemblies are mounted to the spine box plate on the struck-side of the dummy.

A.4 Full arm

A.4.1 Parts list

A.4.1.1 Parts list for full arm

Note that the parts and assemblies required for assembling the WorldSID full arm [W50-61000 (left); W50-61001 (right)] are the upper arm assembly, lower arm assembly (see Figure A.36, Items 1 and 9 respectively), moulded hand (Figure A.36, Item 10), and moulded shoulder bumper (Figure A.36, Item 19), potentiometer, pivot adjustment hardware, and strain relief hardware.

Note that Table A.6 lists the parts required for assembling the WorldSID full arm, which is illustrated in Figure A.36.

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Table A.6 — Parts list for full arm

Item number	Description	Quantity	Part number
1	Upper arm assembly, left	1	W50-61002
Not shown	Upper arm assembly, right	1	W50-61003
2	Elbow shaft assembly	1	W50-61028
3	Elbow potentiometer mass replacement	1	W50-61123
4	M3 flat washer	2	5000181
5	BHCS M3 x 0,5 x 10 mm	2	5000178
6	BHCS M4 x 0,7 x 6 mm	1	5000179
7	M4 flat washer	1	5000155
8	Cable clamp	1	5000191
9	Lower arm assembly	1	W50-61034
10	Moulded hand assembly, left	1	W50-61037
Not shown	Moulded hand assembly, right	1	W50-61069
11	Spring washer	1	W50-61022
12	SHSS M6 x 25 mm	1	5000163
13	BHCS M10 x 1,5 x 20 mm	1	5000176
14	Clamping washer (steel)	1	W50-61014
15	Compression washer (rubber)	1	W50-61016
16	Friction washer	1	W50-52064
17	Cable guide	4	W50-61030
18	BHCS M3 x 0,5 x 6 mm	8	5000171
19	Shoulder bumper assembly	1	W50-61110
20	LHSHCS M3 x 0,5 x 12 mm	2	5000620
21	SSNT M3 x 0,5 x 3 mm	1	5000190
21	Flexion-extension stop assembly	1	W50-61054
22	Full arm clevis assembly	1	W50-61051
23	SSHDP M6 x 1,0 x 6 mm	1	5000165
Not shown	Upper arm flesh, left	1	W50-61099
Not shown	Upper arm flesh, right	1	W50-61098
Not shown	Lower arm flesh	1	W50-61100
Not shown	Elbow potentiometer (optional)	1	W50-61027

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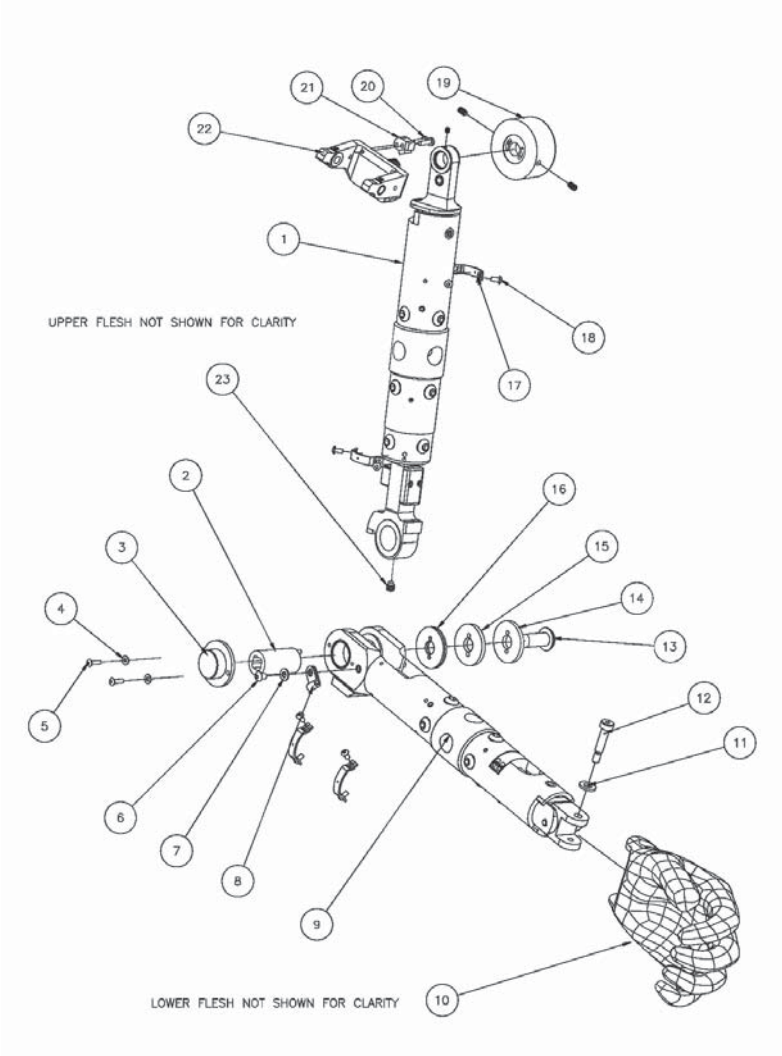

Figure A.36 — Full arm, exploded

A.4.1.2 Parts list for shoulder arm

Note that Table A.7 lists the parts for assembling the WorldSID shoulder-arm, which is illustrated in Figure A.37.

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Table A.7 — Parts list for shoulder-arm

Item number	Description	Quantity	Part number
1	Shoulder load cell	1	W50-71090
Not shown	Shoulder load cell structural replacement	1	W50-71092
2	Shoulder clevis assembly	1	W50-61051
3	SSNT M3 x 0,5 x 3 mm	1	5000190
4	Shoulder bumper	1	W50-61110
5	SSFP M4 x 0,7 x 6 mm	2	5000464
6	Spring plunger	1	5000256
7	Arm tube assembly	1	W50-61012
8	BHCS M6 x 1,0 x 16 mm	1	5000072
9	SSNT M6 x 1,0 x 6 mm	1	5000621

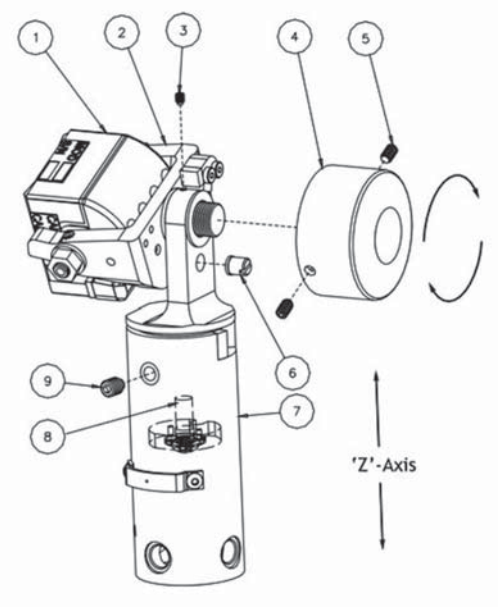

Figure A.37 — Shoulder-arm detail

A.4.1.3 Parts list for upper arm

Note that Table A.8 lists the parts required for assembling the WorldSID upper arm, which is illustrated in Figure A.38.

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Table A.8 — Parts for upper arm

Item number	Description	Quantity	Part number
1	Upper arm "Z"-pivot assembly, left Upper arm "Z"-pivot assembly, right	1	W50-61006 W50-61111
2	Upper arm tube assembly	1	W50-61012
3	Modified button head cap screw	12	W50-61042
4	Wrist washer	1	W50-61019
5	Spring washer	1	W50-61022
6	BHCS M6 x 1,0 x 16 mm	1	5000072
7	Universal arm load cell	1	W50-71070
Not shown	Arm load cell structural replacement	1	W50-61041
8	Upper arm extension tube assembly	1	W50-61004
9	SHCS M2 x 0,4 x 18 mm	2	5000164
10	Accelerometer mass replacement	1	W50-61063
11	Elbow load cell	1	W50-71060
Not shown	Elbow load cell structural replacement	1	W50-61065
Not shown	Triaxial linear accelerometer	1	ISO 15830-3:2013, 4.1.3.2

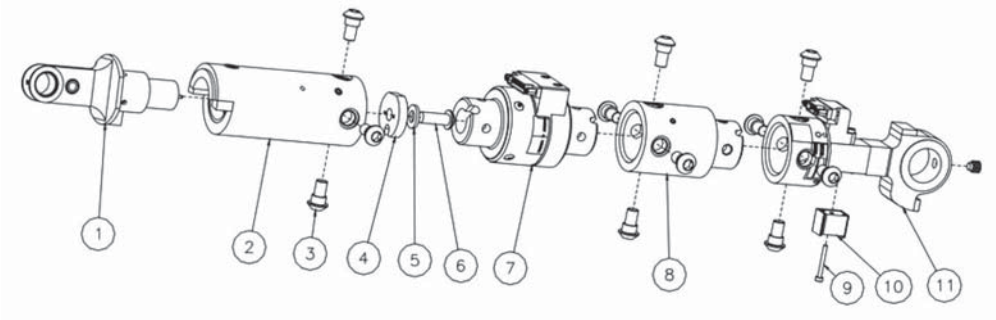

Figure A.38 — Upper arm, exploded

A.4.1.4 Parts list for elbow

Note that Table A.9 lists the parts required for assembling the WorldSID elbow, which is illustrated in Figure A.39.

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Table A.9 — Parts list for elbow

Item number	Description	Quantity	Part number
1	BHCS M3 x 0,5 x 10	2	5000178
2	M3 flat washer	2	5000181
3	Elbow potentiometer assembly	1	W50-61027
4	Elbow clevis assembly	1	W50-61029
5	SSHDP M6 x 1,0 x 6 mm	1	5000165
6	Friction washer assembly	1	W50-52064
7	Compression washer	1	W50-61016
8	Clamping washer	1	W50-61014
9	BHCS M10 x 1,5 x 20 mm	1	5000176
10	Elbow load cell	1	W50-71060
11	Elbow shaft assembly	1	W50-61028
Not shown	Elbow load cell structural replacement	1	W50-61065

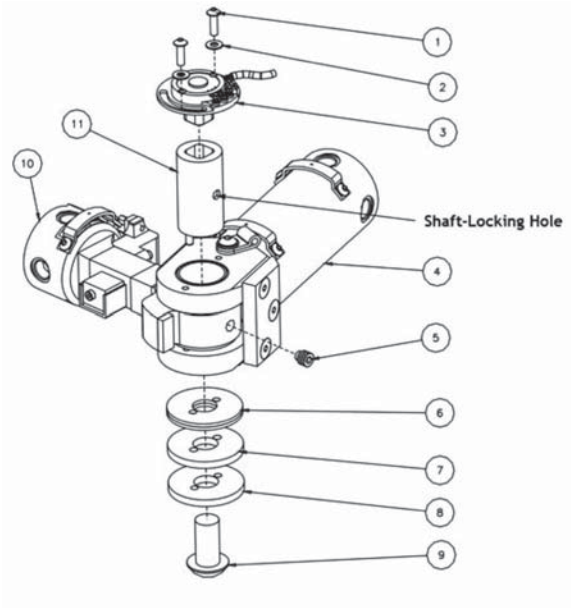

Figure A.39 — Elbow section

A.4.1.5 Parts list for lower arm

Note that Table A.10 lists the parts required for assembling the WorldSID lower arm, which is illustrated in Figure A.40.

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Table A.10 — Parts for lower arm

Item number	Description	Quantity	Part number
1	Elbow clevis assembly	1	W50-61029
2	Modified BHCS	8	W50-61042
3	Arm load cell (optional)	1	W50-71070
Not shown	Arm load cell structural replacement	1	W50-61041
4	BHCS M6 x 1,0 x 16 mm	1	5000072
5, 11	Spring washer	2	W50-61022
6	Wrist washer	1	W50-61019
7	Lower arm tube assembly	1	W50-61035
8	SHCS M3 x 0,5 x 12 mm	1	5000070
9	Wrist pivot assembly	1	W50-61020
10	Wrist clevis assembly	1	W50-61033
12	SHSS M6 x 25 mm	2	5000163
13	Wrist pivot bumper	2	W50-61046
14	SSNT M6 x 1,0 x 6 mm	1	5000622
15	SHCS M2 x 0,4 x 18 mm	1	5000164
16	Accelerometer mass replacement	1	W50-61063
17	Accelerometer mount bracket	1	W50-61039
18	SHCS M2,5 x 0,45 x 8 mm	4	5000458
Not shown	Triaxial linear accelerometer	1	ISO 15830-3:2013, 4.1.3.2

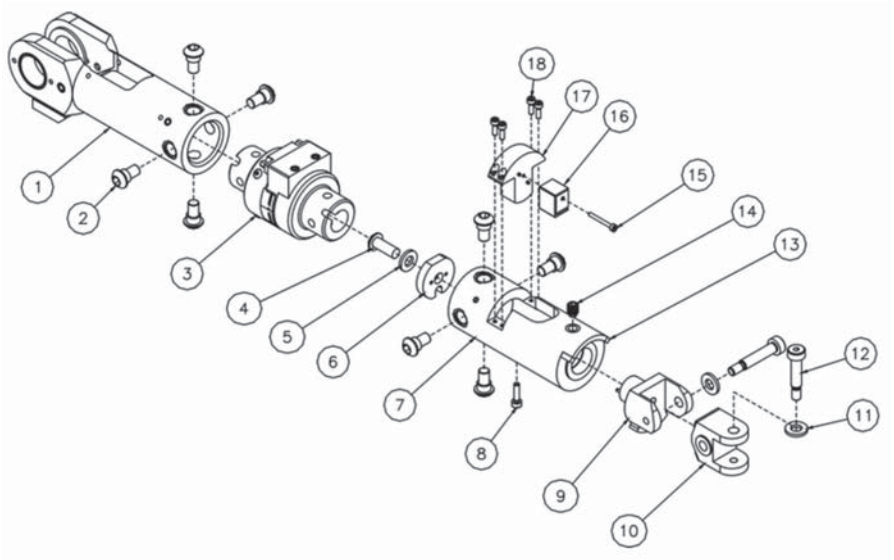

Figure A.40 — Lower arm, exploded

A.4.1.6 Parts list for wrist

Note that Table A.11 lists the parts required for assembling the WorldSID wrist, which is illustrated in Figure A.41.

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Table A.11 — Parts list for wrist

Item number	Description	Quantity	Part number
1	Wrist clevis	1	W50-61033
2	Wrist pivot assembly	1	W50-61020
3	Lower arm tube assembly	1	W50-61036
4	SSNT M6 x 1,0 x 6 mm	1	5000621
5	SHCS M2 x 0,4 x 18 mm	1	5000164
6	Wrist accelerometer mount	1	W50-61039
7	SHCS M2,5 x 0,45 x 8 mm	4	5000458
8	Wrist washer	1	W50-61019
9	Spring washer	2	W50-61022
10	BHCS M6 x 1 x 16 mm	1	5000072
11	SHCS M3 x 0,5 x 12 mm	1	5000173
12	SHSS M6 x 25 mm	1	5000163

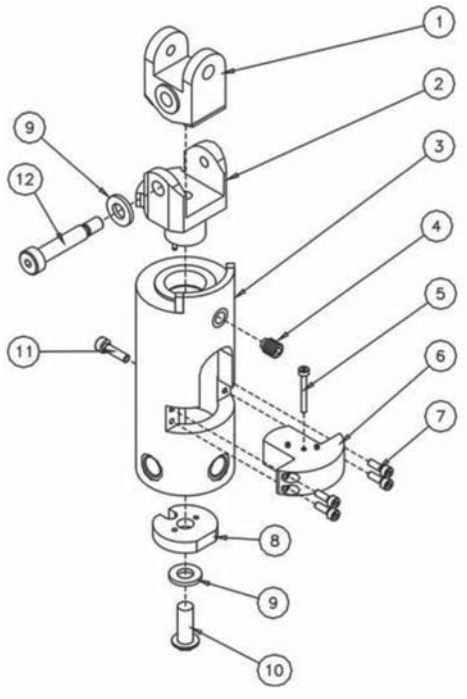

Figure A.41 — Wrist

A.4.2 Disassembling

A.4.2.1 Disassembling the full arm

To remove the arm assembly from the shoulder assembly, loosen the two-friction adjustment set screws (SSFP M4 x 0,7 × 6 mm, Figure A.37, Item 5) in the shoulder bumper (Figure A.37, Item 4). Unthread the shoulder bumper from the shoulder clevis. Remove the SSNT M3 × 0,5 × 3 mm on the top of the "Z"-pivot assembly. Separate the arm assembly from the shoulder assembly.

Remove the hand assembly by taking out the SHSS M6 × 25 mm (Figure A.36, Item 12) at the hand-wrist pivot joint. Watch for the spring washer (Figure A.36, Item 11) to fall out of the assembly as the screw is

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removed. Note that this washer is made of soft plastic (urethane) and thus, the screw head may damage it. Inspect and replace as necessary. Inspect the hand bumpers, checking for cuts in the bumper material or signs that the bumper adhesive may be failing.

Remove the upper arm flesh by opening the Velcro® on the inboard side of the upper arm flesh and then pulling the arm flesh open and off of the arm.

Remove the lower arm flesh by opening the Velcro® holding the flaps at the elbow closed and moving them over the potentiometer assembly and friction adjustment screw. Hold the upper arm and pull the flesh towards the wrist to remove it from the lower arm.

Disassemble the lower arm from the upper by first disconnecting the connector from the lower arm load cell. Remove the cable guides (Figure A.36, Item 17) that are held in position using two BHCS M3 × 0,5 × 6 mm (Figure A.36, Item 18) for each clamp. Remove the potentiometer assembly from the elbow joint by taking out the BHCS M4 × 0,7 × 6 mm and M4 flat washer (Figure A.36, Items 6 and 7) holding the potentiometer wiring cable in position. Remove the two BHCS M3 × 0,5 × 10 mm and M3 flat washer (Figure A.36, Items 5 and 4) securing the potentiometer body in position and slide out the potentiometer from the body of the elbow shaft assembly (Figure A.36, Item 2).

Remove the BHCS M10 × 1,5 × 20 mm (Figure A.36, Item 13) from the elbow shaft assembly along with the three joint friction adjustment washers (Figure A.36, Item 14, 15, and 16). Remove the SSHDP M6 × 1,0 × 6 mm (Figure A.36, Item 23) securing the elbow shaft assembly in the elbow joint and slide the elbow shaft assembly out of the elbow and separate the upper and lower arm assemblies.

A.4.2.2 Disassembling the upper arm

Disconnect the cables to the arm and elbow load cells and remove the accelerometer.

To remove the elbow load cell (Figure A.38, Item 11), take out the four modified BHCS (Figure A.38, Item 3) that attach it to the upper arm extension tube (Figure A.38, Item 8). Note that the elbow load cell also contains the mounting position for the triaxial linear accelerometer. Note that the accelerometer is held in place using a SHCS M2 × 0,4 × 18 mm (Figure A.38, Item 9) on the rear side of the load cell.

Remove all the modified BHCS and separate the arm load cell (Figure A.38, Item 7) from the arm extension tube (Figure A.38, Item 8) and the upper arm tube assembly (Figure A.38, Item 2) from the arm load cell.

To remove the "Z" pivot (Figure A.38, Item 1), loosen the SSNT M6 × 0 × 6 mm friction adjustment screw (Figure A.37, Item 9) and take out the BHCS M6 × 1 × 16 mm (Figure A.38, Item 6) and the spring washer (Figure A.38, Item 5) and wrist washer (Figure A.38, Item 4). Pull the "Z" pivot out of the upper arm tube assembly.

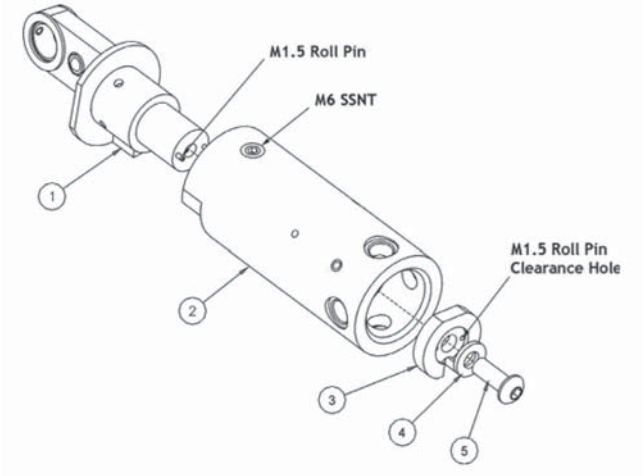

Figure A.42 — "Z" Pivot and upper arm tube

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While the components are disassembled, make a thorough inspection of bearing and mating surfaces. Ensure that wear or damage will not affect the performance of the arm assembly. Refer to Figure A.42. Inspect the M1,5 roll pins in the end of the "Z" pivot (Figure A.38, Item 1) to make sure they are not bent.

A.4.2.3 Disassembling the elbow

The elbow joint is disassembled by removing the BHCS M10 × 1,5 × 20 mm (Figure A.39, Item 9) at the elbow pivot. This BHCS M10 provides the tension necessary for the 1-to-2-G-setting in the elbow. When this screw is removed, the clamping, compression, and friction washers (Figure A.39, Items 8, 7, and 6 respectively) can be pulled from the assembly.

Loosen or remove the SSHDP M6 × 1 × 6 mm (Figure A.39, Item 5) from the elbow load cell and the elbow shaft assembly (Figure A.39, Item 11) can be pulled from the elbow joint. With the shaft assembly removed, the elbow load cell and clevis assembly can be pulled apart.

The elbow potentiometer (Figure A.39, Item 3) can be removed by taking out the two BHCS M3 × 0,5 × 10 mm (Figure A.39, Item 1) and the associated M3 flat washers (Figure A.39, Item 2).

A.4.2.4 Disassembling the lower arm

Before disassembling the lower arm assembly, remove the triaxial linear accelerometer located in the wrist assembly. Remove the accelerometer mounting bracket (Figure A.40, Item 17). Hold the bracket in place by four SHCS M2,5 × 0,45 × 8 mm (Figure A.40, Item 18) and one SHCS M3 × 0,5 × 12 mm (Figure A.40, Item 8). Hold the 7268C triaxial linear accelerometer in position using a SHCS M2 × 0,4 × 18 mm (Figure A.40, Item 15).

To begin disassembly, after disconnecting all cables, remove the modified BHCS (Figure A.40, Item 2) that secure the elbow clevis (Figure A.40, Item 1) and arm load cell (Item 3) and separate these two components. Remove the modified BHCS screws that attach the arm load cell and the wrist assembly, and pull the two sections apart.

A.4.2.5 Disassembling the wrist

The wrist assembly (W50-61035) is shown in Figure A.41.

To remove the wrist pivot and clevis assemblies, take out the BHCS M6 × 1 × 16 mm (Figure A.41, Item 10) that holds the wrist pivot assembly in the wrist assembly. Remove the wrist washer (Figure A.41, Item 8) and the spring washer (Figure A.41, Item 9). Note that these two washers are the same as the parts in the upper arm assembly (Figure A.38, Items 4 and 5). Loosen the SSNT M6 in the wrist assembly (Figure A.41, Item 4) and pull the wrist pivot assembly (Figure A.41, Item 2) from the wrist assembly.

Take out the SHSS M6 × 25 mm (Figure A.41, Item 12) and the spring washer (Figure A.41, Item 9). Separate the wrist pivot and wrist clevis assemblies (Figure A.41, Items 2 and 1 respectively).

Inspect the rubber bumpers (W50-61038) on the wrist clevis to ensure there is no damage to the material and that they are securely fixed in position. If the bumpers should come loose or fall off, re-glue with Loctite® 414[2)], "Super-Glue", or equivalent cyanoacrylate-based adhesive.

A.4.3 Assembling the arm

A.4.3.1 General

Note that, in general, the procedure for assembling the arm is substantially the opposite of the procedure for disassembling it, and that the following descriptions are provided to assist the user to more efficiently assemble the WorldSID arm.

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2) Loctite® and "Super Glue" are commercial products. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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A.4.3.2 Assembling the upper arm

To assemble the arm to the upper torso, install the arm on the shoulder load cell clevis. Push the arm onto the shoulder clevis (Figure A.37, Item 2) until it fully contacts the clevis face. Thread the shoulder bumper (Figure A.37, Item 4) onto the shoulder clevis. Thread the bumper as a coarse adjustment for the arm's 1-to-2-G-setting. Tighten the SSNT M3 × 0,5 × 3 mm (Figure A.37, Item 3) to fine adjust.

Note that inside the upper arm tube there are three components that are involved in the adjustment of "Z"-pivot joint: the wrist washer (Figure A.38, Item 4), spring washer (Figure A.38, Item 5), and a BHCS M6 × 1 × 16 mm (Figure A.38, Item 6).

Slide the "Z"-pivot assembly (Figure A.38, Item 1) into the upper arm tube (Figure A.38, Item 2). Install the wrist washer into the tube as shown in Figure A.42, orient the washer so that the through holes for the M1,5 pins are aligned with the pins on the "Z" pivot. Place the spring washer on the BHCS M6 (Figure A.38, Item 6) and thread the screw into the base of the "Z" pivot. Tighten the BHCS M6 and spring washer until they contact the wrist washer and then turn it 1/8 turn tighter. Do not over tighten this joint; the wrist pivot shall be able to rotate.

A.4.3.3 Assembling the elbow

To reassemble the elbow section, align the elbow load cell (Figure A.39, Item 10) and elbow clevis (Figure A.39, Item 4) so that the elbow shaft assembly (Figure A.39, Item 11) can be inserted into the elbow pivot hole. Line up the shaft-locking hole with the SSHDP M6 × 1 × 6 mm (Figure A.39, Item 5). Note that this screw locks the elbow shaft to the elbow load cell so that the potentiometer attached to the elbow clevis can measure the angular displacement of the elbow load cell about the lower arm assembly.

Install the friction washer assembly (Figure A.39, Item 6) on the elbow shaft. Press the washer over the pins onto the elbow shaft completely. Install the next two washers (Figure A.39, Items 7 and 8) on the elbow shaft and secure all three in place with a BHCS M10 × 1,5 × 20 mm (Figure A.39, Item 9). Use this screw to adjust the joint tension to 1-to-2-G-setting. Do this adjustment with the complete arm assembly.

Attach the elbow potentiometer assembly to the elbow clevis assembly using two BHCS M3 × 0,5 × 10 and two M3 flat washers (Figure A.39, Items 1 and 2 respectively). To adjust the potentiometer to "zero" position, align the elbow load cell body with the elbow clevis body, and then connect the potentiometer to the data acquisition system to be used for testing. Loosen the two BHCS M3 (Figure A.39, Item 1) securing it to the elbow clevis and rotate the potentiometer body until 0 V output is achieved. If there is not sufficient angular displacement available to achieve 0 V, remove the two BHCS M3 and their associated washers, then lift the potentiometer assembly out of the elbow shaft. Rotate the potentiometer insert (see Figure A.43) 90°, replace the unit on the elbow clevis, and check the output again. See Figure A.44 for wiring details.

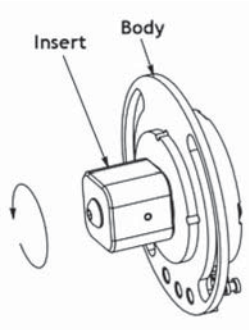

Figure A.43 — Elbow potentiometer

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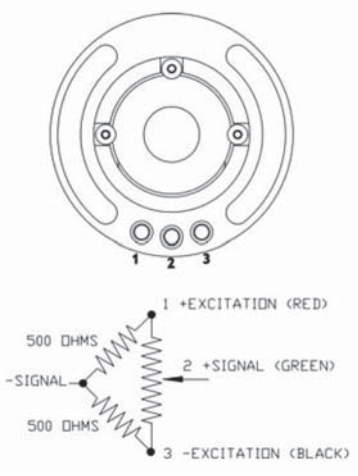

Figure A.44 — Elbow potentiometer wiring

A.4.3.4 Assembling the lower arm

Attach the arm load cell (Figure A.40, Item 3) (or structural replacement) to the elbow clevis assembly (Figure A.40, Item 1) using four modified BHCS M6, and torque to 10 Nm.

The wrist assembly is attached to the arm load cell using four modified BHCS M6 (Figure A.40, Item 2) torqued to 10 Nm.

A.4.3.5 Assembling the wrist

Inspect the hand bumpers (W50-61048). If they are loose or missing, reinstall using Loctite® 414, "Super-Glue", or equivalent cyanoacrylate-based adhesive.

Note that the wrist assembly (see Figure A.41) has the same type of joint as the upper arm "Z" pivot. Re-assemble the wrist assembly by installing the wrist pivot (Figure A.41, Item 2) into the lower arm tube (Figure A.41, Item 3) and then aligning the wrist washer (Figure A.41, Item 8) on to the M1,5 pins. After the wrist washer is installed, insert the spring washer (Figure A.41, Item 9) and an BHCS M6 × 1 × 16 (Figure A.41, Item 10) into the tube, and tighten the screw until the BHCS and spring washer contact the wrist washer. Then turn the screw 1/8 turn tighter. Use the SSNT M6 × 1 × 6 mm (Figure A.41, Item 4) to control rotational friction for the 1-to-2-G-setting.

Fit the wrist-mounted triaxial linear accelerometer on the accelerometer mount (Figure A.41, Item 6). The mount is secured in place with four SHCS M2,5 × 0,45 × 8 mm (Figure A.41, Item 7) and one SHCS M3 × 0,5 × 12 mm (Figure A.41, Item 11). Attach the accelerometer with an SHCS M2 × 0,4 × 18 mm (Figure A.41, Item 5).

Attach the wrist clevis assembly (Figure A.41, Item 1) to the wrist pivot with a spring washer (Figure A.41, Item 9) and an SHSS M6 × 25 mm (Figure A.41, Item 12). Tighten this screw to about 3 Nm to approximate a 1-to-2-G-setting, so that there is some stiffness to the joint without "locking" the joint.

A.4.4 Adjusting the arm

A.4.4.1 General

Note that the arm assembly friction is adjusted at several points along the arm to ensure the biomechanical performance of the assembly during testing, and that all joints are adjusted to a 1-to-2-G-setting.

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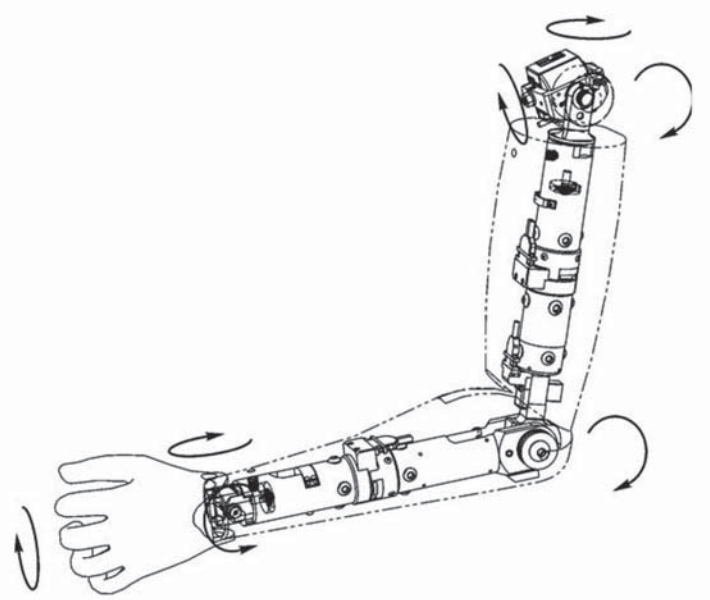

Figure A.45 — Arm joint rotation

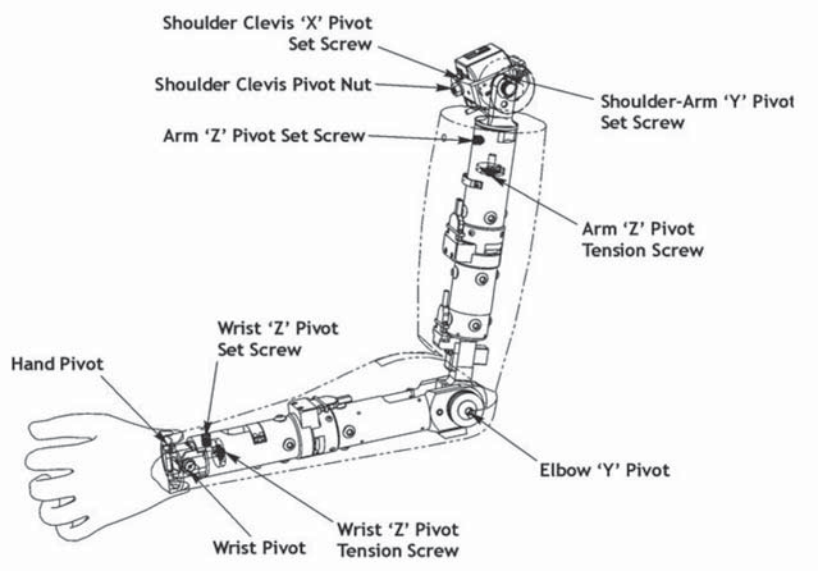

Figure A.46 — Arm joint tension points

Note that Figure A.45 shows the feasible rotations at each joint.

Perform the following procedures while the arm is attached to the dummy.

A.4.4.2 Adjusting the shoulder x-axis pivot

Note the following:

— The shoulder clevis pivots about the x-axis on the shoulder pivot shaft (Figure A.16, Item 2).

— The full arm assembly should be able to support itself in the horizontal position, parallel to the floor and perpendicular to the dummy's mid-plane.

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— When the hand is lightly tapped in the downward direction, the arm assembly should move to the rest position (against the upper torso).

Adjust the shoulder assembly movement by tightening the M6 hex locking nut (Figure A.16, Item 5) until the arm will almost stay fixed when raised to the side horizontally (parallel to floor, perpendicular to torso side). Make the final 1-to-2-G-setting by means of the two SSNT M4 × 0,7 × 4 mm (Figure A.16, Item 6).

A.4.4.3 Adjusting the arm z-axis pivot rotation

Ensure that the upper arm z-axis pivot is properly assembled prior to undertaking the adjustment procedure. Note that the spring washer (Figure A.38, Item 5) in the z-axis pivot joint can cause some variability from assembly to assembly.

Extend the complete arm laterally until it is parallel to the floor. Tighten the shoulder-arm joint until the arm is locked in this position. Bend the arm at the elbow so that the lower arm is perpendicular to the upper but still parallel to the floor. Note that if the z-axis pivot is properly adjusted to a 1-to-2-G-setting, the lower arm should remain parallel to the floor supporting its own weight but move easily when the lower arm is lightly tapped in the downward direction. If it does not, the "Z"-pivot shall be adjusted using the friction adjustment screw (Figure A.37, Item 9).

A.4.4.4 Adjusting the shoulder-arm y-axis pivot rotation

Fully extend the arm from the dummy's upper torso toward the front of the torso, so that the complete arm is straight and parallel to the floor. Note the following:

— The assembly should be approximately parallel to the dummy's midsagittal plane.

— If properly adjusted, the arm will maintain this position without support and will move freely if lightly tapped in the downward direction.

Tighten the bumper on the arm pivot shaft to ensure proper engagement of the spring plunger mechanism (see Figure A.37, Item 6). Loosen the two set screws that lock the bumper in position (see Figure A.37, Item 5). Loosen the arm pivot set screw located at the top of the arm "Z" pivot. Rotate the bumper in a clockwise direction until the arm is almost able to support its own mass without falling. Adjust the set screw M3, (Figure A.37, Item 3) until the arm will not drop when moved to the horizontal but will fall when the hand is lightly tapped in the downward direction.

A.4.4.5 Adjusting the elbow y-axis pivot rotation

Position the upper arm perpendicular to the floor and parallel to the upper torso. Position the lower arm assembly so that it is parallel to the floor and perpendicular to the upper arm. Tighten the elbow pivot screw (see Figure A.47) so that the lower arm remains parallel to the floor and will fall when the lower arm is lightly tapped in the downward direction.

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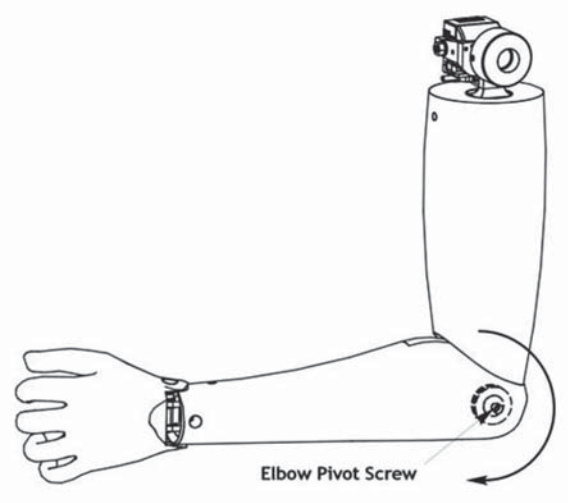

Figure A.47 — Elbow adjustment

If tightening the elbow pivot screw does not provide enough friction to maintain the 1 to 2 G adjustment, inspect the joint to ensure that it is properly assembled. Note that the locking screw (see Figure A.48) shall be installed so that it secures the elbow pivot shaft assembly to the elbow assembly and the locking hole in the elbow pivot shaft assembly shall be aligned with the locking screw.

Inspect the three washers used with the elbow pivot screw. Note that the washers shall be installed in the order shown in Figure A.48 and the friction washer shall have the friction material toward the elbow clevis assembly. Check the compression washer (polychloroprene material) for deformation or other damage and replace as necessary.

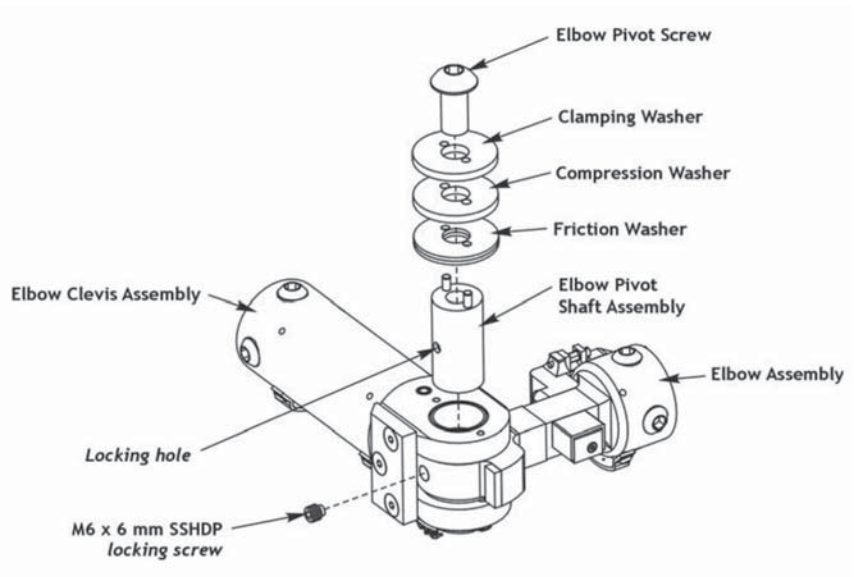

Figure A.48 — Elbow friction adjustment

A.4.4.6 Adjusting the wrist and hand pivot rotations

Note the following:

— The wrist adjustments are not easily done due to the lack of mass of the components.

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— This joint is adjusted to approximate a 1-to-2-G-setting.

Rotate the hand and tighten the modified SHSS M6 × 25 mm to about 3 Nm or until there is an appropriate friction in the wrist-hand joint.

A.4.5 Changing full arm from left to right side impact

To convert the instrumented arm from left side impact to right side impact, or vice versa, several parts have to be exchanged. Replace the "Z" pivot (Figure A.49, Item 1), hand (Figure A.49, Item 4), and upper arm flesh (not shown) with their corresponding components. For example, replace the left hand with the right hand and so on.

Move the cable clamp (Figure A.49, Item 2) on the elbow load cell, the potentiometer assembly (Figure A.49, Item 3), the BHCS M10 at the elbow joint (Figure A.49, Item 5) with its associated washers (Figure A.49, Items 6, 7, 8), and the lower arm assembly cable clamps (Figure A.49, Item 2). Attach the potentiometer on the inside surface of the arm, closest to the torso. Position Items 5, 6, 7, and 8 (Figure A.49) on the outboard side, away from the torso, in the order shown in Figure A.48.

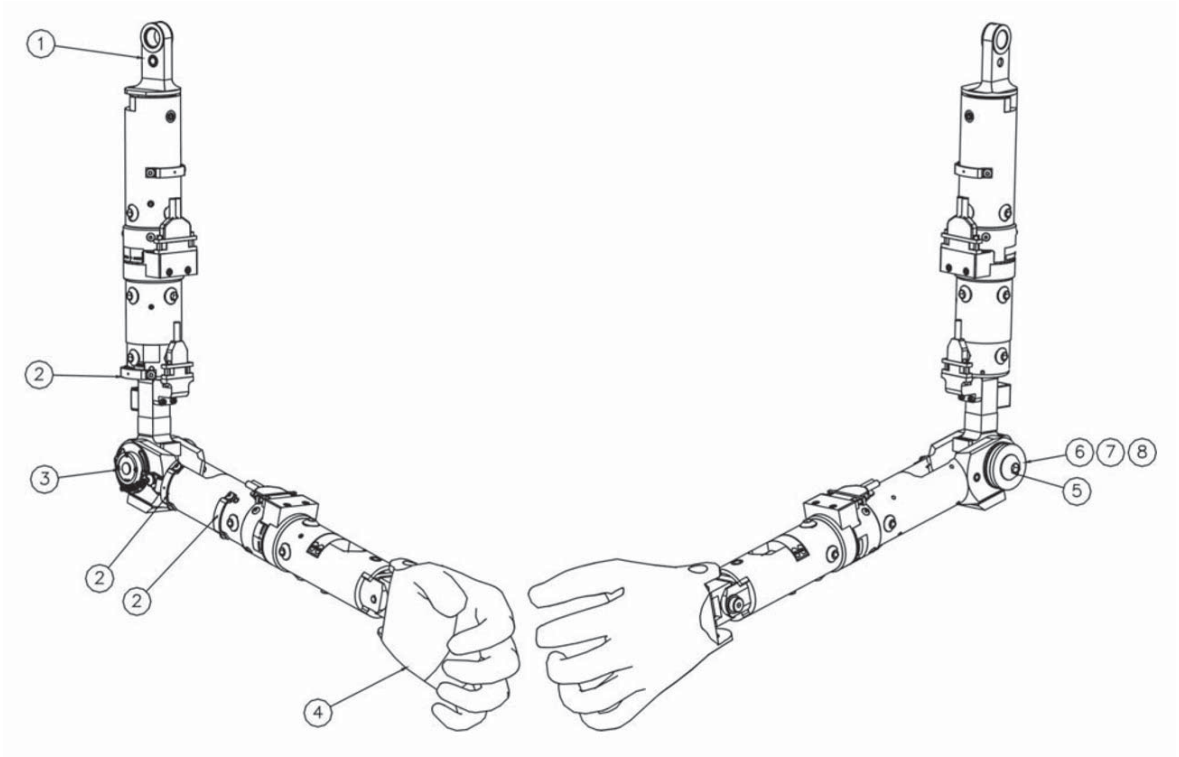

Figure A.49 — Change-over components

A.5 Half arm

A.5.1 Parts list for half arm

The half arm is moulded as one piece which consists of a plastic bone, vinyl skin, and urethane foam. The bone has a spring plunger for locating the arm position. The locknut is used to adjust the 1-to-2-G-settings. The part number for the half arm is shown in Table A.12.

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Table A.12 — Parts list for WorldSID

Item number	Description	Quantity	Part number
1	Half arm assembly	2	W50-62000

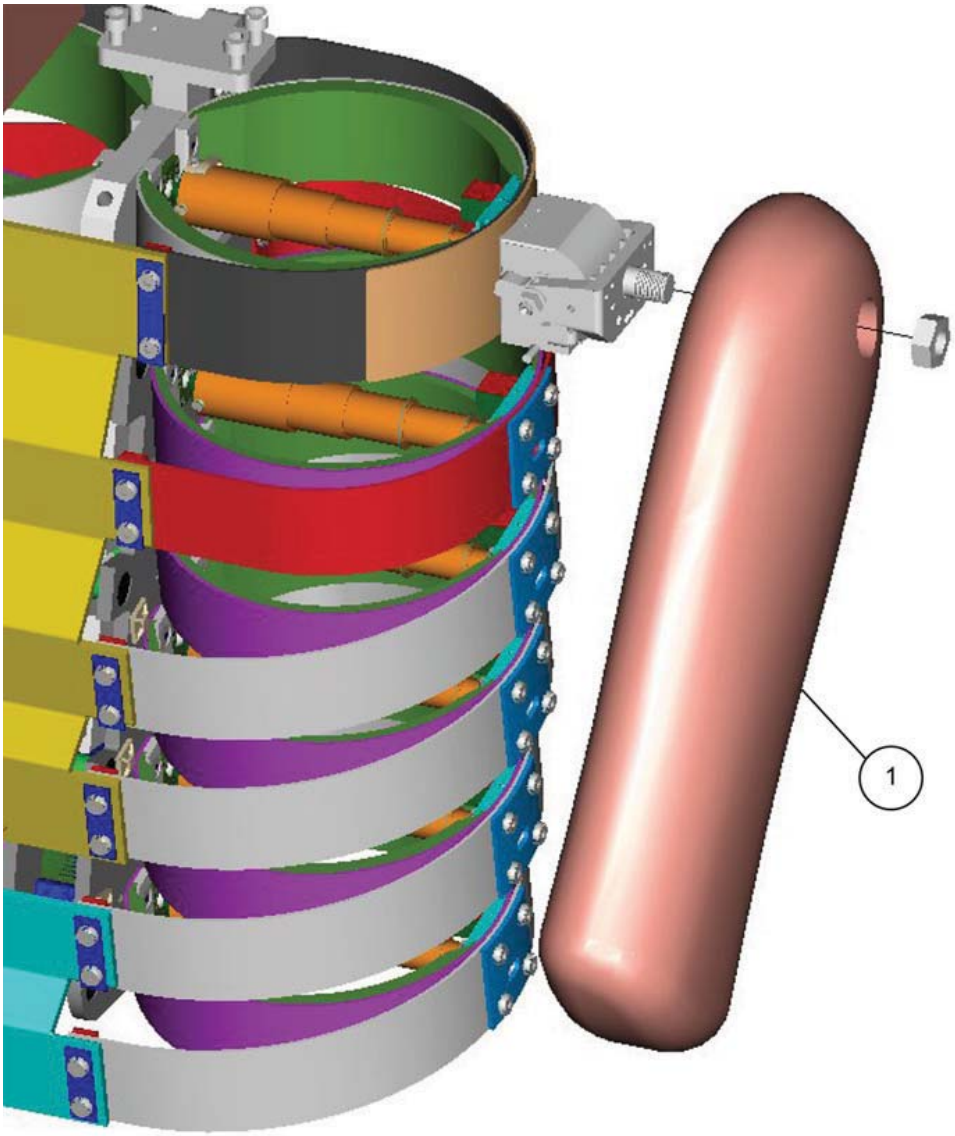

Figure A.50 — Arm assembly

A.5.2 Disassembling

Remove the half arm from the shoulder by removing the locknut with a socket wrench.

A.5.3 Assembling

Attach the half arm to the shoulder using the locknut and a socket wrench, adjusting the joint to a 1-to-2-G-setting.

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A.6 Pelvis

A.6.1 Parts list for pelvis

Note that Table A.13 lists the parts required for assembling the WorldSID pelvis. Note that part numbers refer to those on drawing W50-40000 and in Figure A.51, and that Figure A.52 through Figure A.56 illustrate different views of the pelvis components.

Table A.13 — Parts list for WorldSID pelvis

Item number	Description	Quantity	Part number
1	Sacroiliac l.c. structural replacement	1	W50-71975
2	Structural replacement, lumbar spine load cell	1	W50-71122
3	SI lc interface lh	1	W50-42016
4	SI lc nterface rh	1	W50-42017
5	Pelvis bone, lh	1	W50-42010
6	Pelvis bone, rh	1	W50-42011
7	SI lc backing plate	2	W50-42002
8	Pubic buffer, moulded	2	W50-42510
9	Structural replacement, pubic load cell	1	W50-71059
10	Instrumentation bracket pelvis	1	W50-42040
11	Connector housing replacement	1	W50-75002
12	Pelvis flesh	1	W50-42019
13	Weldment, lower lumbar mounting bracket, WorldSID	1	W50-41030
14	Screw, FHCS M6 X 1 X 16	4	5000090
15	Lumbar spine rubber, WorldSID	1	W50-41018
16	Bushing, lumbar	6	W50-41019
17	Lumbar lower clamping plate, WorldSID	2	W50-41021
18	Lumbar upper clamping plate, WorldSID	1	W50-41022
19	Lumbar mounting wedge, WorldSID	1	W50-41026
20	Screw, BHCS M5 X 0,8 X 25	4	5000466
21	Screw, SHCS M8 X 1,25 X 18	4	5000209
22	Accelerometer, linear triaxial	1	7268C-M1
23	Structural replacement, for MSC 260D/GP-M tilt sensor	1	W50-10011
24	Instrumentation cover plate, pelvis	1	W50-42031
25	Hip joint socket	2	W50-42005
26	Inner ring hip joint	2	W50-42007
27	Hip socket retainer	2	W50-42008
28	Femur bone assembly (ref)	2	FEMUR_BONE
29	Screw, FHCS M6 X 1 X 20	6	5000036
30	Screw, FHCS M6 X 1 X 30	8	5000265
31	Screw, FHCS M4 X 0,7 X 8	1	5000646
32	Screw, FHCS M4 X 0,7 X 10	3	5000023
33	Screw, cheese M3x 6	4	5000222
34	Washer, flat M8 (8,9 ID X 18,8 OD X 2,3 thick)	2	5000123

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Table A.13 *(continued)*

Item number	Description	Quantity	Part number
35	Screw, SHCS M4 X 0,7 X 8	8	5000024
36	Washer, flat M4 (4,3 ID X 9,0 OD X 0,7 thick)	6	5000155
37	Screw, BHCS M4 X 0,7 X 16	6	5000153
38	Screw, SHCS M6 X 1 X 10	16	5000457
39	Screw, SHCS M3 X 0,5 X 8	3	5000388
40	Screw, HH bolt M8 X 1,25 X 10	2	5000569
41	Screw, BHCS M6 X 1 X 20	6	5000438
42	Screw, cheese M2 X 16	1	5000254
43	Screw, MSSFP M4 X 6	6	5000464
44	Screw, SHCS M6 X 1 X 20	4	5000001
45	Bushing, lumbar spine, top	4	W50-41020
46	Cable tie mount, #4 screw, nylon	2	6002036
47	Screw, BHCS M3 X 0,5 X 6	2	5000399
48	Rotational accelerometer replacement	1	W50-10010
49	Screw, FHCS M3 X 0,5 X 6	2	5000098
50	Battery container, WorldSID	1	W50-43001
51	Screw, FHCS M3 X 0,5 X 10	4	5000203
52	Battery replacement	1	W5-3325
53	Thermal pad (not shown)	1	W5-3326
54	Battery cover, WorldSID	1	W50-43002
55	Screw, BHCS M4 X 0,7 X 8	3	5000103

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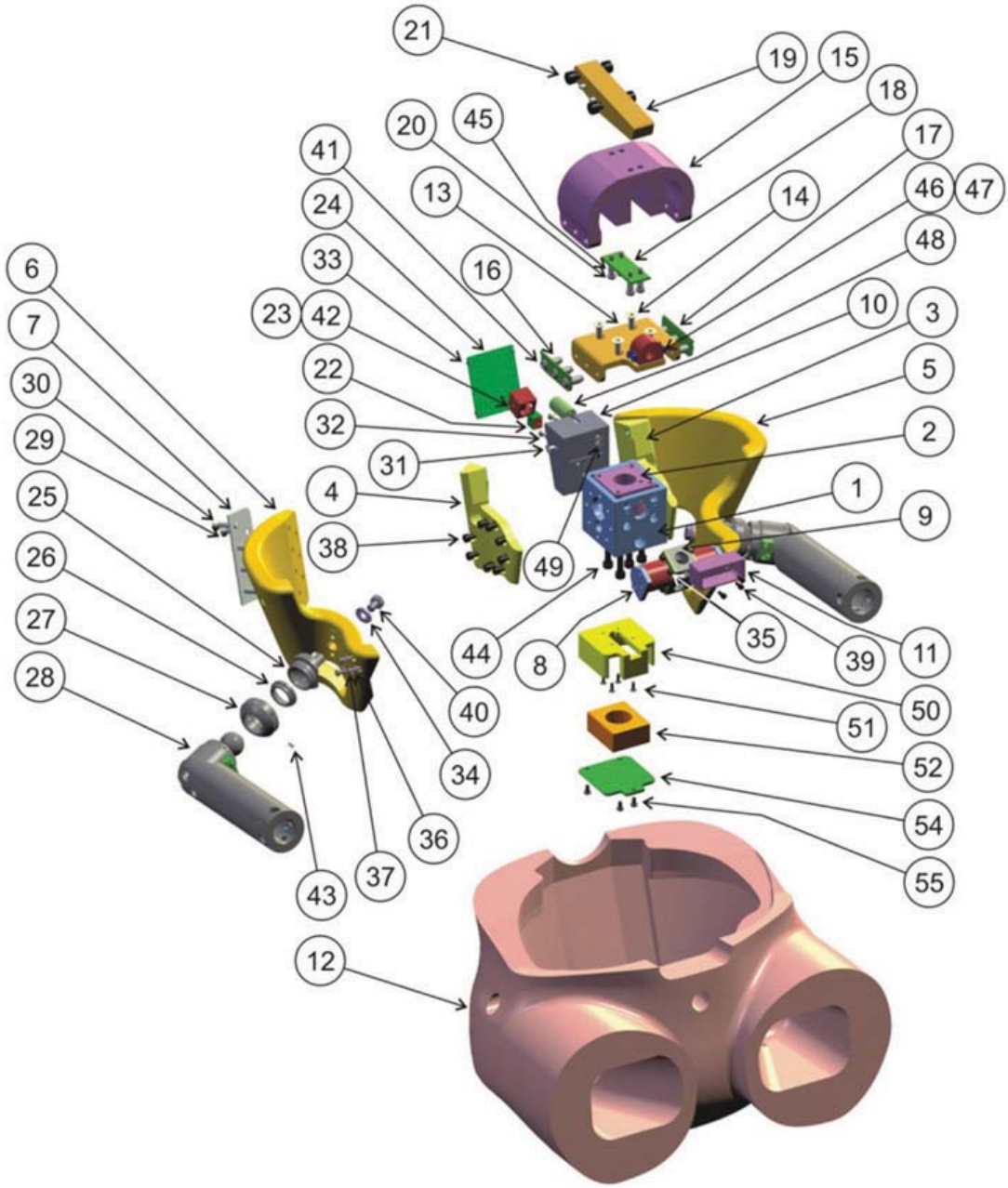

Figure A.51 — WorldSID pelvis components

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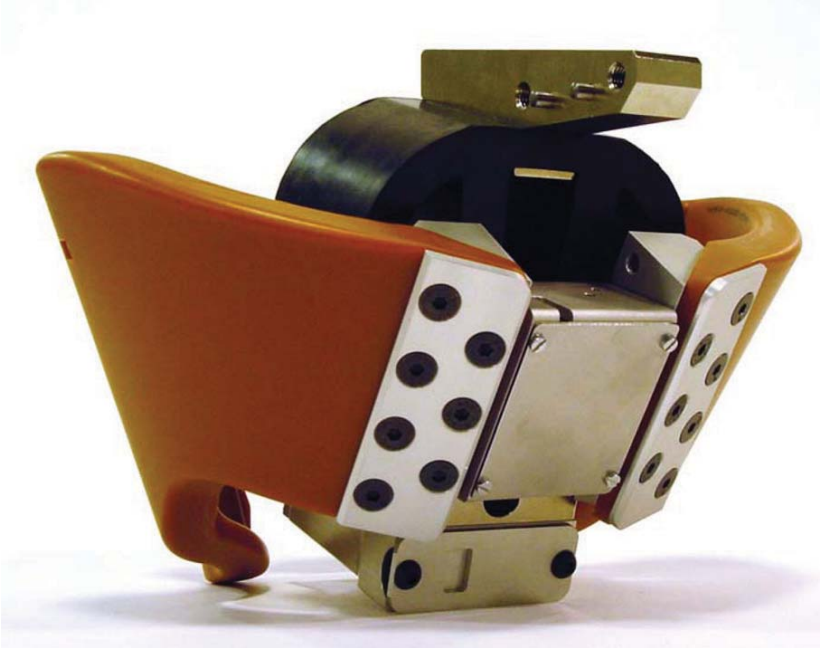

Figure A.52 — Rear view of pelvis assembly

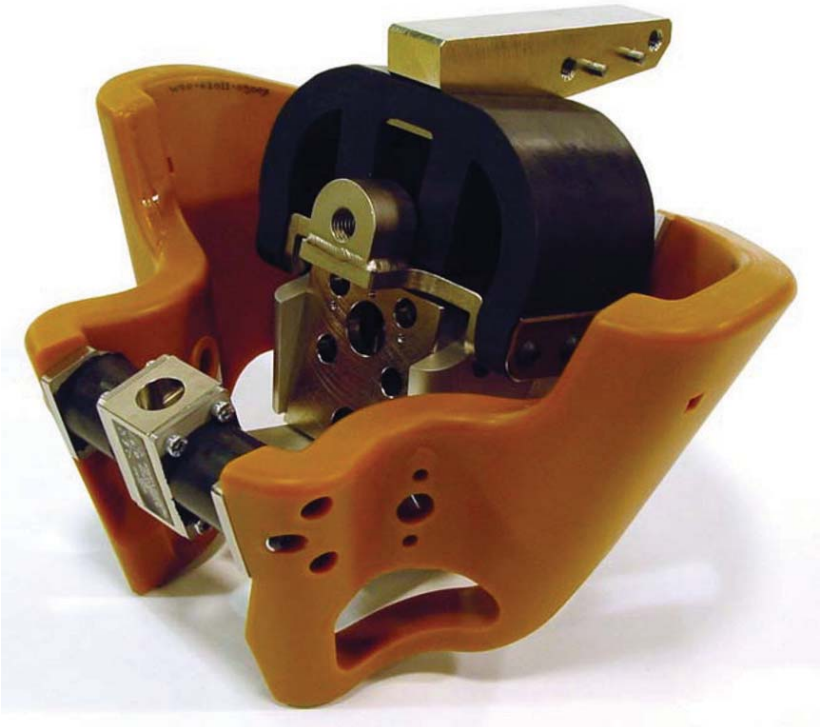

Figure A.53 — Front view of pelvis assembly

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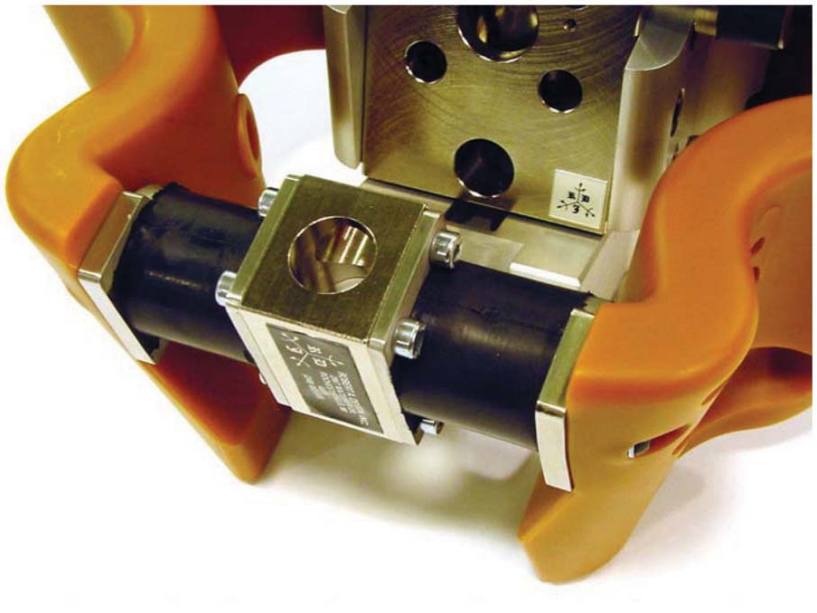

Figure A.54 — Close-up view of pubic assembly

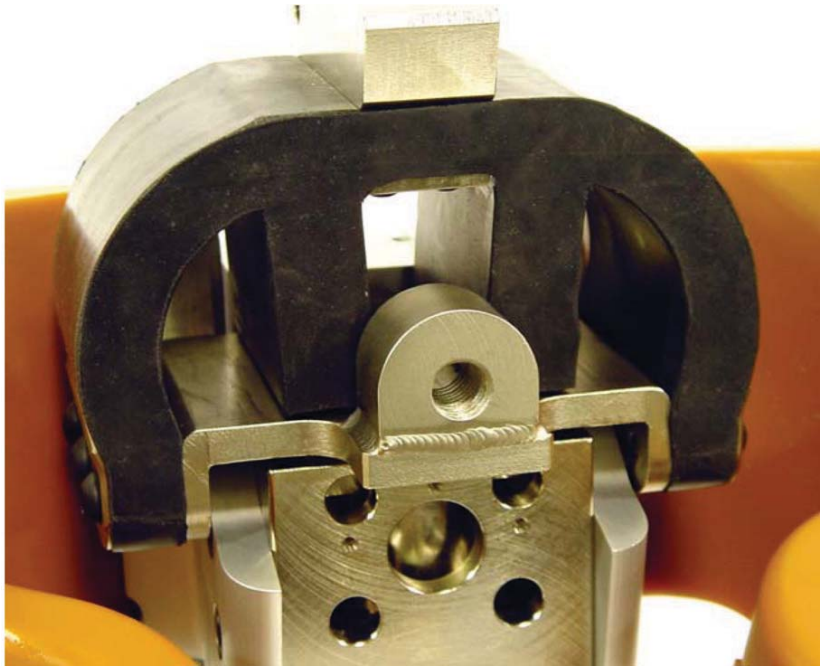

Figure A.55 — Close-up view of lumbar assembly

A.6.2 Disassembling

As shown in Figure A.56, remove the spine box from the pelvis assembly by removing four SHCS M8 × 18 (Figure A.56, Item 14) that connect it to the lumbar mounting wedge (Figure A.56, Item 28).

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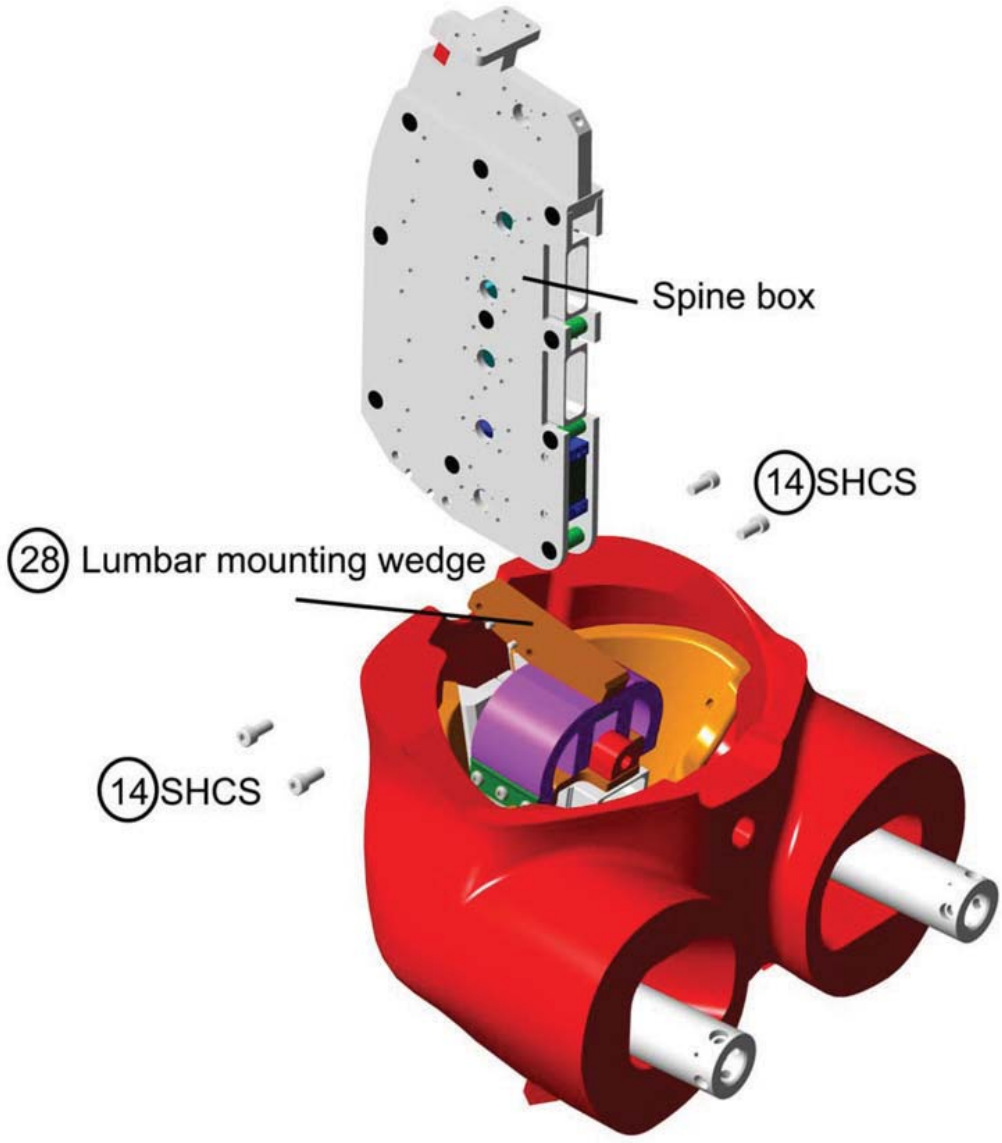

Figure A.56 — Removing spine box from the pelvis

Detach the femur assemblies by removing the hex head screws M8 × 10 (Figure A.57, Item 46) that attach each to the pelvis assembly (see Figure A.57). Note that they are accessible from the interior of the pelvis bone and can be removed with a box end wrench.

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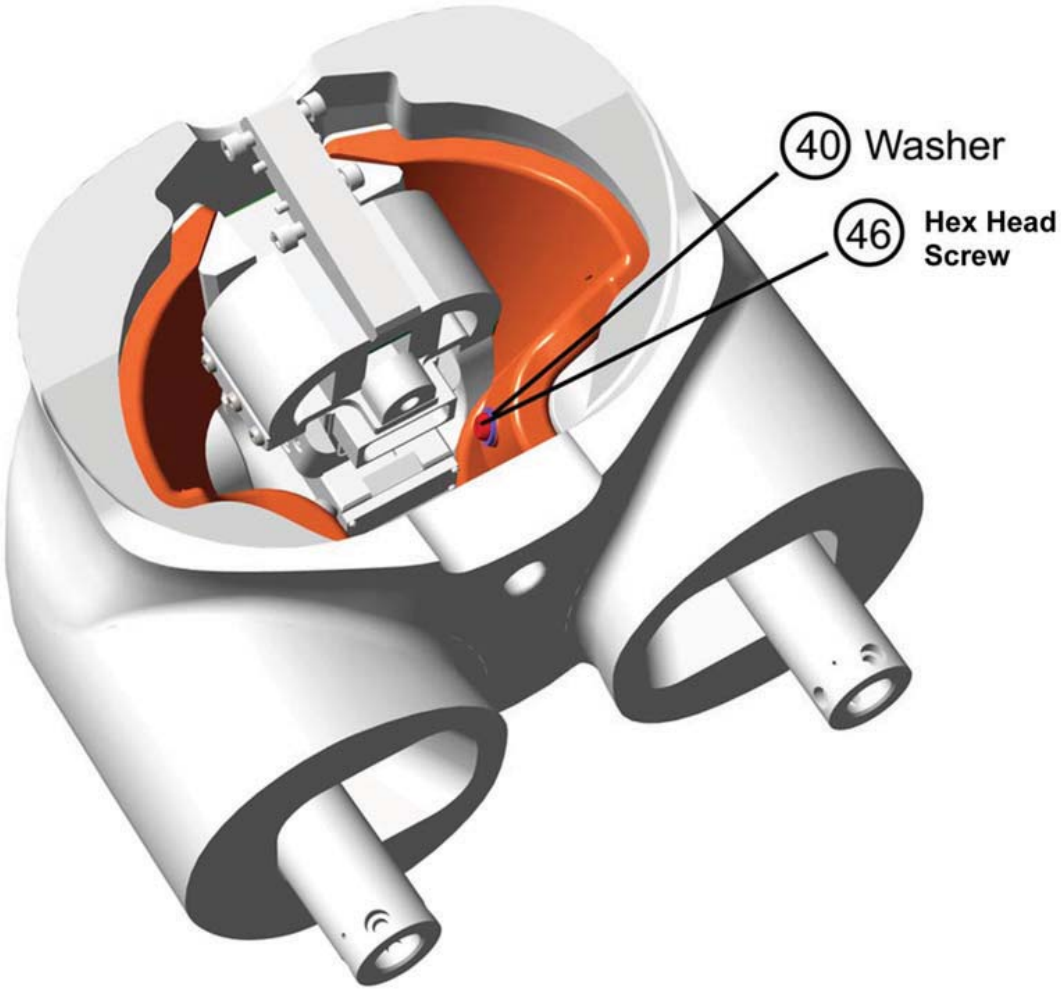

Figure A.57 — Detaching the femur assemblies

Remove the pelvis flesh (Figure A.51, Item 12) by peeling it away from the pelvis (see Figure A.58).

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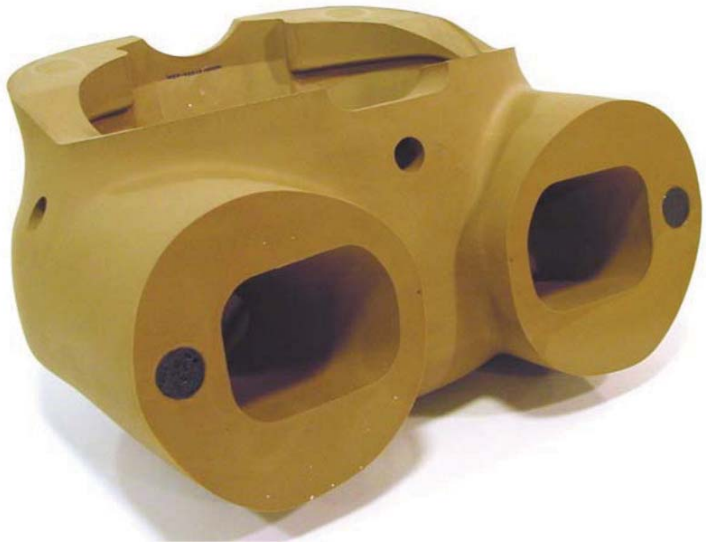

Figure A.58 — Pelvis flesh

As shown in Figure A.59, remove the sacroiliac load cell backing plates (Figure A.51, Item 7) by removing the four FHCS M6 × 30 (Figure A.51, Item 30) and three FHCS M6 × 20 (Figure A.51, Item 29) that secure them. Separate the two pelvis bones (Figure A.51, Items 5 and 6), connected by the pubic buffers (Figure A.51, Item 8) and pubic load cell (Figure A.51, Item 9) from the lumbar instrumentation assembly.

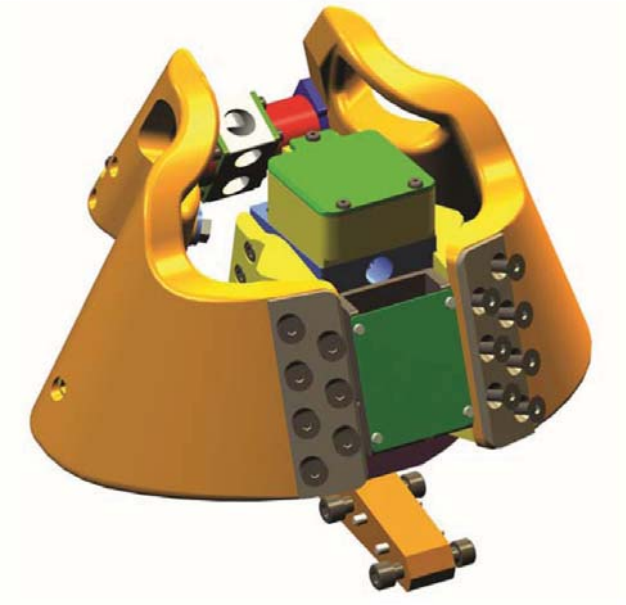

Figure A.59 — Removing sacroiliac backing plates to separate the pelvic bone-pubis assembly

Detach the moulded pubic buffers (Figure A.51, Item 8) from the moulded pelvis by removing the three M4 × 16 (Figure A.51, Item 37) and M4 flat washers (Figure A.51, Item 36) that hold each in place (see Figure A.60).

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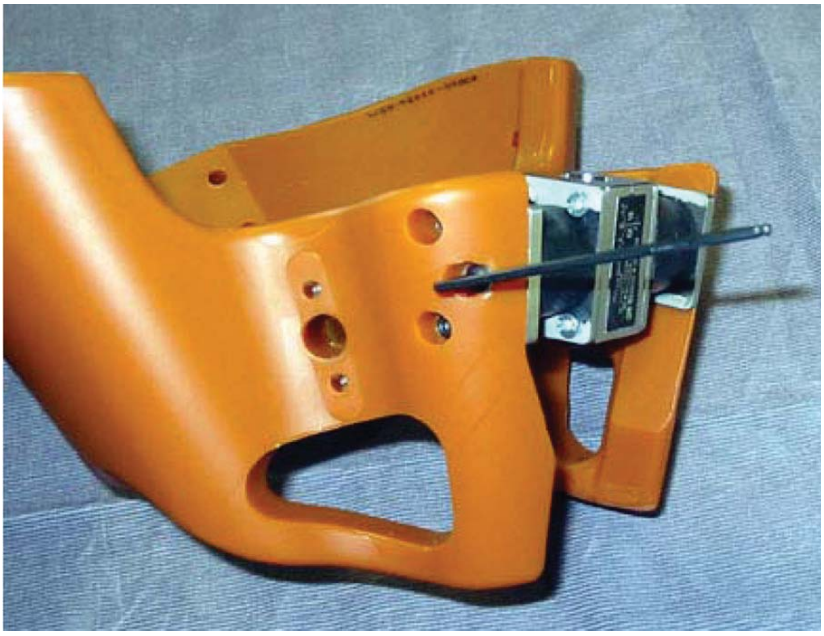

Figure A.60 — Separating moulded pelvis bone from pubis assembly

Detach the pubic buffers from the pubic load cell structural replacement (Figure A.51, Item 9) by removing four SHCS M4 × 8 (Figure A.51, Item 35) from each side (see Figure A.61.)

Figure A.61 — Separating pubic buffers from pubic load cell structural replacement

As shown in Figure A.62, detach the lumbar spine (Figure A.51,Item 15), remove the six BHCS M6 × 20 (Figure A.51, Item 41) and six lumbar bushings (Figure A.51, Item 16) that attach it to the lower lumbar mounting bracket weldment (Figure A.51, Item 13). Remove the two lower lumbar clamping plates (Figure A.51, Item 17).

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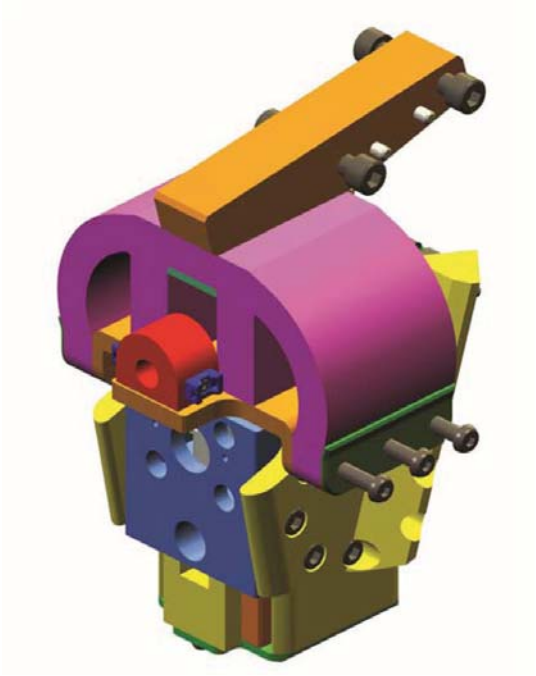

Figure A.62 — Detaching the lumbar spine

Remove the upper lumbar clamping plate (Figure A.51, Item 18) from the lumbar spine by removing the four BHCS M5 × 25 (Figure A.51, Item 20) that secure it (see Figure A.63). Remove the lumbar mounting wedge (Figure A.51, Item 19).

Figure A.63 — Separating the upper lumbar clamping plate and lumbar mounting wedge from the lumbar spine

As shown in Figure A.64, remove the lower lumbar mounting bracket weldment (Figure A.51, Item 13) from the lumbar load cell structural replacement (Figure A.51, Item 2) by removing four FHCS M6 × 16 (Figure A.51, Item 14).

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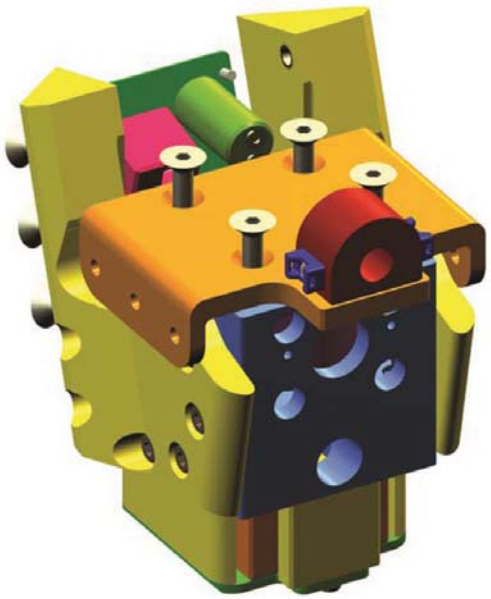

Figure A.64 — Removing the lower lumbar mounting bracket weldment

Detach the left and right sacroiliac load cell interfaces (Figure A.51, Items 3 and Item 4) by removing the eight SHCS M6 × 10 (Figure A.51, Item 38) that hold each in place (see Figure A.65).

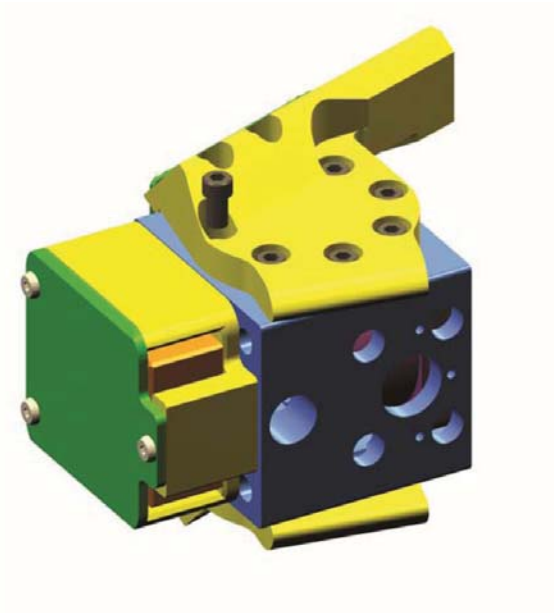

Figure A.65 — Removing the sacroiliac load cell interface

As shown in Figure A.66, remove the pelvis instrumentation cover plate (Figure A.51, Item 24) by removing four cheese screws M3 × 6 (Figure A.51, Item 33).

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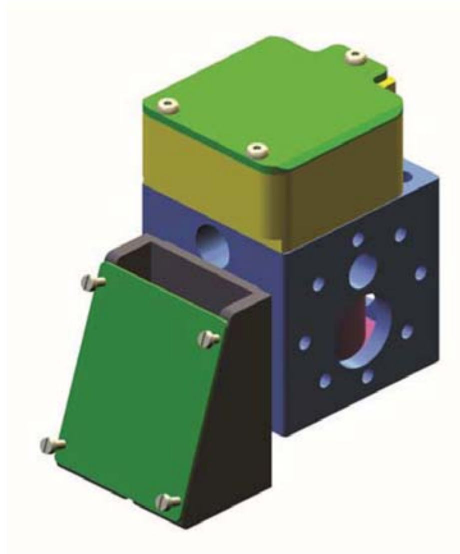

Figure A.66 — Removing pelvis instrumentation cover plate

Detach the pelvis instrumentation bracket (Figure A.51, Item 10) from the sacroiliac load cell structural replacement (Figure A.51, Item 1) by removing three FHCS M4 × 10 (Figure A.51, Item 32) accessed from the back (see Figure A.67).

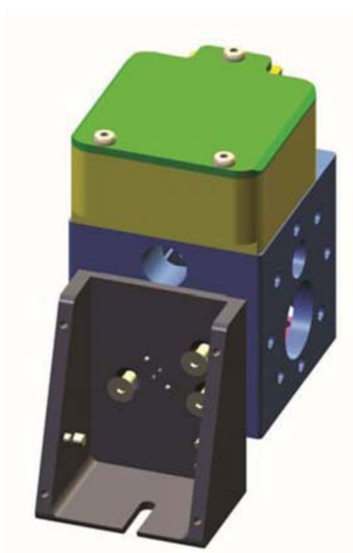

Figure A.67 — Removing the pelvis instrumentation bracket

Detach the battery cover by removing three BHCS and then remove the battery replacement. Next, remove the four FHCS and detach the battery container from the sacroiliac load cell replacement. See Figure A.68.

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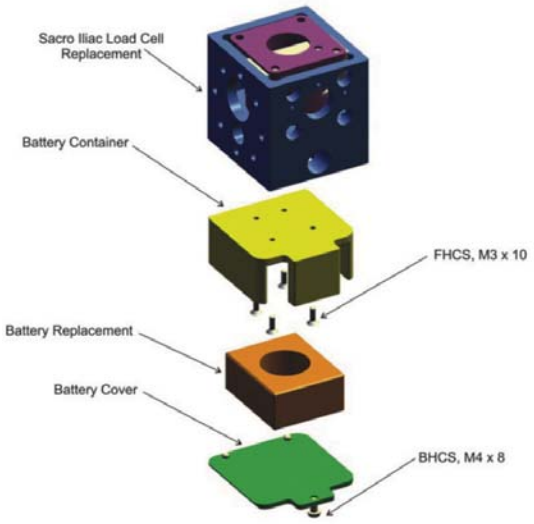

Figure A.68 — Detaching the battery

As shown in Figure A.69, separate the structural replacements for the sacroiliac and lumbar spine load cells by removing the four SHCS M6 × 20 (Figure A.51, Item 44) accessed from the bottom.

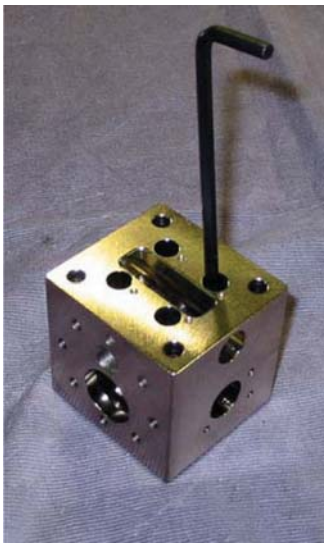

Figure A.69 — Separating the sacroiliac and lumbar spine load cell structural replacements

A.6.3 Assembling the pelvis

Note that in general, the procedure for assembling the pelvis is substantially the opposite of the procedure for disassembling it, and that the following descriptions are provided to assist the user to more efficiently assemble the WorldSID pelvis.

Join the lumbar spine load cell or its mass replacement (Figure A.51, Item 2) to the sacroiliac load cell or its mass replacement (Figure A.51, Item 1) using four SHCS M6 x 20 (Figure A.51, Item 44). The connectors are at the bottom of the load cells and face the front of the dummy. Attach the battery container to the sacroiliac load cell with four FHCS M3 x 10 (Figure A.51, Item 51). Next, place the battery into the container. Attach the cover (Figure A.51, Item 54) with three BHCS M4 x 8. Secure the connector housing

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or its replacement (Figure A.51, Item 11) to the front of the sacroiliac load cell with three SHCS M3 x 8 (Figure A.51, Item 39).

Mount the linear triaxial accelerometer (Figure A.51, Item 22) to the pelvis instrumentation bracket (Figure A.51, Item 10) using a cheese screw M2 x 16 (Figure A.51, Item 42) accessed from the back. Attach the dual-axis tilt sensor (Figure A.51, Item 23) with a SHCS M4 x 8 (Figure A.51, Item 31) accessed from the side. Secure the pelvis instrumentation bracket (Figure A.51, Item 10) to the sacroiliac load cell or its structural replacement (Figure A.51, Item 1) with three FHCS M4 x 10 (Figure A.51, Item 32). Mount the pelvis instrumentation cover plate (Figure A.51, Item 24) with four cheese screws M3 x 6 (Figure A.51, Item 33). The wires for the accelerometer and tilt sensor should exit the slot in the top of the instrumentation bracket. The accelerometer wire should be routed over the non-struck sacroiliac load cell interface towards the front of the dummy.

Attach the left and right sacroiliac load cell interfaces (Figure A.51, Item 3 and Item 4) with eight SHCS M6 x 10 (Figure A.51, Item 38) that hold each in place. Connect the lumbar mounting bracket weldment (Figure A.51, Item 13) to the lumbar load cell or its structural replacement (Figure A.51, Item 2) with four FHCS M6 x 16 (Figure A.51, Item 14). Place the lumbar mounting wedge (Figure A.51, Item 19) on top of the lumbar spine, lining up the threaded holes on the bottom with those in the lumbar spine. Place the upper lumbar clamping plate (Figure A.51, Item 18) over the holes in the lumbar spine and secure it with four BHCS M5 x 25 (Figure A.51, Item 20) and four bushings (Figure A.51, Item 45).

Place the assembled lumbar spine (Figure A.51, Item 15) over the lumbar mounting bracket. Position a lower lumbar clamping plate (Figure A.51, Item 17) over the holes in the side of the lumbar spine so the curve of the plate matches the curve in the rubber, with the radius edge facing down. Secure the lumbar spine and clamping plate to the mounting bracket with three BHCS M6 x 20 (Figure A.51, Item 41) and three lumbar bushings (Figure A.51, Item 16). Repeat the procedure for the other side of the lumbar spine.

Connect the pubic buffers to the pubic load cell or its structural replacement (Figure A.51, Item 9) with four SHCS M4 x 8 (Figure A.51, Item 35) on each side. Attach the moulded pubic buffers (Figure A.51, Item 8) to the moulded pelvis with three M4 x 16 (Figure A.51, Item 37) and M4 flat washers (Figure A.51, Item 36) on each side. Position the central assembled portion of the pelvis within the moulded pelvis/pubic assembly. Attach each sacroiliac load cell backing plate (Figure A.51, Item 7) with four FHCS M6 x 30 (Figure A.51, Item 30) and three FHCS M6 x 20 (Figure A.51, Item 29). The shorter screws are used on the inboard holes.

Plug in the connectors for the lumbar, pubic, and sacroiliac load cells and the pelvis triaxial accelerometer. Make sure the connectors for the tilt sensor are free so they can be connected to the off-board readout later. The wires should be routed toward the front along the non-struck side so they can be plugged into the non-struck side G5 module on the spine box. See Figure A.70.

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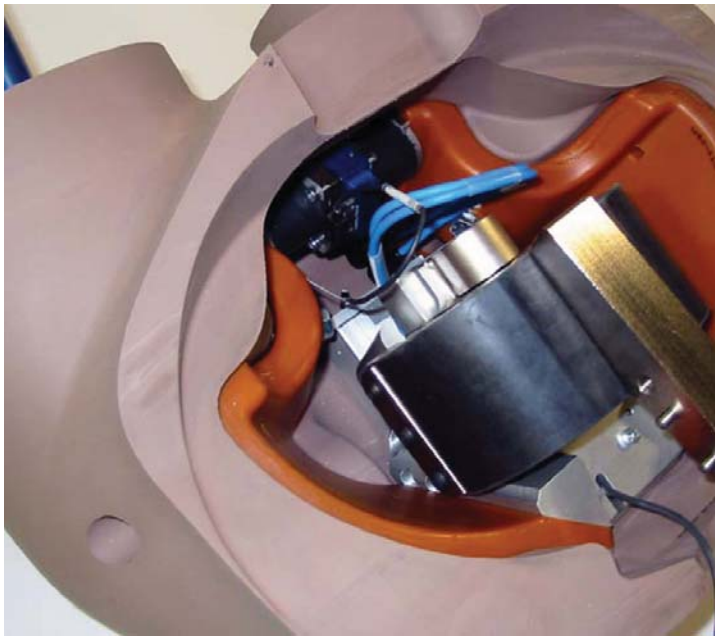

Figure A.70 — Routing of wires for pelvis instrumentation

Place the pelvis into the pelvis flesh, placing the pubic assembly in first, then adjusting the flesh over the pelvic bones. Make sure the flesh is correctly positioned over the pelvis by checking that access holes in the pelvis flesh line up with screws in the pelvis.

When assembling the hip joint as shown in Figure A.51, apply grease to the hip joint inner ring (Figure A.51, Item 26) and the hip joint socket (Figure A.51, Item 25) before tightening the hip socket retainer (Figure A.51, item 27). Insert the hip joint assembly through the front access hole in the pelvis flesh. Secure from the inside of the pelvis with a M8 × 10 bolt (Figure A.51, Item 40). Place the assembled spine box over the lumbar wedge (Figure A.51, Item 19) and secure with four SHCS M8 × 18 (Figure A.51, Item 21).

A.6.4 Instrumentation mounting

Note that the pelvis instrumentation for the WorldSID includes pubic, sacroiliac, and lumbar spine load cells. A battery and container can be mounted to the bottom of the pelvis assembly. Note that the pelvis instrumentation cavity can be equipped with a linear triaxial accelerometer and a dual-axis tilt sensor.

A.7 Full leg assembly

A.7.1 Parts list

A.7.1.1 General

Note that the full leg assembly includes the femoral neck assembly, the upper leg assembly, the knee assembly, the lower leg assembly, and the ankle-foot assembly.

A.7.1.2 Parts for femoral neck assembly

Note that Table A.14 lists the parts required for assembling the WorldSID femoral neck assembly, which is illustrated in Figure A.71.

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Table A.14 — Parts list for femoral neck (W50-51034)

Item number	Description	Quantity	Part number
1	SSCP M4 x 0,7 x 6 mm	1	5000076
2	Femoral neck ball	1	W50-51038
3	LHSHCS M6 x 1,0 x 12 mm	4	5000072
4	Femoral neck base	1	W50-51035

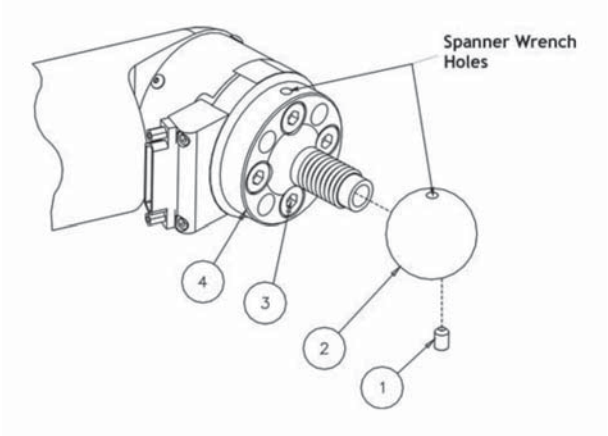

Figure A.71 — Femoral neck

A.7.1.3 Parts list for upper leg assembly

Note that Table A.15 lists the parts required for assembling the WorldSID upper leg, which is illustrated in Figure A.72.

Table A.15 — Parts for upper leg

Item number	Description	Quantity	Part number
1	LHSHCS M6 x 1,0 x 12 mm	4	5000194
2	Femoral neck assembly	1	W50-51034
3	Femoral neck load cell (optional)	1	W50-71080
Not shown	Femoral neck load cell structural replacement	1	W50-71965
4	DAS mass replacement assembly	1	W50-51053
5	Modified BHCS	12	W50-61042
6	Knee assembly, right	1	W50-52001
Not shown	Knee assembly, left	1	W50-52019
7	Leg tube assembly	1	W50-51068
8	Leg load cell (optional)	1	W50-71010
Not shown	Leg load cell structural replacement	1	W50-51060
9	Trochanter assembly, right	1	W50-51022
Not shown	Trochanter assembly, left	1	W50-51023
10	BHCS M6 x 1,0 x 16 mm	4	5000072

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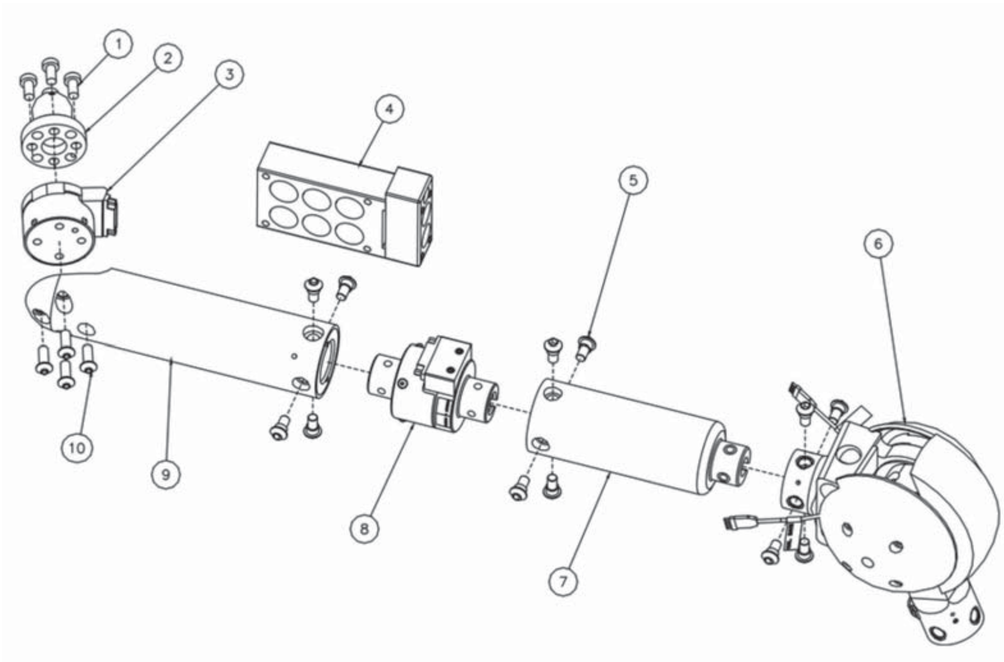

Figure A.72 — Upper leg assembly

A.7.1.4 Parts list for knee assembly

Note that Table A.16 lists the parts required for assembling the WorldSID knee, which is illustrated in Figure A.73.

Table A.16 — Parts list for knee

Item number	Description	Quantity	Part number
1	SHCS M4 x 0,7 x 10 mm	16	5000151
2	Knee cover	2	W50-52004
3	Knee contact load cell structural replacement	2	W50-52015
Not shown	Knee contact load cell (optional)	2	W50-71020
4	Rotary potentiometer (optional)	1	W50-61027
5	BHCS M3 x 0,5 x 6 mm	2	5000171
6	BHCS M3 x 0,5 x 6 mm	2	5000171
7	Cable guide	1	W50-61030
8	Knee pivot shaft assembly	1	W50-52008
9	Knee clevis assembly, right	1	W50-52009
Not shown	Knee clevis assembly, left	1	W50-52021
10	Friction washer	1	W50-52064
11	Compression washer (rubber)	1	W50-61016
12	Clamping washer (steel)	1	W50-61014
13	BHCS M10 x 1,5 x 20 mm	1	5000176
14	Knee pad mould assembly	1	W50-52010
15	BHCS M4 x 0,7 x 12 mm	6	5000005

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Table A.16 *(continued)*

Item number	Description	Quantity	Part number
16	Knee bone assembly	1	W50-52002
17	SSHDP M6 x 1,0 x 12 mm	1	5000185
Not shown	Rotary potentiometer mass replacement	1	W50-61123

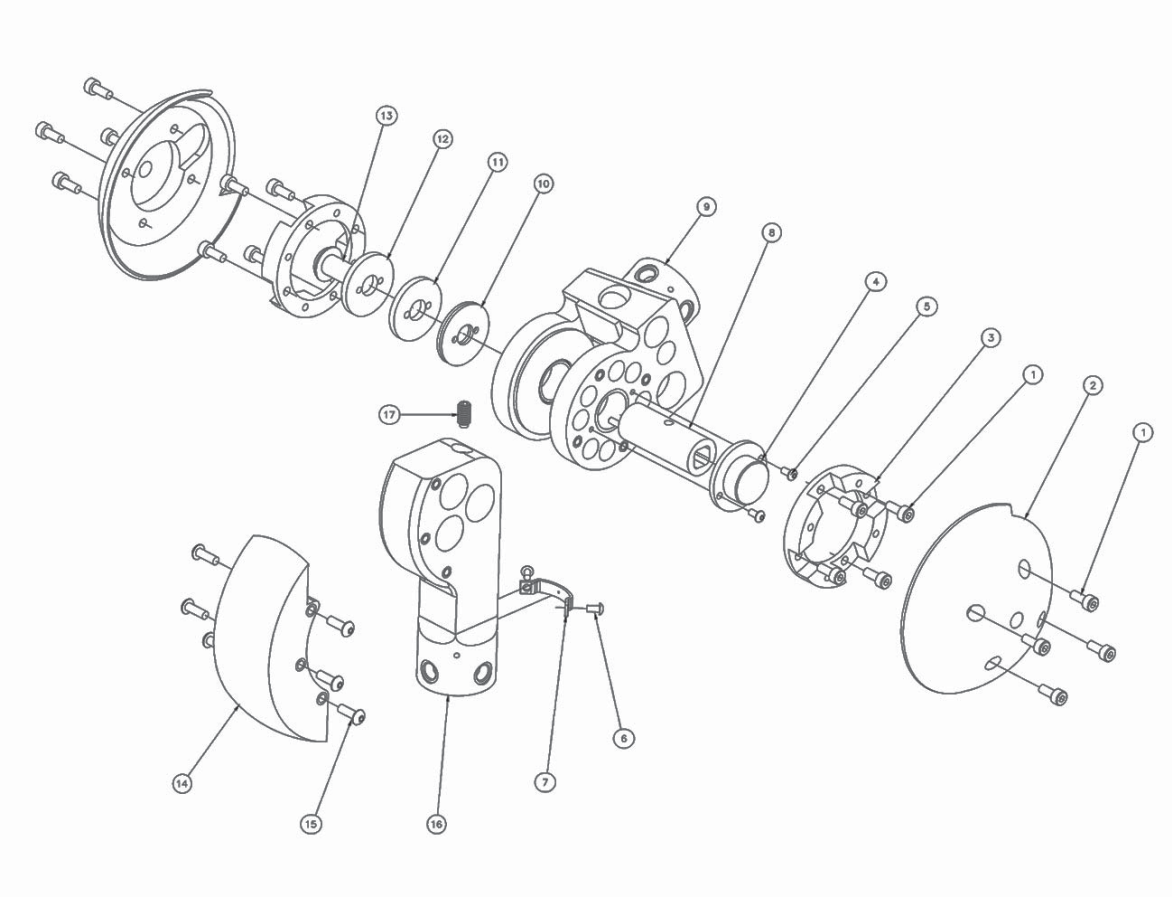

Figure A.73 — Knee

A.7.1.5 Parts list for lower leg tube assembly

Note that Table A.17 lists the parts required for assembling the WorldSID lower leg tube, which is illustrated in Figure A.74.

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Table A.17 — Parts list for lower leg tube

Item number	Description	Quantity	Part number
1	Leg load cell (optional)	2	W50-71010
Not shown	Leg load cell structural replacement	2	W50-51060
2	Modified button head cap screw	8	W50-61042
3	Lower leg tube	1	W50-53001
4	SSCP M6 x 1,0 x 8 mm	3	5000622
5	Z-axis radial limit screw	1	W50-54041
6	"Z"-pivot pin	1	W50-54009
7	Z-axis anti-rattle washer	1	W50-54024
8	Z-axis rotational washer	1	W50-54010
9	Z-axis nut	1	W50-54023
10	BHCS M3 x 0,5 x 6 mm	4	5000171
11	Cable guide	2	W50-61030
12	Leg flesh orienting block	1	W50-54038
13	SHCS M6 x 1,0 x 12 mm	1	5000281

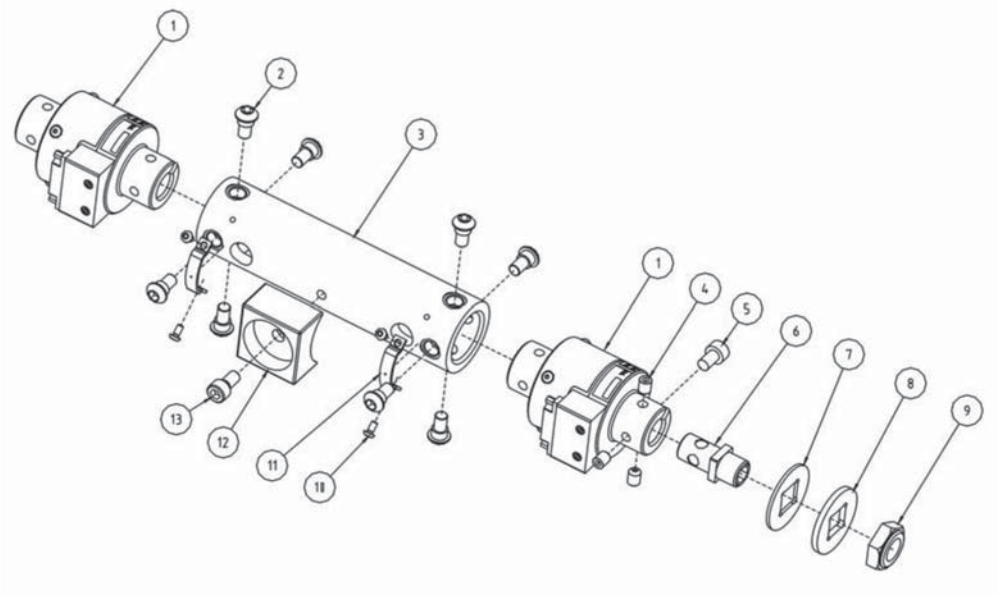

Figure A.74 — Lower leg tube assembly

A.7.1.6 Parts list for ankle-foot

Note that Table A.18 lists the parts required for assembly of the WorldSID ankle-foot, which is illustrated in Figure A.75.

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Table A.18 — Parts list for ankle-foot

Item	Description	Quantity	Part number
1	Leg load cell (optional)	1	W50-71010
Not shown	Leg load cell structural replacement	1	W50-51060
2	Ankle assembly	1	W50-54054
3	Moulded foot assembly, right	1	W50-55005
Not shown	Moulded foot assembly, left		W50-55004
4	SHCS M5 x 0,8 x 16	4	5000020

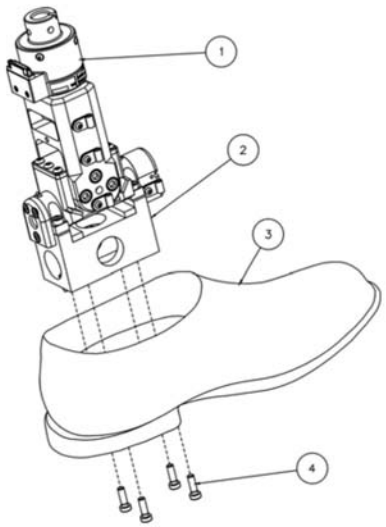

Figure A.75 — Foot and ankle

A.7.1.7 Parts list for ankle

Note that Table A.19 lists the parts required for assembly of the WorldSID ankle, which is illustrated in Figure A.76.

Table A.19 — Parts list for ankle

Item number	Description	Quantity	Part number
1	SSNT M6 x 1,0 x 6,0	1	5000621
2	Clevis assembly	1	W50-54047
3	SHCS M6 x 1,0 x 12 mm	6	5000281
4	Y-axis potentiometer assembly (optional)	1	W50-54052
5, 14, 25	SSNT M3 x 0,5 x 3	4	5000190
6	Left flexion centre assembly	1	W50-54048
7	SSCP M3 x 0,5 x 4 mm	1	5000470
8	SHCS M5 x 0,8 x 16 mm	4	5000020
9	Retainer bracket	2	W50-54014
10	BHCS M4 x 0,7 x 10 mm	6	5000010
11	Ankle joint cover	1	W50-54015

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Table A.19 *(continued)*

Item number	Description	Quantity	Part number
12	Ankle joint assembly	1	W50-54045
13	Front bearing assembly	1	W50-54042
15	SHCS M5 x 0,8 x 12 mm	6	5000002
16	X-axis potentiometer (optional)	1	W50-54012
17	Cable clamp, 1/8”	4	5000191
18	BHCS M3 x 0,5 x 6 mm	4	5000171
19	X-version assembly	1	W50-54044
20	Rear bearing assembly	1	W50-54043
21	X-version resistive element	8	W50-54035
22	Resistive element (Dorsi. & Plantar.)	8	W50-54036
23	Right flexion centre assembly	1	W50-54049
24	Z-axis potentiometer assembly (optional)	1	W50-54051
Not shown	Stop pad	4	W50-54022
Not shown	Compression pad	2	W50-54021
Not shown	Ankle potentiometer mass replacement	3	W50-54013

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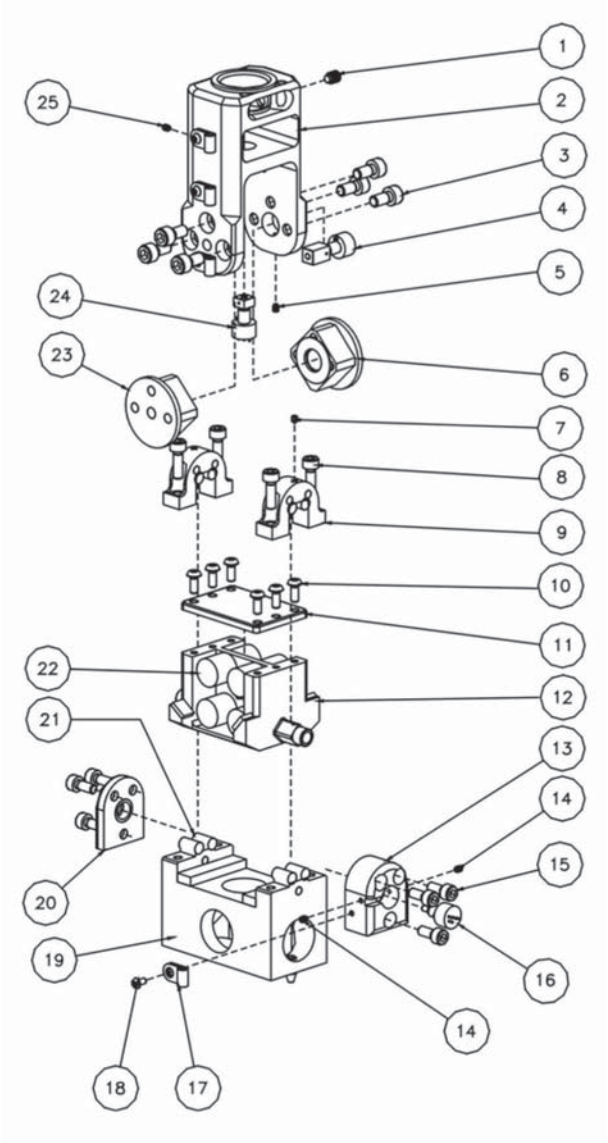

Figure A.76 — Ankle assembly

A.7.2 Disassembling

A.7.2.1 Femoral neck

Disassemble the femoral neck by loosening the SSCP M4 × 0,7 × 6 mm (Figure A.71, Item 1) that holds the femoral ball in place and unthread the ball (Figure A.71, Item 2) from the femoral neck base (Figure A.71, Item 4). Use a spanner wrench to turn the ball (modified 25 mm to 28 mm diameter; W50-51001) and a spanner wrench 40 mm to 42 mm (W50-51002) to hold the femoral neck base (Figure A.71, Item 4). Be careful not to damage the surface of the ball during disassembly and re-assembly.

Remove the four LHSHCS M6 × 1,0 × 12 mm (Figure A.71, Item 3) that attach the assembly to the femoral neck load cell (Figure A.72, Item 3). Note that these screws can be removed without removing the ball using a modified hex key wrench (W50-51003).

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A.7.2.2 Upper leg

Disconnect all the cable connectors and remove the cable guides.

Remove the femoral neck load cell (Figure A.72, Item 3) by taking out the four BHCS M6 × 1,0 × 16 (Figure A.72, Item 10) that attach it to the trochanter assembly (Figure A.72, Item 9).

Remove the 12 modified BHCS (Figure A.72, Item 5) that respectively attach the trochanter (Figure A.72, Item 9) to the leg load cell (Figure A.72, Item 8), the leg tube assembly (Figure A.74, Item 7) to the leg load cell, and the leg tube assembly (Figure A.72, Item 7) to the knee assembly (Figure A.72, Item 6). Separate these assemblies.

A.7.2.3 Knee

Detach the lower leg assembly by removing the four modified BHCS that attach the knee assembly to the leg load cell at the upper tibia position (Figure A.74, Item 1).

Remove the knee covers (Figure A.73, Item 2) by removing the four SHCS M4 × 0,7 × 10 mm (Figure A.73, Item 1) holding each cover in place. Remove the potentiometer assembly (Figure A.73, Item 4) by taking out the BHCS M3 × 0,5 × 6 mm (Figure A.73, Item 5) at each side of the potentiometer. Note that the knee contact load cell structural replacement (Figure A.73, Item 3) is positioned directly beneath the knee cover and is removed by taking out four SHCS M4 × 0,7 × 10 mm (Figure A.73, Item 1) for each load cell. Note that the screw used to secure the knee covers is the same size screw used to secure the knee contact load cell or its structural replacement.

Remove the knee bone (Figure A.73, Item 16) by taking out the SSHDP M6 × 1,0 × 12 mm (Figure A.73, Item 17). Remove the BHCS M10 × 1,5 × 20 mm (Figure A.73, Item 13) along with the associated washers (Figure A.73, Item 12, 11 and 10). Inspect these washers for damage and wear. Note that the middle washer (Figure A.73, Item 11) is the compression washer and is made from a soft polychloroprene rubber. Note that because it is a soft material, permanent compression and/or tearing could occur. Note that if the part is permanently compressed or damaged in any way, it should be replaced.

Remove the knee pivot shaft (Figure A.73, Item 8) by sliding it out of the assembly. Slide the knee bone out of the knee clevis assembly. Remove the knee pad (Figure A.73, Item 14) from the knee bone by taking out the six BHCS M4 × 0,7 × 12 mm (Figure A.73, Item 15) (three on each side) that hold it in position. Inspect the knee pad for tearing and/or cuts in the material.

A.7.2.4 Lower leg

Remove the BHCS M3 × 0,5 × 6mm (Figure A.74, Item 10). Remove the cable guides (Figure A.74, Item 11) and disconnect the cables from the load cells. Remove the upper tibia load cell by removing four modified BHCS (Figure A.74, Item 2) and separating the leg load cell (Figure A.74, Item 1) from the lower leg tube (Figure A.74, Item 3).

Remove the z-axis radial limit screw (Figure A.74, Item 5) to remove the lower tibia leg load cell (Figure A.74, Item 1). Loosen the SSNT M6 × 6 mm (Figure A.76, Item 1). Use this set screw to adjust the z-axis rotational friction for the lower tibia load cell. Disconnect the cables from both ends of the tibia. Using a modified 22 mm open-end wrench (W50-51004), hold the z-axis nut (Figure A.74, Item 9) in place while rotating the leg tube and load cell assembly until the lower tibia leg load cell can be pulled from the ankle assembly. Remove the anti-rattle and rotational washers (Figure A.74, Items 7 and 8) from the assembly.

Remove the four SHCS M5 × 0,8 × 16 mm that secure the foot to the ankle assembly (Figure A.75, Item 4) to remove the moulded foot.

A.7.2.5 Ankle

Remove the Y-Axis potentiometer (Figure A.76, Item 4), if equipped, by loosening the SSNT M3 × 0,5 × 3 mm (Figure A.76, Item 5) holding it in place. Pull the potentiometer from the assembly. Remove the six BHCS

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M4 × 0,7 × 10 mm (Figure A.76, Item 10) that attach the ankle joint cover (Figure A.76, Item 11) to the ankle joint assembly (Figure A.76, Item 12).

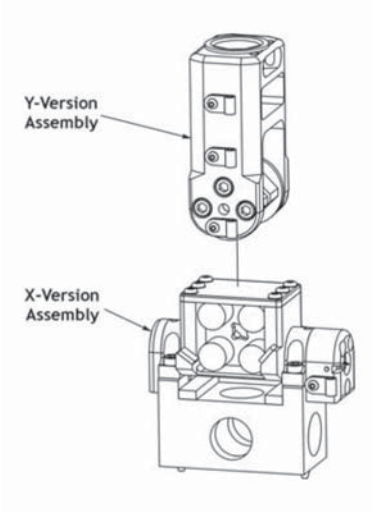

Figure A.77 — Ankle

Lift the Y-version assembly off the X-version assembly. Note that when the two assemblies separate, the resistive elements (Figure A.76, Item 22) will fall out of the assembly. With the two assemblies separated, take apart each assembly. Check the resistive elements for signs of permanent deformation, crushing, or cracks.

To remove the z-axis potentiometer assembly (Figure A.76, Item 24), first loosen the SSNT M3 x 0,5 x 3 mm (Figure A.76, Item 25) that holds it in position. If the potentiometer is connected to a cable, first release the cable from the cable clamps located along the side of the clevis assembly (Figure A.76, Item 2). Then move it downward out of the clevis assembly.

To disassemble the X-version assembly, start by taking out the four SHCS M5 × 0,8 × 16 mm (Figure A.76, Item 8) that secure the retainer brackets (Figure A.76, Item 9). With the retainer brackets removed, remove the ankle joint assembly (Figure A.76, Item 12) from the assembly.

Note that while removing the retainer brackets, the X-version resistive elements (Figure A.76, Item 21) could fall out. Check the resistive elements for crushing, deformation, or cracks.

Check the stop pads (Figure A.76, Item 26) and compression pads (Figure A.76, Item 27) for tears and deformation. Re-secure the pads using Loctite 414, “Super Glue”, or equivalent cyanoacrylate-based adhesive, if they come loose.

A.7.3 Assembling the leg

Note that, in general, the procedure for assembling the leg is substantially the opposite of the procedure for disassembling it, and that the following descriptions are provided to assist the user to more efficiently assemble the WorldSID leg.

A.7.3.1 Assembling the femoral neck

Thread the femoral neck ball on to the femoral neck base until tight (see Figure A.71). Tighten the ball on to the base using a modified 25 mm to 28 mm spanner wrench (W50-51001) to turn the ball and a spanner wrench 40 mm to 42 mm (W50-51002) to hold the femoral neck base (Figure A.71, Item 4). Be careful not to damage the surface of the ball during disassembly and re-assembly. Secure the ball by tightening the SSCP M4 (Figure A.71, Item 1) to 2 Nm torque.

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A.7.3.2 Assembling the upper leg

Attach the femoral neck load cell assembly (Figure A.72, Item 3) to the trochanter assembly (Figure A.72, Item 9). Ensure that the base of the load cell is aligned with the dowel pin in the trochanter before tightening the four BHCS M6 × 1 × 16 mm (Figure A.72, Item 5). Torque the BHCS M6 to 10 Nm.

Attach the trochanter assembly and the leg tube assembly (Figure A.72, Item 7) to the upper leg load cell (Item 8) using eight modified BHCS M6 (Figure A.72, Item 5), four at each side of the load cell. Torque the modified BHCS M6 to 10 Nm.

The knee assembly (Figure A.72, Item 6) is attached to the leg tube assembly using four modified BHCS M6. The left and right knee assemblies are different.

A.7.3.3 Assembling the knee

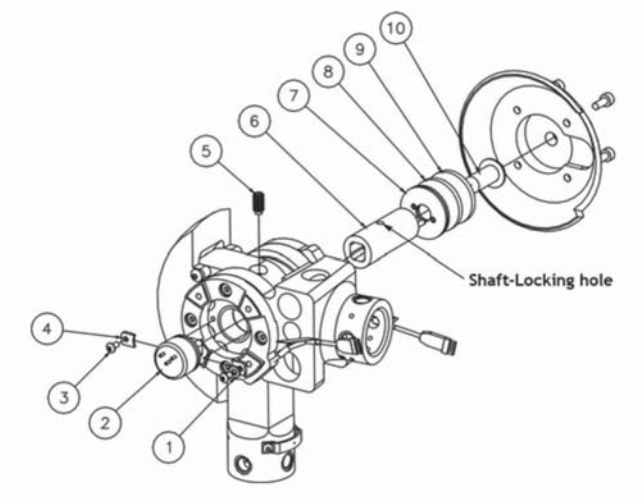

Figure A.78 — Knee assembly

To assemble the knee, start by placing the knee bone (Figure A.73, Item 16) in the knee clevis (Figure A.73, Item 9) and push the knee pivot shaft (Figure A.73, Item 8) into the pivot hole. Align the shaft-locking hole with the SSHDP M6 × 1 × 12 (Figure A.73, Item 17). Tighten the SSHDP M6 so that the knee pivot shaft is locked in place. Note that if the pivot shaft is not locked into the knee bone, the shaft will not rotate with the knee bone during testing. Once the pivot shaft is in place, install the friction, compression, and clamping washers (Figure A.78, Items 7, 8, and 9, respectively). Note that the friction washer (Figure A.78, Item 7) is made up of two disks; one disk is steel and the other is a commercial braking material. Push the friction washer on to the pivot shaft pins so that the braking material side of the washer is against the knee clevis. Install the compression and clamping washers and secure them with a BHCS M10 × 1,5 × 20 mm (Figure A.78, Item 10), which is the adjustment for the 1-to-2-G-setting adjustment of the knee section.

To install the knee potentiometer, place the potentiometer insert into the square hole end of the knee pivot shaft (see Figure A.80). Insert the two BHCS M3 × 0,5 × 6 mm (Figure A.78, Item 3) into the potentiometer clips and thread them into the knee clevis. Tighten these two BHCS M3 so that the potentiometer body is secure and will not rotate. See Figure A.79 for wiring details.

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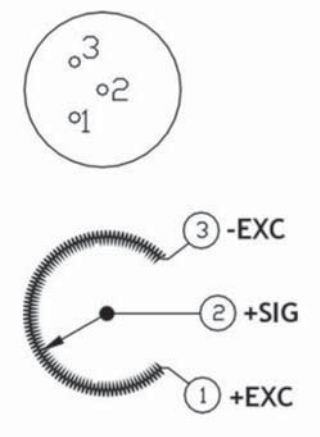

Figure A.79 — Knee potentiometer wiring

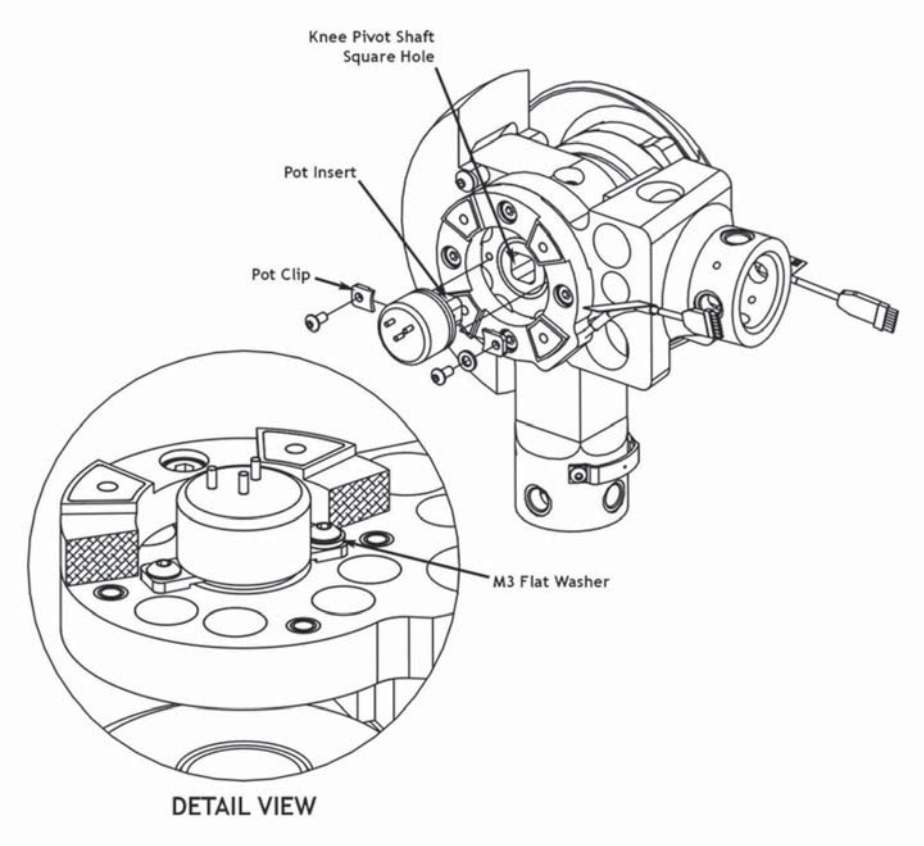

Figure A.80 — Knee potentiometer installation

Attach the knee contact load cell (Figure A.73, Item 3), using four SHCS M4 × 0,7 × 10 mm for each load cell (Figure A.73, Item 1). Install the load cell directly on to the knee clevis and install the M4 screws in the counter bored holes. Tighten these M4 screws to 5 Nm, using the M4 "star" pattern (see Figure A.81) so as to distribute the load equally across the load cell.

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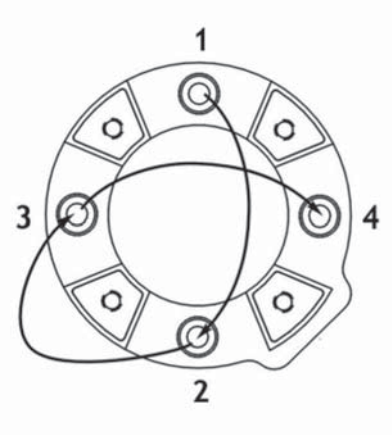

Figure A.81 — Sequence for torqueing the screws of knee contact load cell

Attach the knee covers (Figure A.73, Item 2) and pad (Figure A.73, Item 14). Attach the knee covers directly to the knee contact load cells with four SHCS M4 × 0,7 × 10. Re-attach the knee covers using the same "star" pattern as the knee contact load cell (see Figure A.81). Attach the knee pad using six BHCS M4 × 0,7 × 12 mm (Figure A.73, Item 15).

A.7.3.4 Assembling the lower leg

The lower leg load cells (Figure A.74, Item 1) are attached to the lower leg tube using four modified BHCS M6 (Figure A.74, Item 2) for each load cell. Torque these modified BHCS to 10 Nm. Both the upper and lower leg load cells are W50-71010 and can be positioned interchangeably but shall be annotated so that the correct sensitivities are used. The load cells shall be installed with the connectors positioned toward the knee end of the assembly.

The ankle "Z"-pivot pin (Figure A.74, Item 6) is installed in the lower load cell. The "Z"-pivot pin is secured in position using three SSCP M6 × 1 × 8 mm (Figure A.74, Item 4) installed in the load cell and aligned with the drill points in the pin. A fourth screw (Figure A.74, Item 5) is installed after the ankle assembly is installed along with the anti-rattle washer, rotational washer, and nut (Figure A.74, Items 7, 8, and 9, respectively). The fourth screw is known as the z-axis radial limit screw." This "limit screw" is a modified SHCS M6 and is installed on the anterior of the lower leg to control the radial travel of the ankle.

The ankle assembly (Figure A.75, Item 2) is attached to the lower leg assembly with the "Z"-pivot pin, anti-rattle washer, rotational washer, and z-axis nut (Figure A.74, Items 6, 7, 8, and 9, respectively) (see Figure A.87 for a clearer diagram of the ankle to lower leg assembly). These components shall be in place in the ankle before the lower leg assembly can be attached.

Once the lower leg assembly is installed on the ankle, the washers and nut can be tightened until the z-axis movement is eliminated. Then, with the leg flesh orienting block (Figure A.74, Item 12) positioned toward the rear (posterior) of the assembly, install the z-axis radial limiting screw (Figure A.74, Item 5 or Figure A.87).

A.7.3.5 Assembling the ankle

Note that the ankle assembly is made up of two sections: 'X' version and 'Y' version. Note that the upper section is the 'Y' version assembly. Note that the lower section of the ankle assembly is the 'X' version assembly (see Figure A.77 and Figure A.83).

Place the resistive elements, two on each side (Figure A.83, Item 4), on the ankle joint assembly (Figure A.83, Item 5), slide the 'Y' version assembly on to the ankle joint assembly. Check periodically for damage to the Polytetrafluoroethylene (PTFE)® washers attached to the inner surfaces of the 'Y' version left and right flexion centre assemblies (Figure A.76, Items 6 and 23). See Figure A.82 for wiring details.

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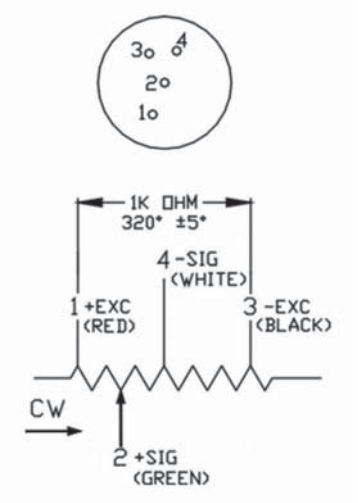

Figure A.82 — Ankle potentiometer wiring

NOTE When reinstalling each potentiometer, do not over tighten the set screw on the body of the potentiometer or the device may be damaged. Tighten it just enough to hold it in position securely.

With the 'Y' version assembly positioned on the ankle joint assembly, place the remaining four resistive elements on top of the left and right flexion centre assemblies and install the ankle joint cover (Figure A.83, Item 3). In order to compress the resistive elements sufficiently to be able to insert the six BHCS M4 × 0,7 × 10 mm to attach to the cover, two SHCS M4 × 0,7 × 18 mm are used. Tighten the two SHCS M4 (Figure A.83, Item 1) until the BHCS M4 × 0,7 × 10 mm can be installed and then replace the two SHCS with BHCS M4.

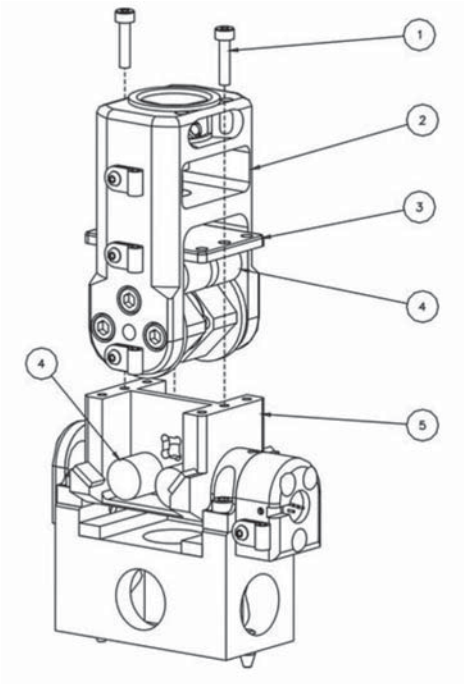

Figure A.83 — 'X' and 'Y' version assembling

Install the potentiometer (W50-54012) into the 'X' version assembly by loosening the three screws (Figure A.76, Item 15) and inserting the potentiometer into the hole at the front side of the ankle

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assembly (see Figure A.84). Do not over tighten the two SSNT M3 × 0,5 × 3 mm set screws that secure the potentiometer body or there may be damage to the potentiometer. Note that there is an SSCP M3 × 0,5 × 4 mm (Figure A.76, Item 7) that secures the potentiometer shaft.

Note that to install the y-axis potentiometer, this section shall be assembled on to the 'X' version assembly. Insert the potentiometer body into the appropriate mounting hole shown in Figure A.84 and tighten the SSNT M3 × 0,5 × 3 mm. Do not over tighten this set screw or the potentiometer will be damaged. Note that the SSNT M3 × 0,5 × 3 mm need only be tightened enough to secure the body and keep it from moving.

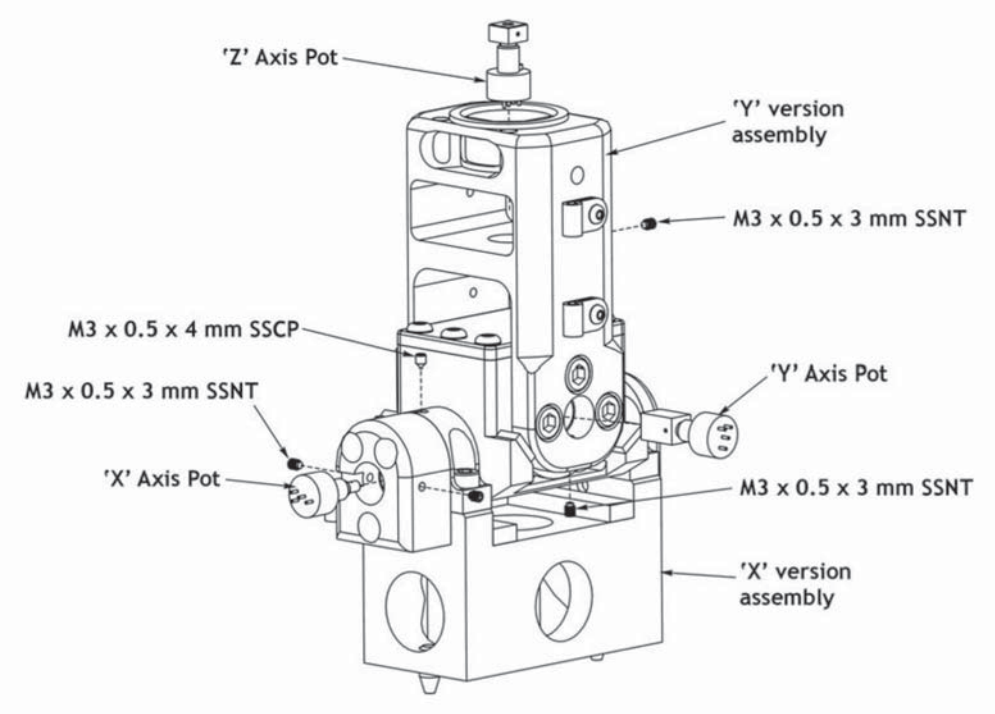

Figure A.84 — Ankle assembly potentiometers

A.7.4 Adjusting the leg

A.7.4.1 General

Note that the WorldSID leg assembly has two joint adjustments that control the 1-to-2-G-setting, and that one of the joint adjustment points is located at the knee pivot and the other is located at the top of the ankle assembly.

A.7.4.2 Adjusting knee pivot rotation

Note the following:

— The knee pivot screw (see Figure A.85) controls the motion of the lower leg. In order to do this, there are several components involved: clamping, compression and friction washers, and the pivot shaft assembly. For the knee pivot screw to control the friction in the knee joint, all of these components shall be correctly installed and in good working condition. Tighten the knee pivot screw to obtain a 1-to-2-G-setting. This screw will squeeze the compression washer against the friction washer, thus increasing the resistance to movement of the knee bone in the knee clevis.

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— The friction washer shall be installed with the friction material toward the knee clevis or the washer will provide very little resistance to movement. The compression washer (a polychloroprene material) should be inspected to ensure that it is not permanently compressed or damaged.

— The SSHDP that locks the pivot shaft assembly in place in the knee bone shall be correctly installed. The SSHDP M6 shown in Figure A.86 shall be installed so that the tip is in the locking hole at the middle of the pivot shaft.

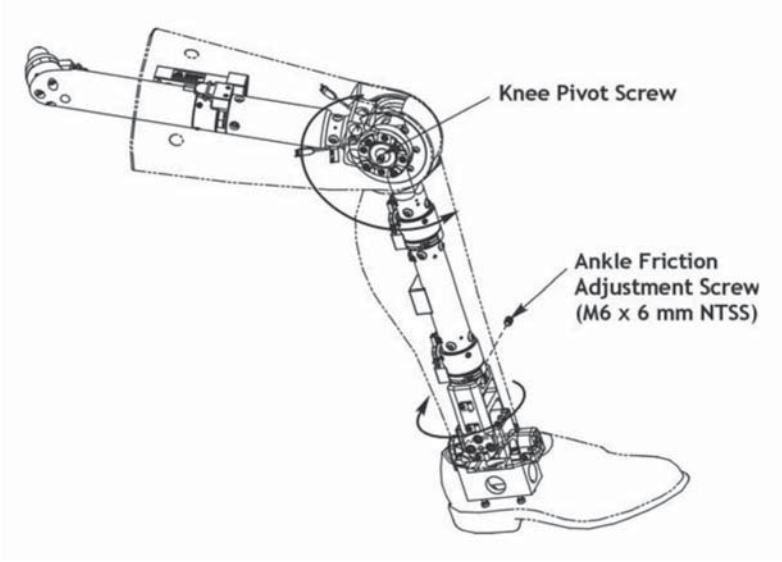

Figure A.85 — Knee assembly

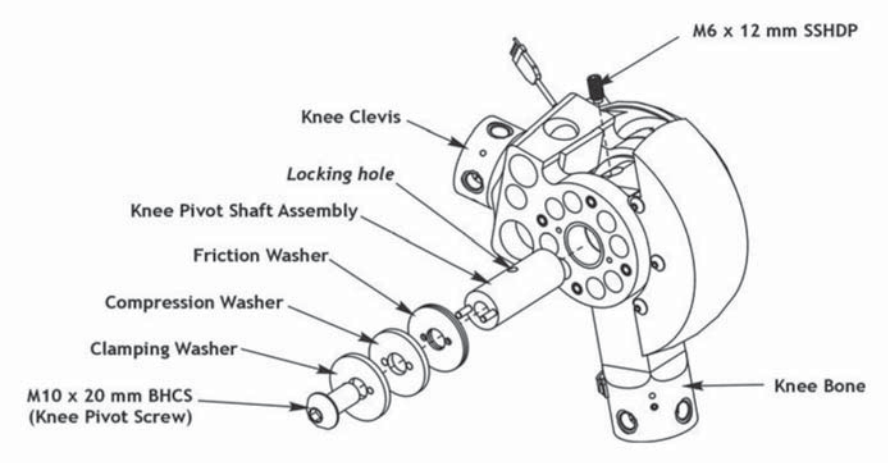

Figure A.86 — Leg joint adjustments

A.7.4.3 Adjusting ankle rotation

Note the following:

— The ankle adjustments are not easily done due to the lack of mass of the components.

— This joint is adjusted to approximate a 1-to-2-G-setting.

— The ankle rotation friction is controlled by a M6 set screw and a M14 lock nut (z-axis nut) (see Figure A.87).

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Loosen the M6 set screw and check the z-axis movement of the lower leg load cell in the ankle assembly. Note that the z-axis is on a line extending perpendicular to the sole of the foot and through longitudinal centerline of the lower leg load cell. Tighten the z-axis nut sufficiently to eliminate movement along the z-axis at the load cell while allowing for free rotation about the z-axis.

Adjust the set screw M6 in the ankle assembly such that there is consistent stiffness in the joint to approximate a 1-to-2-G-setting as the foot is rotated about the lower leg.

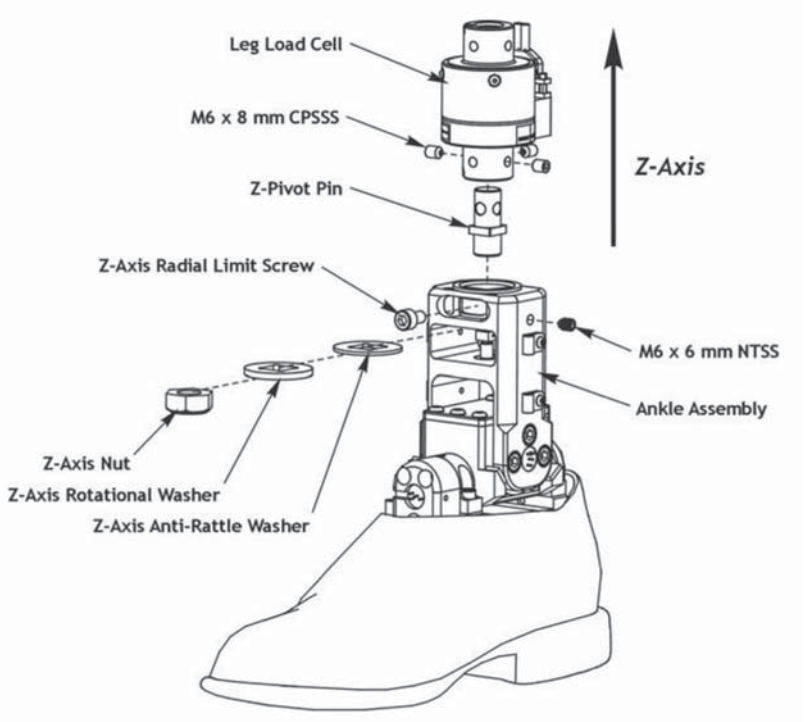

Figure A.87 — Ankle adjustment

A.8 Suit assembly

A.8.1 Parts list for suit

The part number for the WorldSID suit is W50-80100.

A.8.2 Disassembly

Unzip all suit zippers and carefully remove the suit by reversing the assembly procedures

A.8.3 Assembly

Install the dummy lifting bracket, and lift the dummy with a hoist. Open all the zippers on the suit, including the front and rear of the thorax and both legs. If working with a full arm, set the full arm sleeves aside at this point. Insert the arms through the short sleeves and close the zipper on the rear side of the dummy. Straighten the legs, pull the suit tight around the legs, and close both leg zippers. Make sure the shoulder pads are in the proper position, and zip the front thorax zipper half way. Note the front thorax zipper cannot be fully zipped due to the lifting bracket. Install full arm sleeves if needed. Move the dummy to the bench or inside the vehicle; remove the lifting bracket by removing the M8 bolt on the top and M12 bolt on the bottom, and then close the front thorax zipper.

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Annex B
(informative)

Overview of an example permissible internal data acquisition system

B.1 General

This annex gives an overview of the main functional components of and cable pinout scheme for the WorldSID G5 DAS[3)] which is an example permissible internal data acquisition system for the WorldSID.

Users of a permissible internal data acquisition system should contact the manufacturer to request operating procedures and specifications for the system.

The normative portions of ISO 15830-3:2013 specify some geometric, mass, and performance characteristics for permissible internal data acquisition systems.

The WorldSID G5 DAS is an example of a system which conforms to these normative specifications and was used in the 11 pre-production WorldSIDs.

B.2 System components

The basic components of the WorldSID G5 DAS system are shown in Figure B.1. Note that Table B.1 lists parts and part numbers. A description of each item is given below for the convenience of users of this example system.

Table B.1 — WorldSID G5 DAS parts list

Description	Part number
TDAS G5 Module	TDAS5-M32
TDAS G5-DB	TDAS5-DB
TDAS G5 DB Dog Bone connector clamp	TDAS5-DBCON-CL
TDAS G5-DB Dummy exit cable	TDAS5-C-DBDE
Dummy exit to TDAS status box cable	TDAS5-C-DESB
Ethernet communication cable: from status box to PC	TDAS5-ETH-SBPC
Wireless Ethernet programming cable	TDAS5-C-WEP
Wireless Ethernet jumper plug	TDAS5-P-WEJ
TDAS status box	TDAS5-SB
Antenna	TDAS5-SBAN
TDAS power supply	TDAS5-PS
TDAS G5 User's manual and software	TDAS5-Soft
Allen wrench	TDAS5-Wrench
Rugged instrument case, Pelican 1550	TDAS5-1550
2,4 Amp power supply with 4-Pin Lemo connector	TDAS5-PS-2,4Amp

3) The WorldSID G5 DAS is a system supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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B.2.1 G5 module[4)]

Each G5 module records data from as many as 32 sensors and has sensor ID capabilities. The G5 system installed on the WorldSID pre-production dummies had the provision for mounting five G5 modules on the dummy, two in the spine, one in the pelvis, and one in each upper leg skin. Later design revisions moved the pelvis G5 to the non-struck side of the thorax. In addition, if needed, additional G5 units can be located in the dummy suit pockets to support full arm sensors. See the manufacturer-supplied G5 module hardware user's manual for additional information.

B.2.2 G5 docking station[5)]

The docking station consists of a mechanical guide and connector for the G5 module, flex cable, and sensor input connectors. As specified in the G5 documentation, when attaching a G5 to the docking station the attachment bolt torque should be 1,6 to 1,8 Nm. Additional information regarding the docking station is found in the manufacturer-supplied G5 module hardware user's manual.

B.2.3 G5-DB[6)]

The G5-DB is used to link up to five G5 Modules together inside the dummy. Note that the in-dummy temperature sensor is also connected to the G5-DB. The G5-DB also manages power input from the in-dummy battery and external power sources. See the G5-DB hardware user's manual for additional information.

B.2.4 Docking station to G5-DB cable[7)]

The G5 docking station to G5-DB cable connects each G5 Module to the G5-DB. Additional information regarding the cable is found in the G5-DB hardware user's manual.

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4) The WorldSID G5 DAS is a module supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

5) The G5 docking station is a product supplied by Humanetics (formerly First Technology Safety Systems, Inc.), Plymouth Michigan, USA (www.humaneticsatd.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

6) The G5-DB is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

7) The docking station to G5-DB cable is a product supplied by Humanetics (formerly First Technology Safety Systems, Inc.), Plymouth Michigan, USA (www.Humaneticsatd.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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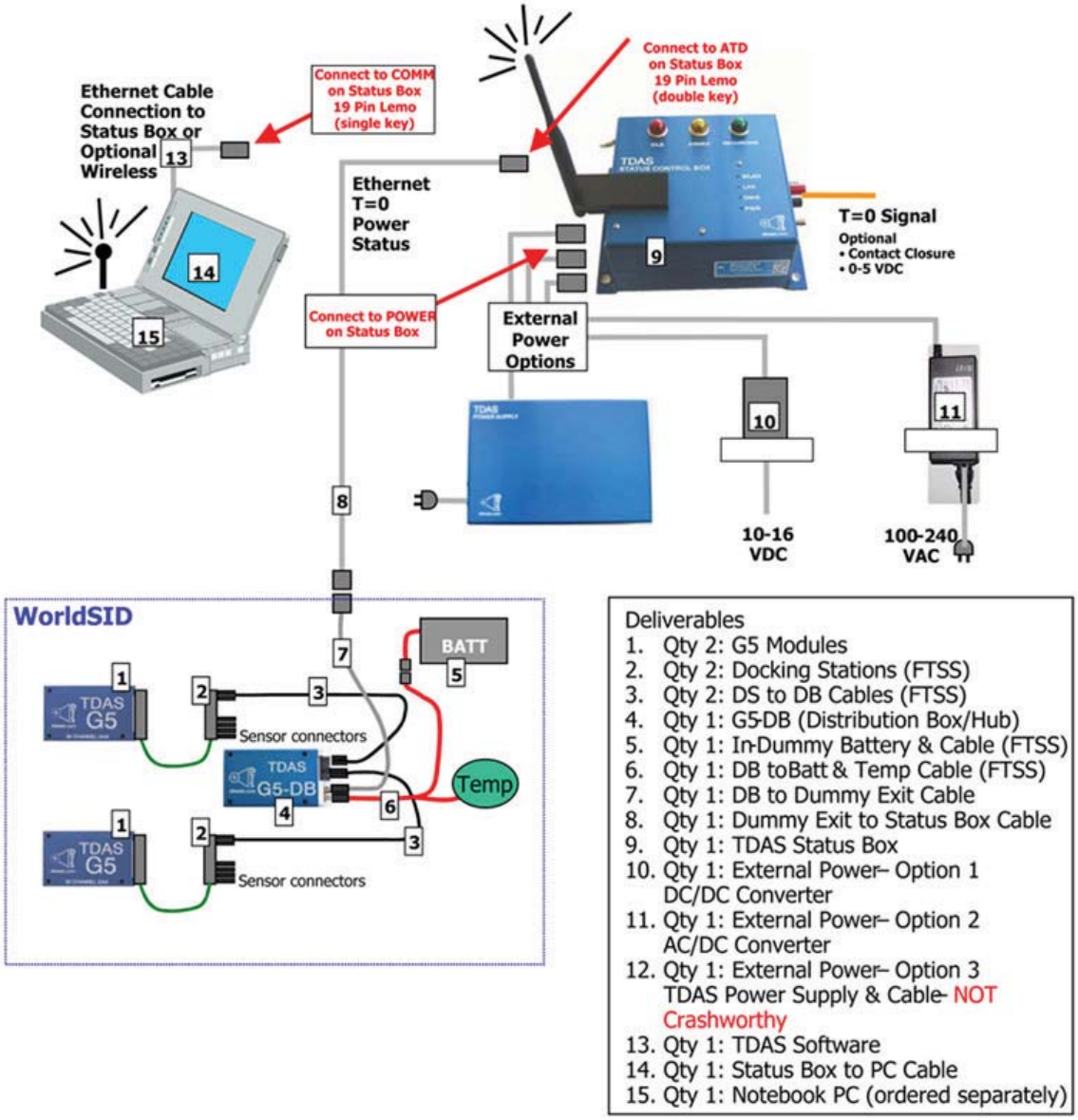

Figure B.1 — WorldSID G5 DAS system diagram

B.2.5 In-dummy battery and cable[8)]

The in-dummy battery and integrated cable provide backup power for the G5 system. However, it is only for backup purposes and should not be relied upon for more than brief periods (see manufacturer's specification for battery capacities).

8) The in-dummy battery and cable is a product supplied by Humanetics (formerly First Technology Safety Systems, Inc.), Plymouth Michigan, USA. (www.humaneticsatd.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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B.2.6 G5-DB to battery and temperature sensor cable[9)]

The G5-DB to battery and temperature sensor cable connects these three components.

B.2.7 G5-DB to dummy exit cable[10)]

The G5-DB to dummy exit cable is a separate, replaceable cable used for connecting the G5-DB system to the outside of the dummy. This cable carries external power, Ethernet communications, t = 0 event signal, and status signals. See the manufacturer-supplied G5-DB hardware user's manual for additional information.

B.2.8 Dummy exit to TDAS status box cable[11)]

The dummy exit to TDAS status box cable is a separate, replaceable cable used for connecting the WorldSID to the TDAS Status Box. This cable carries external power, Ethernet communications, t = 0 event signal, and status signals. See B.5 for additional information.

B.2.9 TDAS status box[12)]

The impact-resistant TDAS status box is connected to the WorldSID and displays the status of the system via large red, yellow, and green lights. Note that in place of the internal Li-Ion batteries, DTS has provided two options for external power (see B.2.10 and B.2.11 below). The TDAS Status Box is described in a later clause of this annex.

B.2.10 DC/DC converter[13)]

This impact-resistant device accepts 10-18 VDC input and provides 13,5 VDC output to the TDAS Status Box. The user shall supply a 10-18 VDC source with a minimum of 5A current capability.

B.2.11 AC/DC converter[14)]

This impact-resistant device accepts 100-240 VAC input and provides 13,5 VDC output to the TDAS Status Box. The user shall supply a 100-240 VAC source.

---

9) The G5-DB to battery and temperature sensor cable is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

10) G5-DB to dummy exit cable is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

11) Dummy exit to TDAS status box cable is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

12) TDAS status box is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

13) DC/DC converter is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

14) AC/DC converter is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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B.2.12 TDAS power supply[15)]

The TDAS power supply non-impact resistant device accepts 100-240 VAC input and provides 13,5 VDC output to the TDAS Status Box. The user shall supply a 100-240 VAC source.

B.2.13 TDAS software[16)]

The provided TDAS software is used for sensor database management, test setup, test execution, data download, post test viewing, and data export. See the manufacturer-supplied software user's manual for additional information.

B.2.14 Status box to PC cable[17)]

The status box to PC cable connects a PC to the TDAS Status Box. This cable carries Ethernet communications signals.

B.2.15 Notebook PC

If an optional notebook PC was acquired with the WorldSID G5 DAS, it may be pre-loaded with TDAS software, sensor database, and example test setups. Since WorldSIDs will move from place to place, it is strongly recommended that a PC be dedicated to the dummy. This will make setup at the new operating location much easier.

B.3 Dummy exit to status box cable pinout

Table B.2, and Figures B.2 and B.3 give the cable printout scheme for the dummy exit to status box cable.

15) TDAS power supply is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

16) TDAS software is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

17) Status box to PC cable is a product supplied by Diversified Technical Systems, Inc. (DTS), Seal Beach California, USA (support@dtsweb.com). This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Alternative products may be used if they can be shown to lead to the same results.

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Table B.2 — Dummy exit to status box cable pinout

Lemo pin pumber	20 Feet 9507 – Color code	Function
1	red	Main Power, +12 VDC
2	black	Main Power, +12 VDC
8	brown	Main GND
4	black	Main GND
5	green	Ethernet +Rx
6	black	Ethernet –Rx
7	orange	Ethernet +Tx
3	black	Ethernet –Tx
9	white	Event +
10	black	Event –
11	blue	Arm Status (RS-232 Level, +V=Armed)
12	black	Power ON (short to GND = ON)
13	yellow	Status Output (5V = OK)
14	black	Start Record (Vin = Record)

NOTE Belden 9507 cable contains 7 twisted pairs. Each pair contains a black wire and a coloured wire. It is very important that the pairs be kept together as shown above.

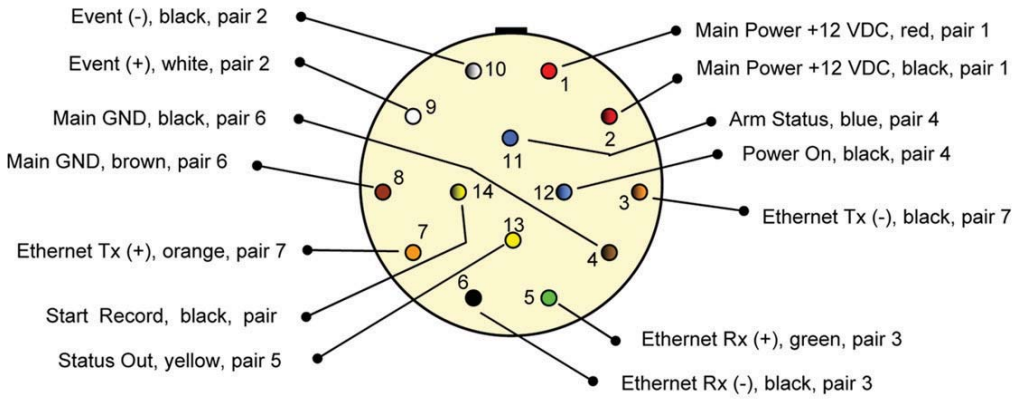

Figure B.2 — Dummy exit to TDAS status box cable 2B 14-pin lemo connector wiring side view sockets

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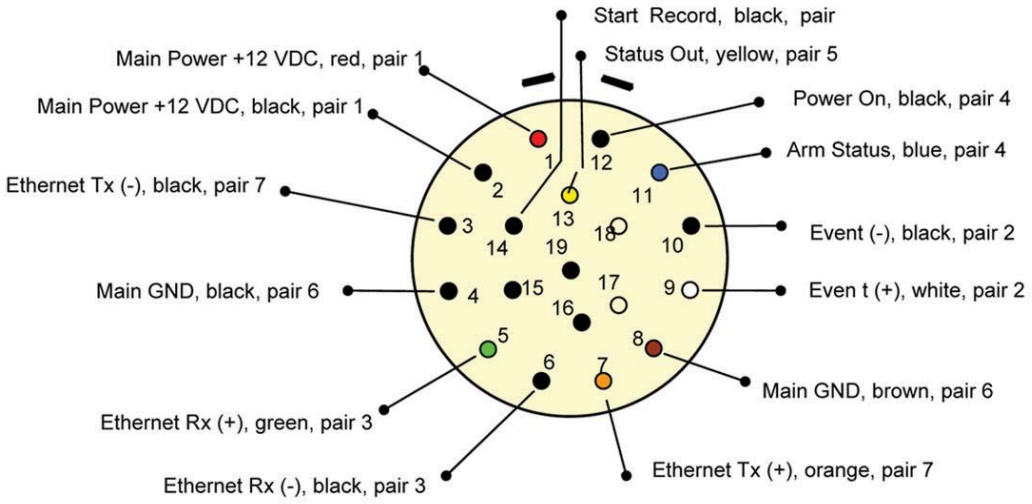

Figure B.3 — Dummy exit to TDAS status box cable 2B 19-pin lemo connector, wiring side view, pins

B.4 Sensor cable length

When the G5 system is used in the WorldSID, sensor cable lengths will be dependent upon the location of the sensor and the location of the G5 used to record the sensor data. Cable lengths for a pre-production example G5 and sensor system are shown in Table B.3.

Table B.3 — Example instrumentation cable lengths

Position	No. of channels	Length[a] mm (inches)	DAS[b] location	Qty	Part number
Head accelerometer	3	767 (30,2)	Upper spine	1	W50-71164-767
Head rotation accelerometer	1	750 (29,5)	Upper spine	3	W50-71165-750
Upper neck	6	692 (27,2)	Upper spine	1	W50-71982-692
Lower neck	6	314 (12,4)	Mid spine	1	W50-71981-314
Thorax accelerometer	3	553 (21,8)	Mid spine	1	W50-71164-553
Thorax rotation accelerometer	1	234 (9,2)	Mid spine	1	W50-71165-234
T1 accelerometer	3	416 (16,4)	Mid spine	1	W50-71164-416
T4 accelerometer	3	326 (12,8)	Mid spine	1	W50-71164-326
Rib accelerometers	3	394 (15,5)	Mid spine	6	W50-71164-394
T12 accelerometer	3	347 (13,7)	Mid spine	1	W50-71164-347
Pelvis accelerometer	3	382 (15,0)[c]	Pelvis	1	W50-71164-382
IR-TRACC (shoulder)	1	280 (11,0)	Upper spine	1	W50-74411
IR-TRACC (thorax)	1	280 (11,0)	Mid spine	3	W50-74411
IR-TRACC (abdomen)	1	280 (11,0)	Mid spine	2	W50-74411

[a] 9,2 m optional cables for off board DAS are also available.

[b] Multiple DAS locations require different cable lengths.

[c] Different cable lengths would be needed for later dummies in which the pelvis DAS was moved to the non-struck side of the thorax.

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Table B.3 *(continued)*

Position	No. of channels	Length[a] mm (inches)	DAS[b] location	Qty	Part number
Sacro-iliac (R & L)	6	290 (11,4)[c]	Pelvis	2	W50-71983-290
Lumbar[b]	6	475 (18,7)	Mid spine	1	W50-71983-475
Lumbar	6	318 (12,5)[c]	Pelvis	1	W50-71983-318
Pubic	1	246 (9,7)[c]	Pelvis	1	W50-71987-246
Pubic	1	435 (17,1)	Mid spine	1	W50-71987-435
Femoral neck	3	406 (16,0)	Leg	2	W50-71984-406
Femoral neck[b]	3	1080 (42,5)[c]	Pelvis	2	W50-71984-1080
Mid-femur	6	254 (10,0)	Leg	2	W50-71981-254
Knee contact	1	356 (14,0)	Leg	4	W50-71020-356
Knee pot.	1	356 (14,0)	Leg	2	W50-71162
Upper tibia	6	508 (20,0)	Leg	2	W50-71981-508
Lower tibia	6	686 (27,0)	Leg	2	W50-71981-686
Ankle pot.	3	914 (36,0)	Leg	2	W50-71161
Upper arm	6	700 (27,6)	Upper spine	1	W50-71981-700
Lower arm	6	1100 (43,3)	Upper spine	1	W50-71981-1100
Wrist accelerometer	3	1200 (47,2)	Upper spine	1	W50-71164-1200
Elbow	2	800 (31,5)	Upper spine	1	W50-71992-800
Elbow accelerometer	3	1200 (47,2)	Upper spine	1	W50-71164-1200
Elbow potentiometer	1	950 (37,4)	Upper spine	1	W50-71163
Shoulder	3	355 (14,0)	Upper spine	2	W50-71986-355

[a] 9,2 m optional cables for off board DAS are also available.

[b] Multiple DAS locations require different cable lengths.

[c] Different cable lengths would be needed for later dummies in which the pelvis DAS was moved to the non-struck side of the thorax.

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Annex C
(normative)

Fastener torque values

Table C.1 — Screw torques

Screw type	Screw size	Torque[a]	
		Nm	in-lbf
SHCS	M2 X 0,4	0.3	3
SHCS	M2,5 X 0,45	0.7	6
SHCS	M3 X 0,5	1	9
SHCS	M4 X 0,7	3	27
SHCS	M5 x 0,8	6	53
SHCS	M6 x 1	10	89
SHCS	M8	25	220
SHSS (hand and wrist pivot screw)	M6 X 25 mm	3	27
BHCS	M2,5	0.7	6
BHCS	M3 X 0,5	1	9
BHCS	M4 X 0,7	3	27
BHCS	M5	6	53
BHCS	M6	10	89
Modified BHCS (p/n: W50-61042)	M6 x 1	10	89
BHCS (“Z”-pivot screw)	M6 X 1	2[b]	18
BHCS (Elbow pivot screw)	M10 X 1,5	3[b]	27
BHCS	M10	50	445
Cheese screw	M2	0.3	3
FHCS	M2,5	0.7	6
FHCS	M3	1	9
FHCS	M4 X 0,7	3	27
FHCS	M5	6	53
FHCS	M6	10	89
LHSHCS	M3 X 0,5	1	9
LHSHCS	M6 X 1	10	89
CPSSS	M3 x 0,5	1	9
CPSSS	M6 x 1	7	62
SSCP	M4 X 0,7	2	18
SSCP	M6 X 1	7	62
SSFP	M4 X 0,7	2	18
SSNT	M3 x 0,5	1	9

[a] Torques based on manufacturer’s recommendation of 50 % of yield strength.

[b] Used for 1-to-2-G-setting. Torque may vary with components.

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Table C.1 *(continued)*

Screw type	Screw size	Torque[a]	
		Nm	in-lbf
SSNT	M4 X 0,7	2	18
SSNT ("Z"-pivot screw)	M6 X 1	3[b]	27
SSHDP	M6 X 1	8	71

[a] Torques based on manufacturer's recommendation of 50 % of yield strength.

[b] Used for 1-to-2-G-setting. Torque may vary with components.

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Annex D
(informative)

Fastener abbreviations and ISO references for user convenience

Table D.1 gives a summary of fastener abbreviations, descriptions, and ISO references, for the convenience of users of this part of ISO 15830. The normative definitions are provided in ISO 15830-1.

Table D.1 — Summary of fastener abbreviations, descriptions, and ISO references

Abbreviations	Descriptions	ISO references
BHCS	Button head cap screw	ISO 7380
Cheese screw	Cheese head screw	ISO 1207
CPNT	Cone point nylon tip set screw	-
CPSS	Cone point set screw	ISO 4027
CPSSS	Cone point socket set screw	ISO 4027
FHCS	Flat head cap screw	ISO 10642
LHSHCS	Low head socket head cap screw	-
SHCS	Socket head cap screw	ISO 4762
SHSS	Socket head shoulder screw	ISO 7379
SSCP	Set screw cup point	ISO 4029
SSFP	Set screw flat point	ISO 4026
SSHDP	Set screw half dog point	-
SSNT	Set screw with nylon tip	-

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Annex E
(informative)

Recommended WorldSID general practices

E.1 Validation test intervals

The acceptable interval between WorldSID validation tests is highly dependent upon the type and severity of impacts to which the WorldSID is subjected. Each user should determine their own requirements based on their existing policies, regulatory requirements, impact severity, and experiences with the WorldSID.

Users should perform validation tests as follows:

— before and after each series of sled tests;

— after every three full-scale vehicle tests;

— after each high-energy impact;

— after any unusual impact;

— if ribs exhibit more than 2 mm of permanent deformation when compared to their original shape.

E.2 Recommended inspection practices

As with the validation test interval discussed in E.1, each WorldSID user should determine their own inspection requirements based on their existing policies, regulatory requirements, impact severity, and their experience with the WorldSID.

When establishing appropriate inspection practices, users should consider the following:

— All parts should be visually inspected during each assembly and disassembly process.

— Before performing validation tests, the involved parts should be visually inspected.

— Components subjected to high-energy impact should be inspected following the test.

— Ribs should be inspected on a regular basis and after high-energy impacts to determine if permanent deformation exceed 2 mm.

— The rib doubler to rib joint should be inspected on a regular basis and after high-energy impacts to determine if there has been any separation of the doubler from the rib.

— Flesh components should be inspected for tears.

— Sensor and DAS cables should be inspected for cuts and excessive wear.

— Joint tension should be checked and adjusted as described in Annex A.

— Sensor and DAS functions should be verified prior to each test.

E.3 WorldSID thorax half width

When calculating thorax injury indices, a WorldSID thorax half width of 170 mm should be used.

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E.4 Avoiding possible connector damage

When using the optional pre-production dummy G5 DAS, each WorldSID sensor cable has a connector with exposed pins which can be damaged during installation, removal, or handling.

To prevent damage, the user should consider the following preventative measures:

1) Use extreme care when the connectors are installed, handled, or routed in the dummy.

2) Install available connector covers, any time the pins are exposed, removing them only immediately before plugging the connector into the interposer.

E.5 Temperature range

The WorldSID dummy temperature, when measured by the optional internal temperature sensor, should be 20,6 °C to 22,2 °C. The test environment temperature should be 20,6 °C to 22,2 °C.

E.6 Dummy handling

E.6.1 General

A bracket assembly and fasteners (part number W50-84100) as shown in Figure E.1 containing the parts listed in Table E.1 is included with each dummy for handling.

Table E.1 — Parts list for lifting bracket assembly

Item number	Quantity	Part number	Description
1	1	5000537	Screw, SHCS M8 x 1,25 x 80
2	1	W50-84106	Handle, threaded rod
3	1	W50-84104	Handle, threaded hole
4	1	W50-84110	Lifting bracket weldment
5	1	5000538	Screw, SHCS M12 x 1,75 x 150

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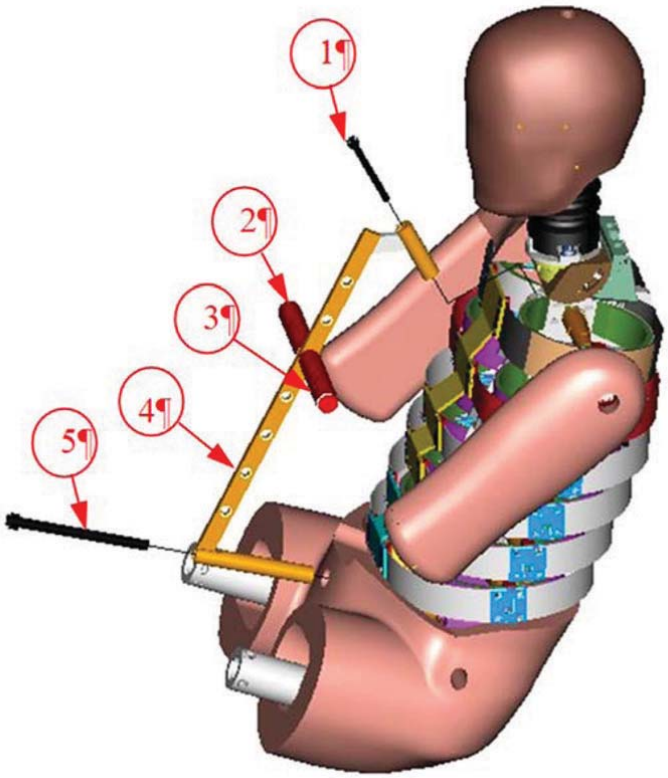

Figure E.1 — Lifting bracket assembly

E.6.2 Procedures for using the lifting bracket

1) Insert the lifting bracket (Figure E.1, Item 4) through a hole on the pelvis flesh and align it with the threaded hole inside the pelvis.

2) Thread screw (Figure E.1, Item 5) a few threads into the pelvis so that it is engaged but not tight.

3) Bend the dummy forward to align the upper portion of the lifting bracket with the hole on the top front of the spine box assembly.

4) Loosely install screw (Figure E.1, Item 1).

5) Tighten both screws (Figure E.1, Items 1 and 5).

6) If needed, some soft webbing can be used to loop around the upper leg above the knee area and attached to the lifting bracket to help support the legs.

7) Handles (Figure E.1, Items 2 and 3) can be used for handling of the dummy inside the vehicle.

8) When the dummy is positioned, remove the bracket from the dummy before conducting any test.

E.7 Dummy storage

The dummy should be stored in a seating position with the lifting bracket installed.

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Annex F
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Recommended WorldSID seating procedure

Repeatable and reproducible crash test results are highly dependent upon systematic seating procedures. At the time of publication of this ISO document, a worldwide group of researchers, with extensive WorldSID test experience, was actively working to produce an agreed upon seating procedure for the WorldSID. The reader should contact members of the WorldSID Task Group or Tri-Chair to obtain the most recent recommended WorldSID seating procedures.

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Annex G
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Suggested WorldSID wiring procedures

There is no specified WorldSID DAS configuration, thus each individual dummy may contain different sensors, connectors, recorders, and cables. The information in this annex is only intended to provide an example that may or may not be applicable to a given dummy.

G.1 Head wiring

Head wiring should be installed as follows.

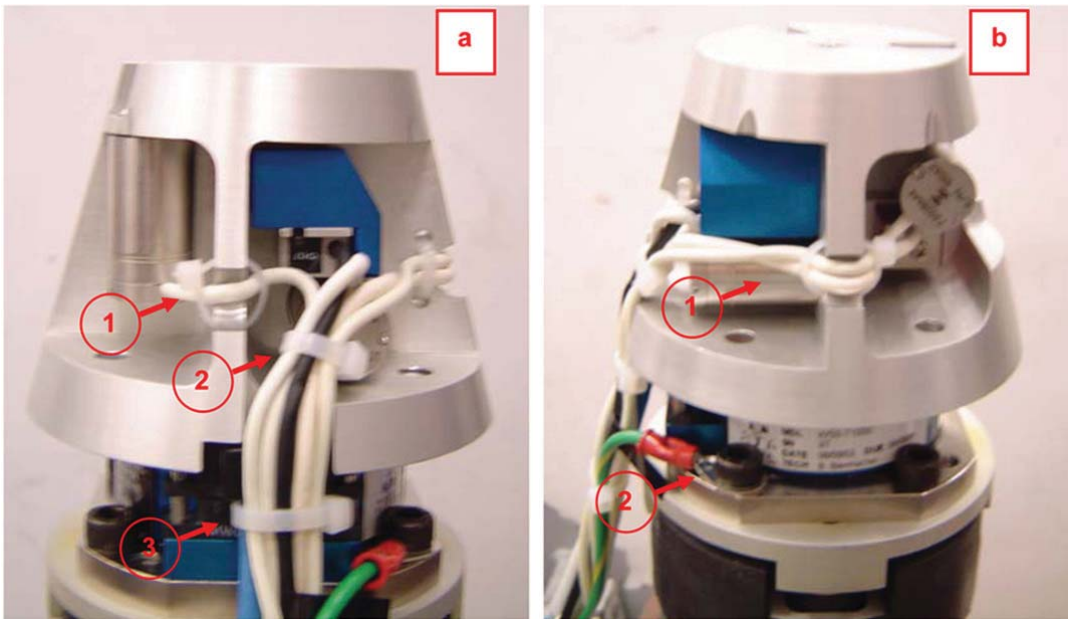

Figure G.1 — Cable routing for the head

1) Use a cable tie to mount z-axis rotational accelerometer as illustrated in Figure G.1a), Item 1.
2) Bundle the accelerometer and y-axis rotational accelerometer cables with cable tie as shown in Figure G.1b), Item 1.
3) Sort all the cables together and tie them together with cable tie as shown in Figure G.1a), Item 2.
4) Lay all the cables from the head as shown and tie them together with the upper neck load cell cables as shown in Figure G.1a), Item 3.
5) Small extra loops of wire inside the head core may be utilized as a precaution against cable pulls damaging the sensor.

G.2 Neck

Neck wiring should be installed as follows.

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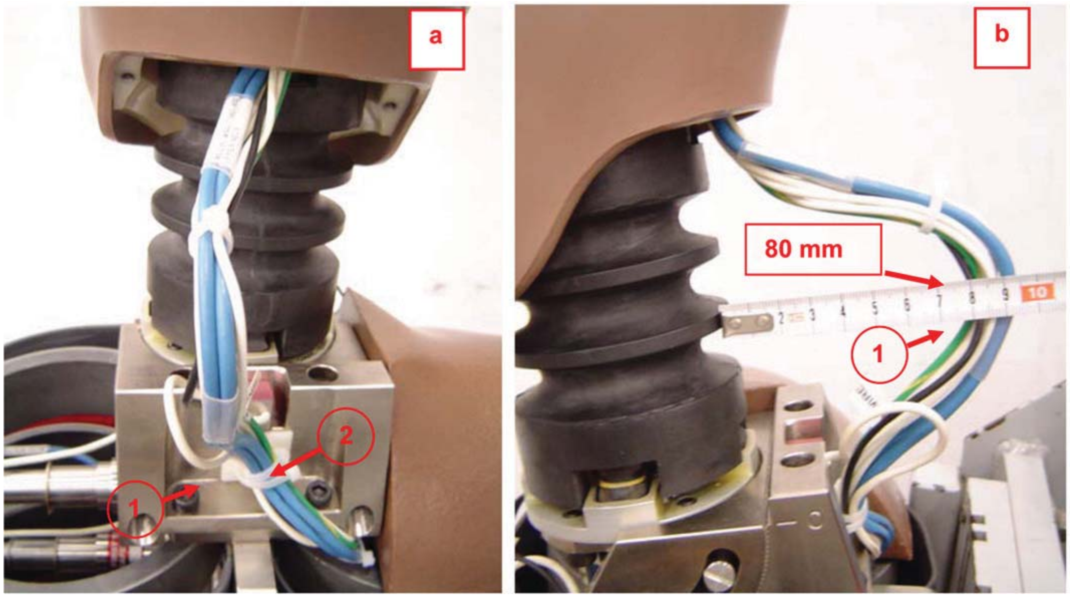

Figure G.2 — WorldSID neck cable routing

1) Install the head and install a cable tie mount on the back of the lower neck bracket as shown in Figure G.2a), Item 1.

2) Bundle all the cables to the cable tie mount as shown in Figure G.2a), Item 2, making sure the cable has enough slack as illustrated in Figure G.2b), Item 1.

G.3 Shoulder rib and 1st thorax rib

Shoulder rib and 1st thorax rib wiring should be installed as follows.

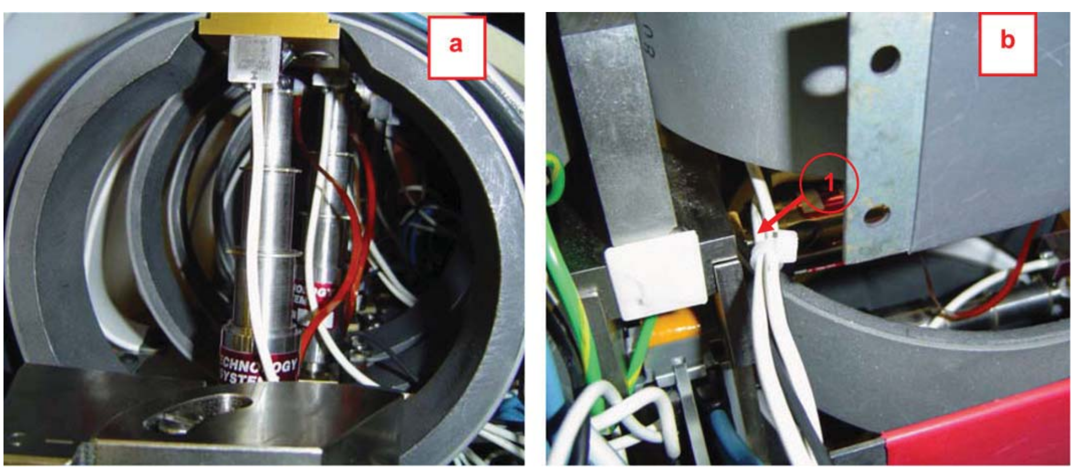

Figure G.3 — IR-TRACC and linear accelerometer routing for shoulder and 1st thorax ribs

1) Lay the cables of the IR-TRACCs and rib accelerometers as shown in Figure G.3a).

2) Group these four cables and bundle them together with tie wrap as shown in Figure G.3b), Item 1.

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G.4 2nd and 3rd Thorax ribs and abdomen ribs

Second and 3rd thorax ribs and abdomen ribs wiring should be installed as follows.

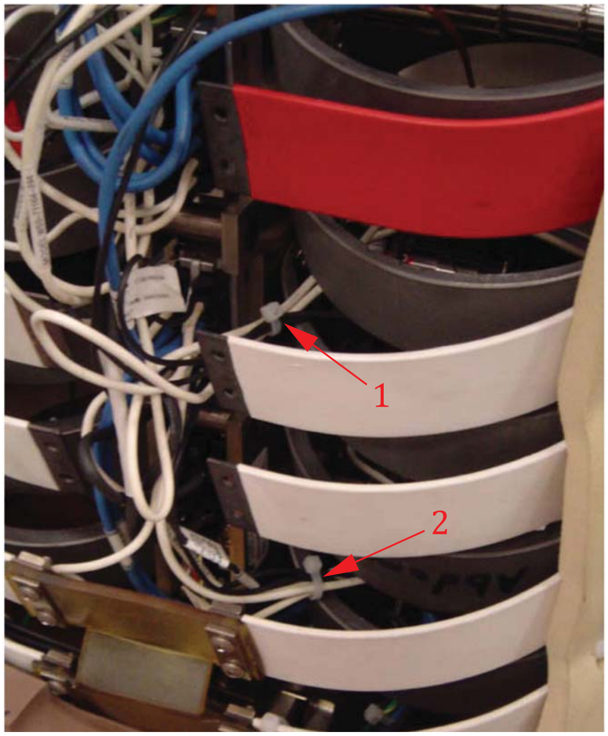

Figure G.4 — Cable routing for IR-TRACC and linear triax accelerometers of the 2nd, 3rd thorax ribs, and abdomen ribs

1) Layout the IR-TRACC and rib accelerometer cables similar to the shoulder as shown in Figure G.3a).

2) Route sensor cables of the 2nd and 3rd thorax ribs through the gap between 2nd and 3rd thorax ribs and bundle them as shown in Figure G.4, Item 1.

3) Route the sensor cables of the 1st and 2nd abdomen ribs as shown in Figure G.4, Item 2.

G.5 Pelvis cable routing

Pelvis wiring should be installed as follows.

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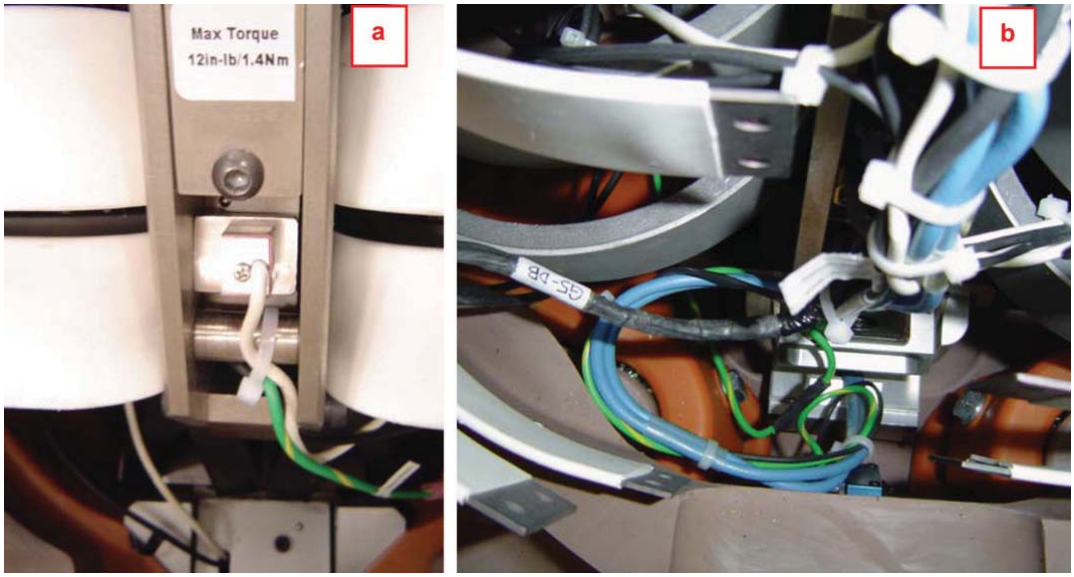

Figure G.5 — Pelvis cable routing

1) Tie the T12 and ground cable to the back of the spine box as shown in Figure G.5a).

2) Route the pelvis cable as shown in the Figure G.5b).

G.6 Installation of sensor connectors to the thorax connector station

Thorax connector station wiring should be installed as follows.

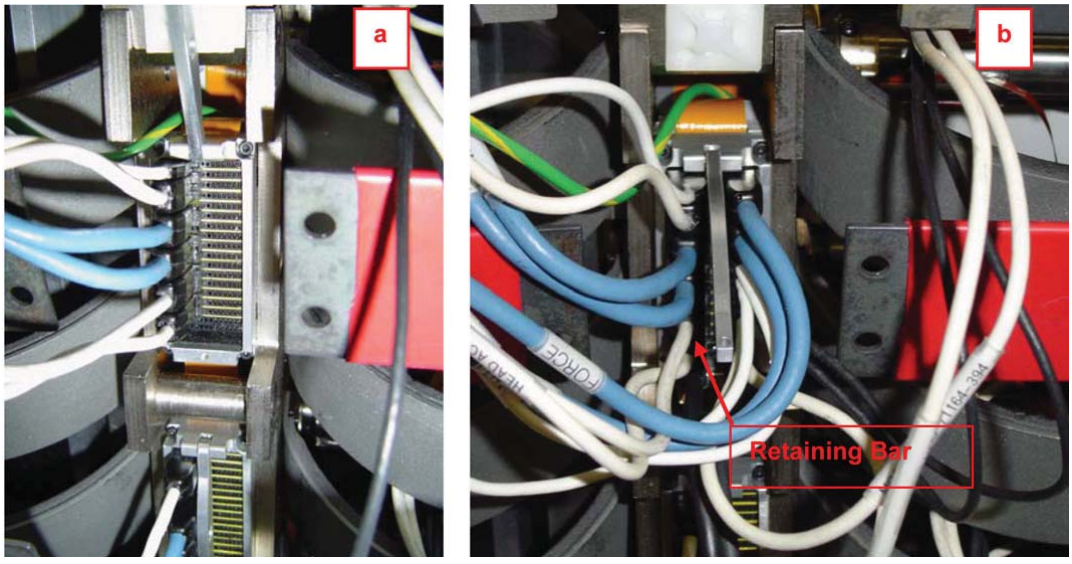

Figure G.6 — Installations of sensor connectors to the thorax connector station

1) Route all cables from the head and neck cables to the non-impact side through the gap between the shoulder rib and 1st thorax rib.

2) Sort all the cables in front of the connector station and determine the final plug and connector positions.

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3) The following cable groupings are recommended. Dummies with a pelvis DAS or DAS mounted on the non-struck side of the thorax will be different.

DAS number 1 upper thorax:

1. Upper neck load cell (6 channels)
2. Lower neck load cell (6 channels)
3. Shoulder load cell (3 channels)
4. Head rotational accelerometer x
5. Head rotational accelerometer y
6. Head rotational accelerometer z
7. Head triax accelerometer
8. T1 triax accelerometer
9. T4 triax accelerometer
10. Shoulder triax accelerometer
11. Shoulder IR-TRACC
12. Thoracic rib 1 IR-TRACC

DAS number 2 lower thorax:

1. Thorax rib 1 triax accelerometer
2. Thorax rib 2 triax accelerometer
3. Thorax rib 3 triax accelerometer
4. Abdominal rib 1 triax accelerometer
5. Abdominal rib 2 triax accelerometer
6. Thorax rib 2 IR-TRACC
7. Thorax rib 3 IR-TRACC
8. Abdominal rib 1 IR-TRACC
9. Abdominal rib 2 IR-TRACC
10. T12 accelerometer
11. Pelvis triax accelerometer
12. Pubic load cell (1 channel)
13. Lumbar load cell (6 channels)

NOTE Special care is needed when plugging in the sensor connectors to prevent pin damage. A flashlight is helpful for better visibility.

4) Plug in the connectors along one side for the upper thorax station as shown in Figure G.6a) and then the other side as shown in Figure G.6b).

5) Connect the DAS communication cable and secure the retaining bar shown in Figure G.6b) with an SHCS M1,6.

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6) Repeat steps 4 and 5 for the lower thorax station as shown in Figure G.7.

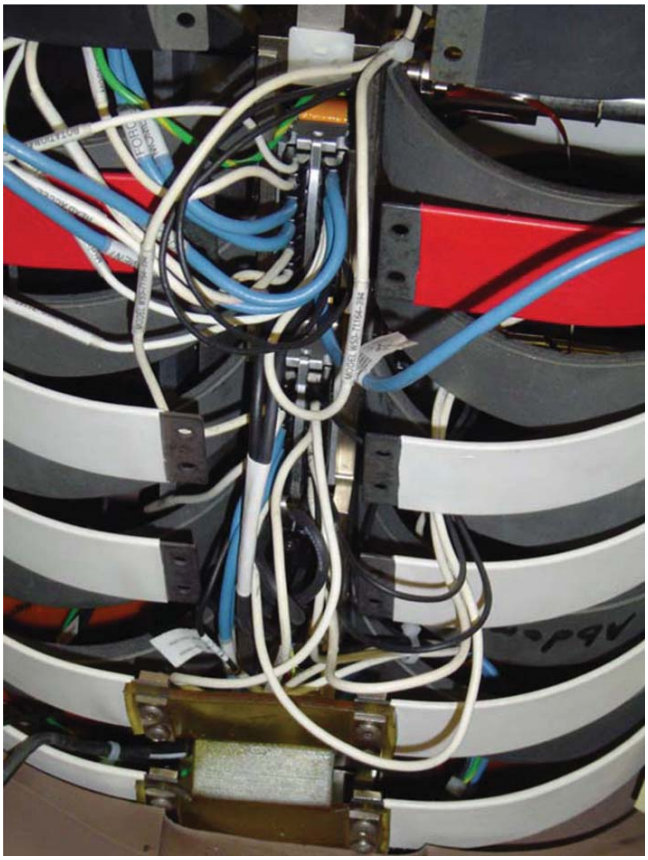

Figure G.7 — Cable routing for the thorax connector station

7) Bundle the cables at the upper thorax portion to a cable mount as shown in Figure G.8a), and tie the rest of the cable as illustrated in Figure G.8b).

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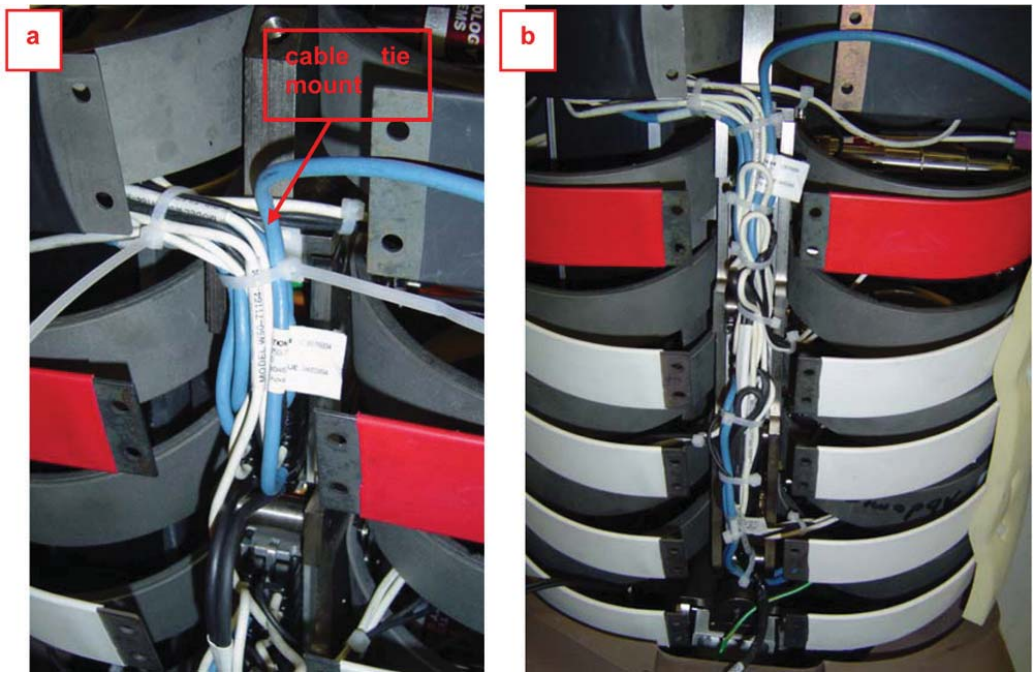

Figure G.8 — Thorax cable bundles

8) Group and bundle the cables in the shoulder area as shown in Figure G.9.

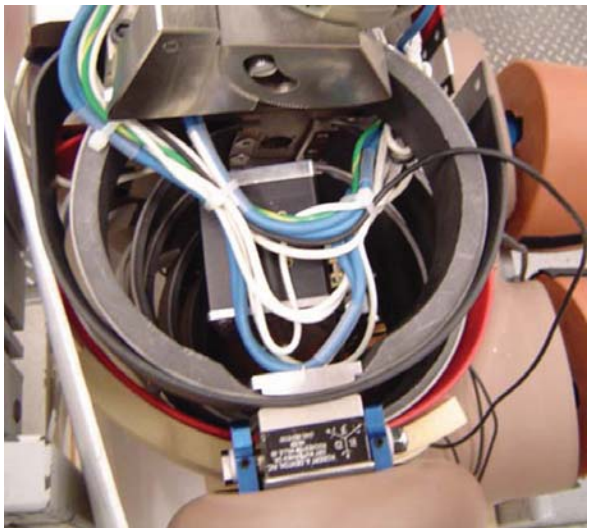

Figure G.9 — Shoulder area final cable routing

9) Tie the pelvis cable and dummy exit cable as shown in Figure G.10. The overall thorax cable routing will be as illustrated in Figure G.11.

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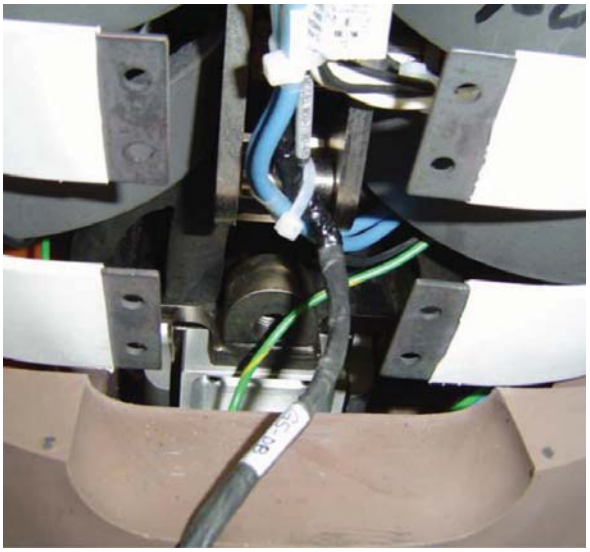

Figure G.10 — Pelvis cable and dummy exit cable routing

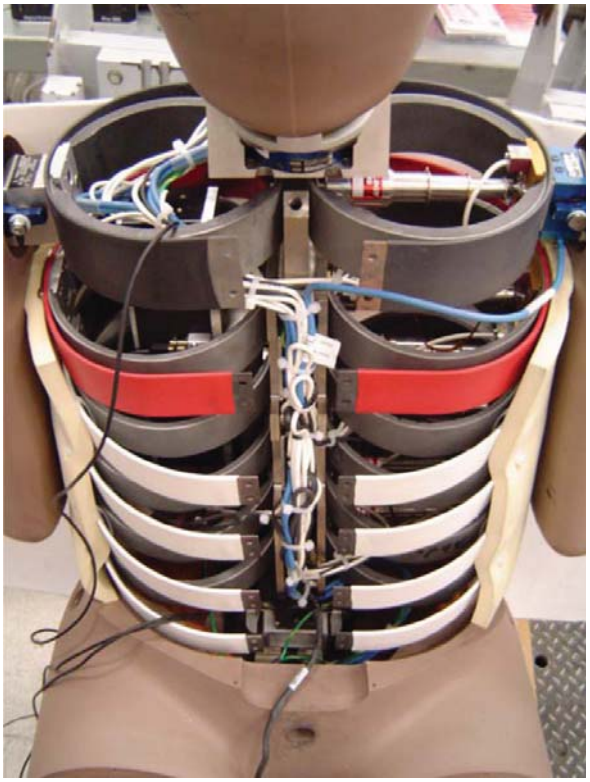

Figure G.11 — Thorax cable routing

10) Install the sternum and the abdomen coupling, make sure that the dummy exit cable and tilt sensor cables are routed between the abdomen ribs as shown in Figure G.12. Loop a cable tie around the 2nd abdomen rib (Figure G.12, Item 1), then secure the cables to the loop with another cable tie (Figure G.12, Item 2).

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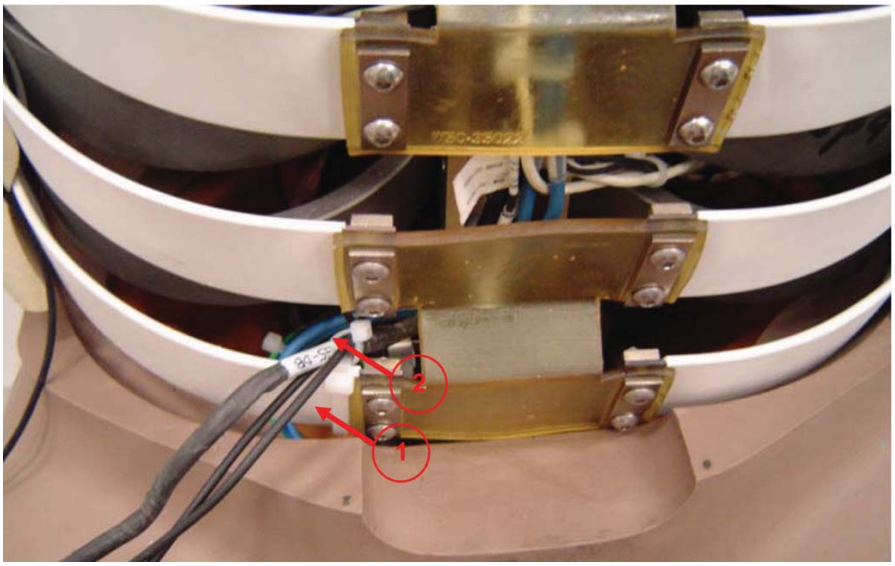

Figure G.12 — DAS exit cable and tilt sensor cables

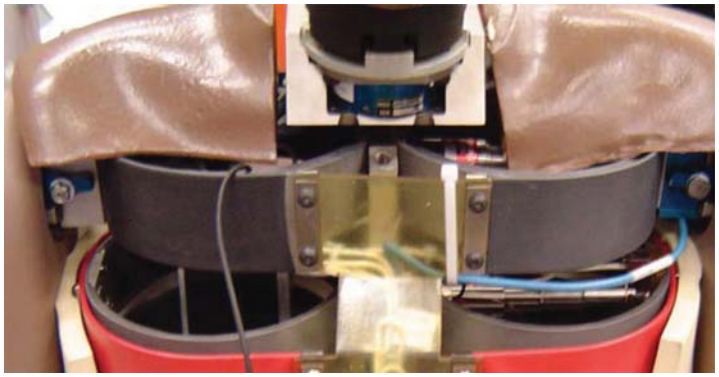

Figure G.13 — Shoulder load cell cable rounting

11) Route the shoulder load cell cable as shown in Figure G.13 and tie it to the sternum with a cable tie. The finished wiring looks as shown in Figure G.14.

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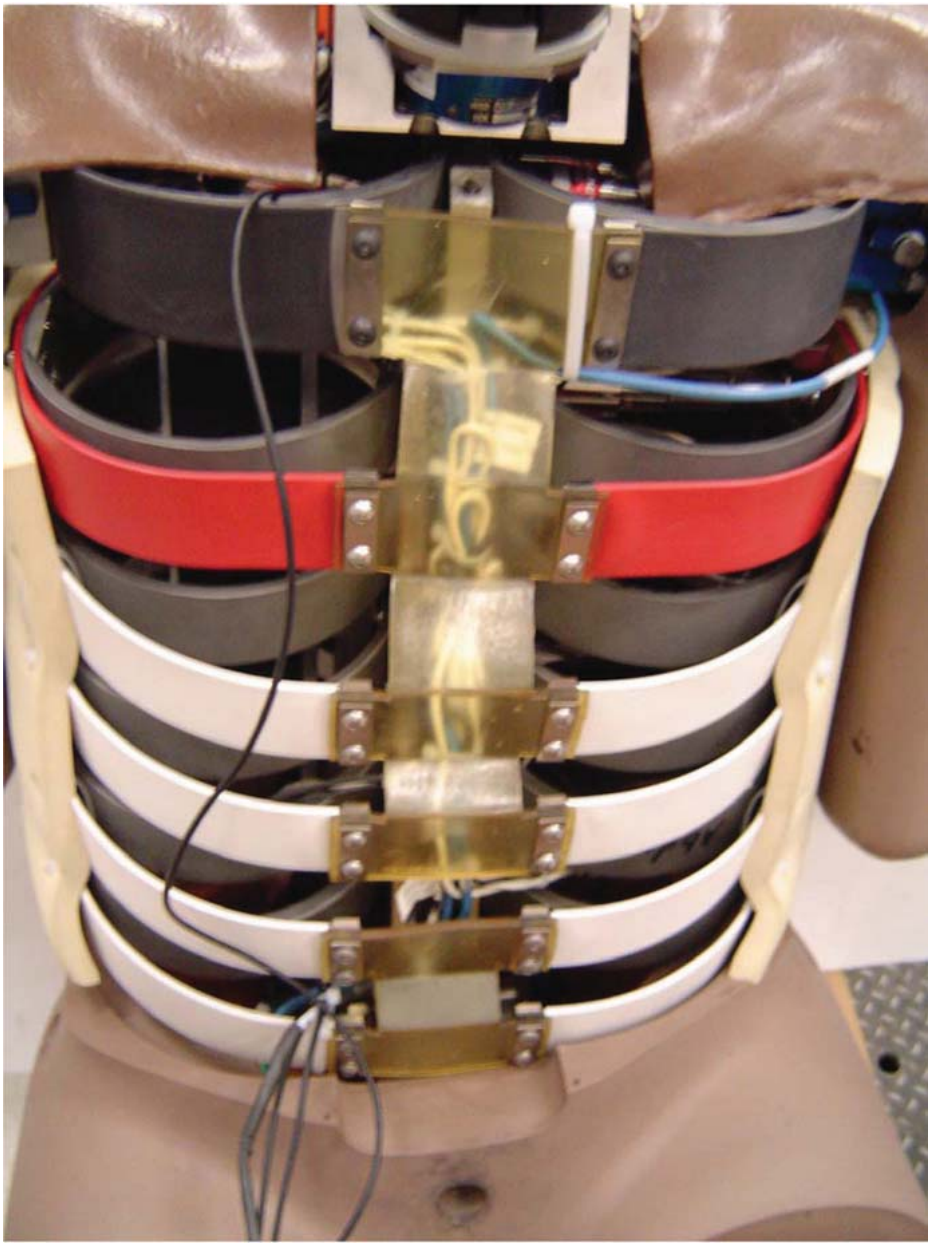

Figure G.14 — WorldSID final dummy wiring

G.7 Instrumented arm cable routing

G.7.1 General considerations

The following are recommended WorldSID instrumentation cable routing procedures. There are two primary concerns with instrumentation cable routing: 1) cable protection during dynamic testing, and 2) reducing the cable's influence on the motion of the dummy during dynamic testing.

G.7.2 Lower arm cables

Route and secure the lower arm cables as shown in Figure G.15.

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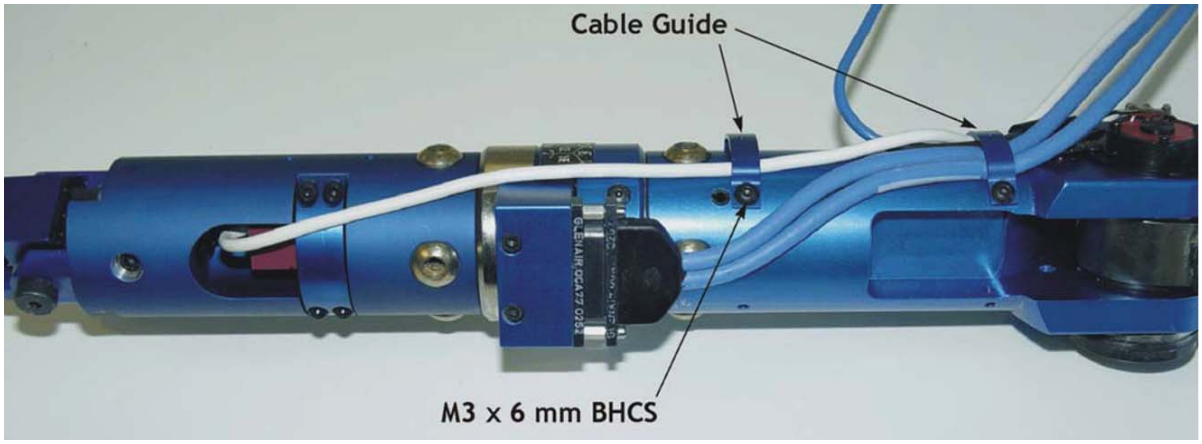

Figure G.15 — Lower arm cables

G.7.3 Upper arm cables

Route and secure the upper arm cables as shown in Figure G.16.

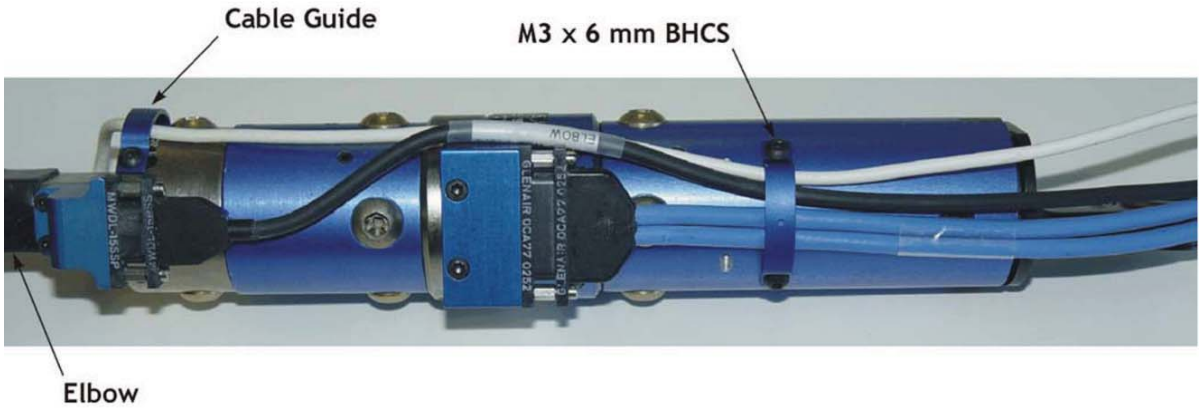

Figure G.16 — Upper arm cables

G.7.4 Elbow cables

Route and secure cables in the area of the elbow as shown in Figure G.17.

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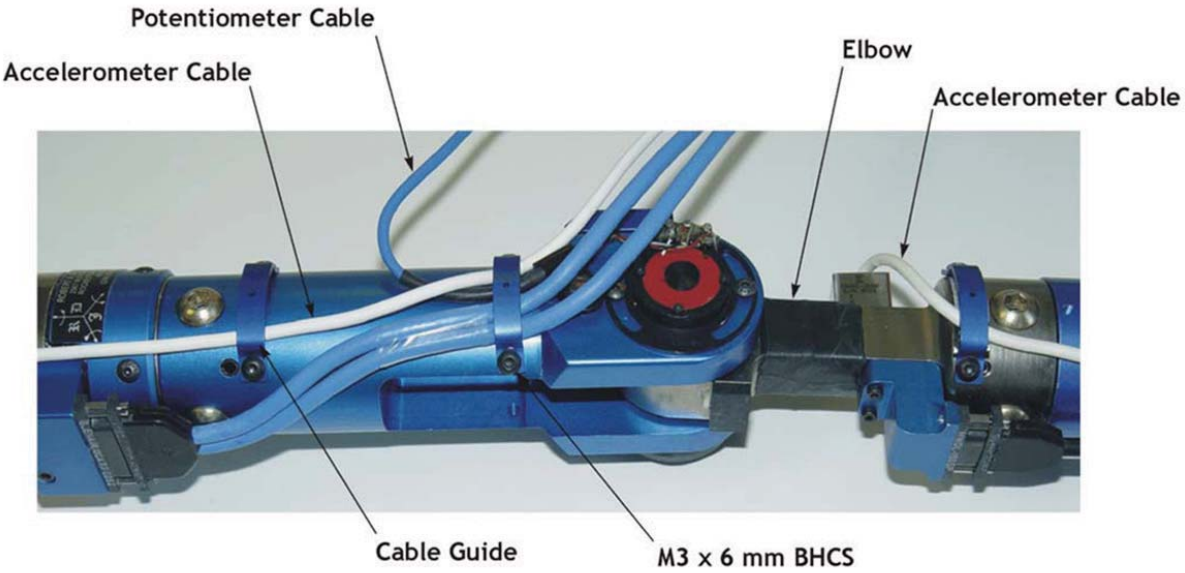

Figure G.17 — Cables in the elbow region

G.7.5 Routing wires through flesh component

The instrumented arm flesh and suit components should be installed with wire routing as shown in Figure G.18, Figure G.19, and Figure G.20.

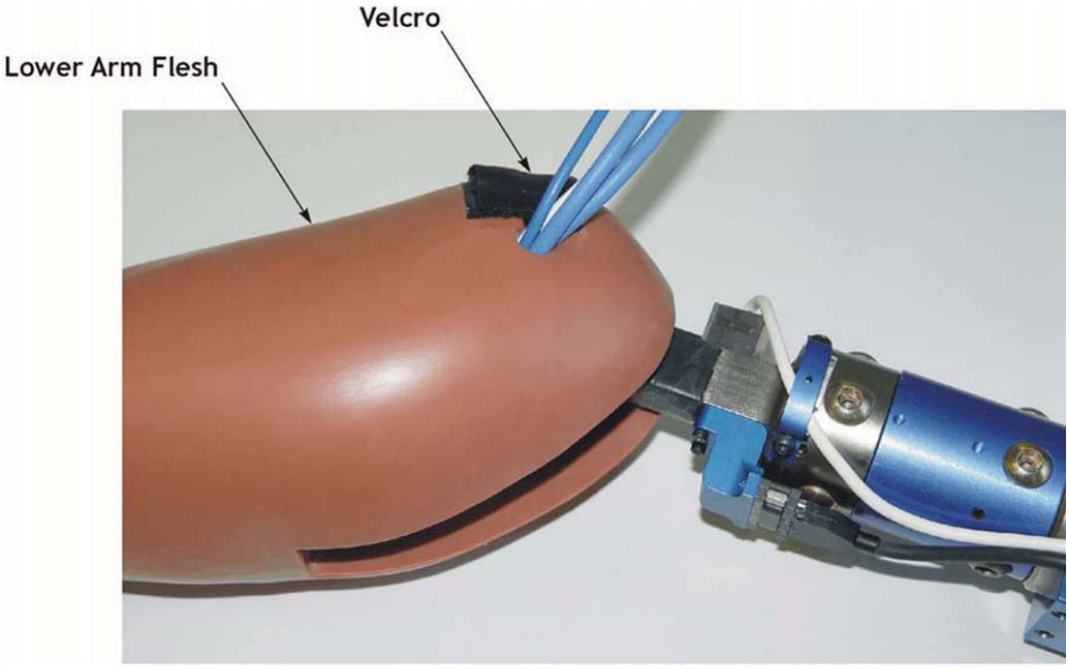

Figure G.18 — Lower arm flesh

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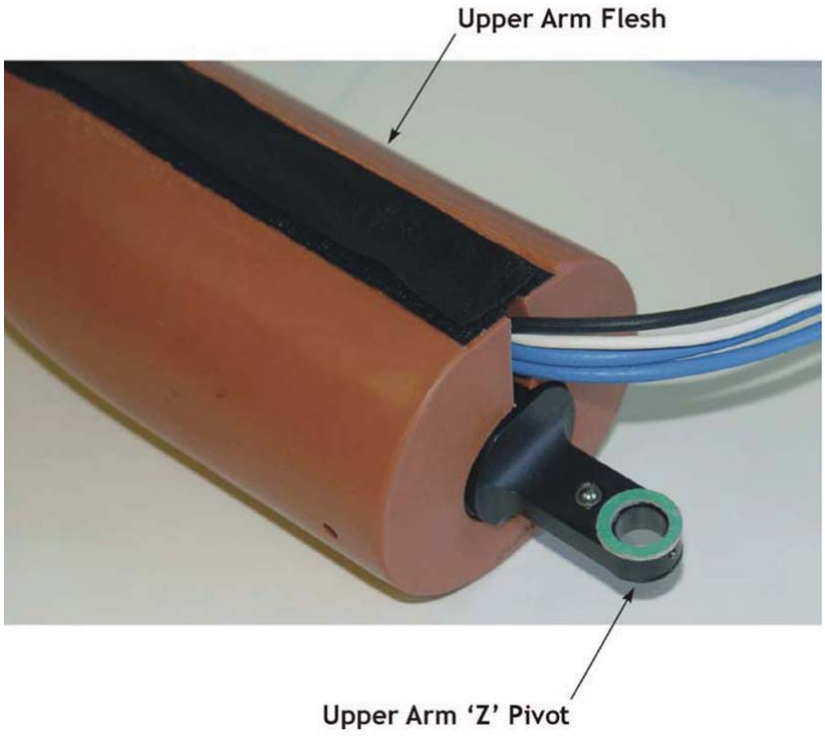

Figure G.19 — Upper arm flesh

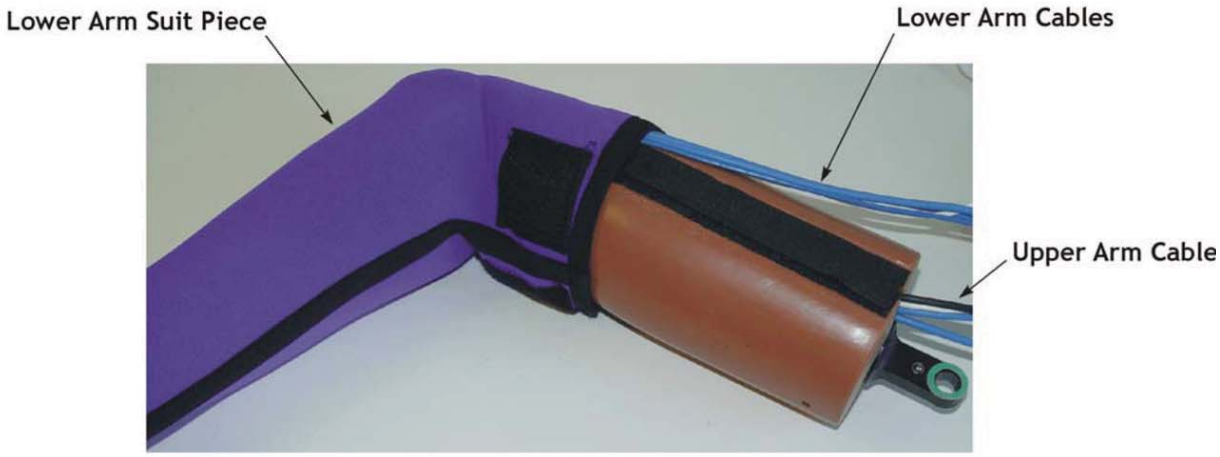

Figure G.20 — Lower arm suit

G.8 Instrumented leg cable routing

G.8.1 Lower leg cable routing

Route and secure the lower leg cables as shown in Figure G.21.

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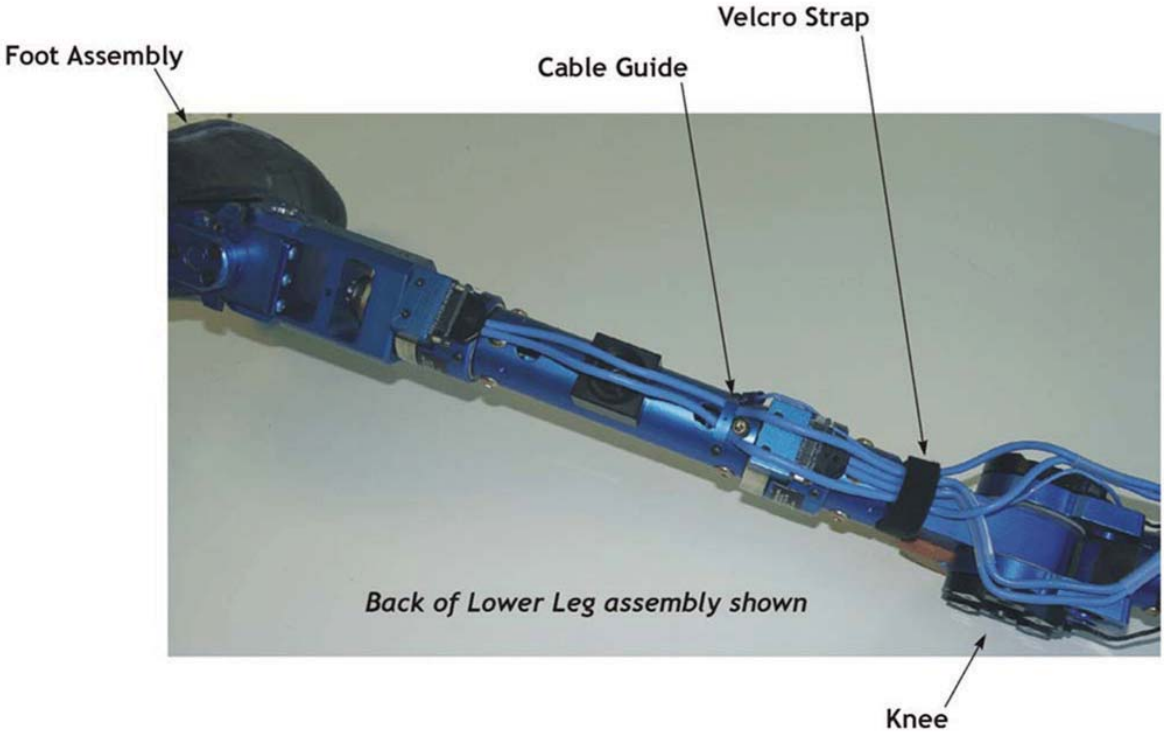

Figure G.21 — Lower leg cables

G.8.2 Knee cable routing

Route and secure cables in the area of the knee as shown in Figure G.22, Figure G.23, and Figure G.24.

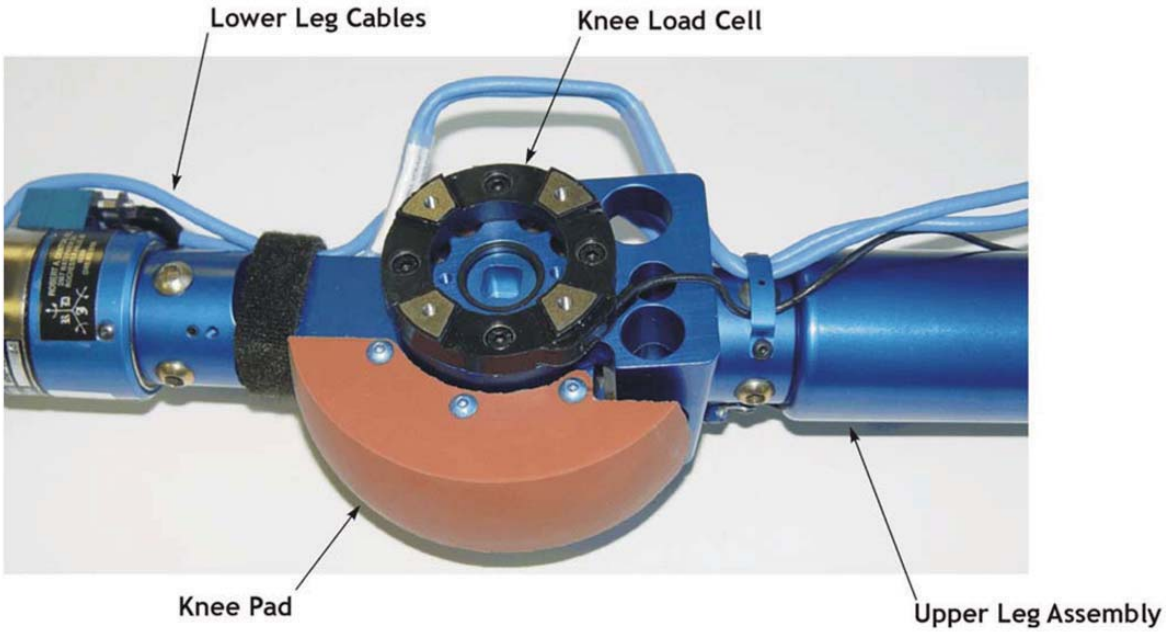

Figure G.22 — Knee area cable routing

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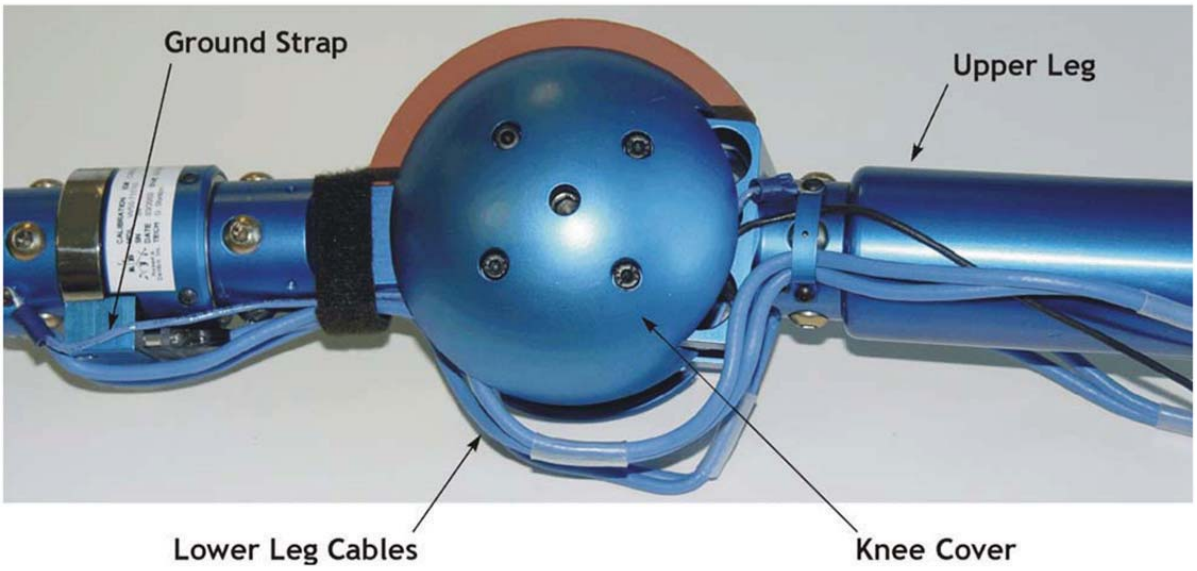

Figure G.23 — Knee area cable routing

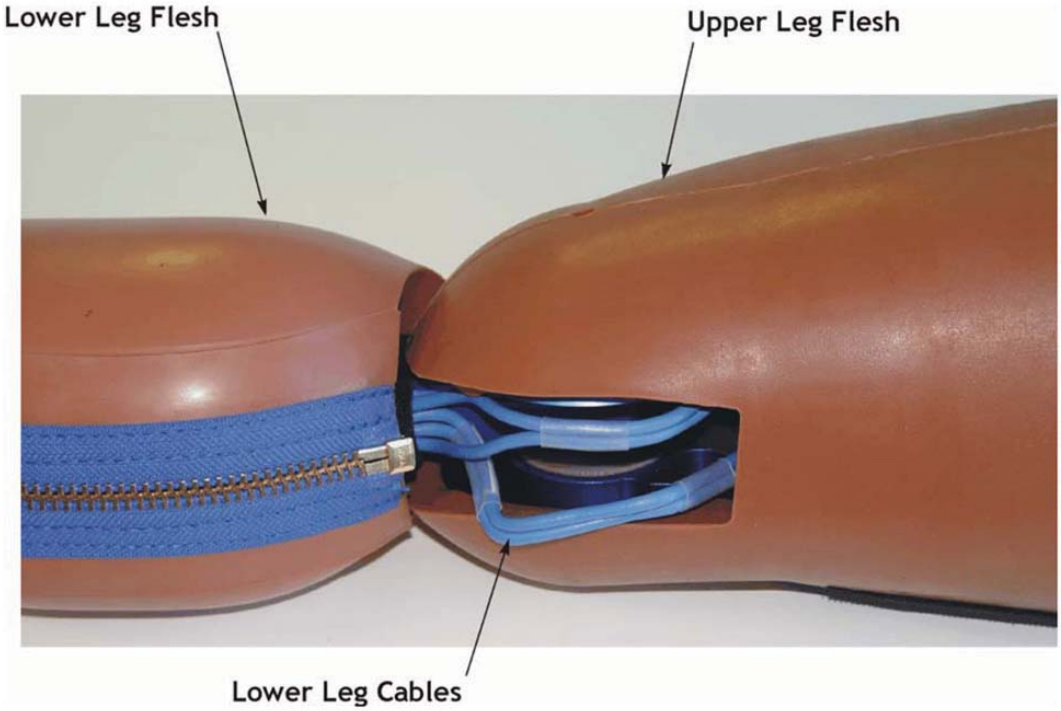

Figure G.24 — Knee area cable routing and flesh

G.8.3 Femoral neck cable routing

The femoral neck load cell cable should be routed as shown in Figure G.25.

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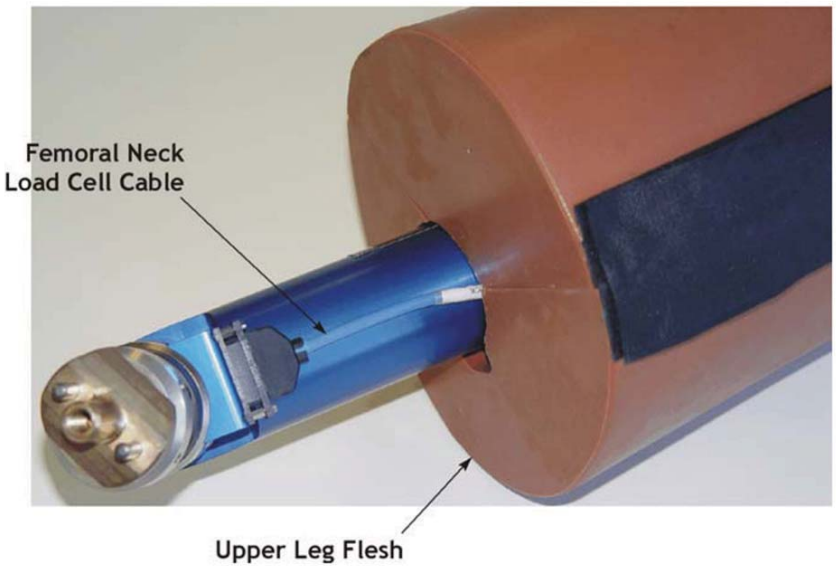

Figure G.25 — Femoral neck cable routing

G.9 Wiring with an external DAS

For sensor wiring in conjunction with an external DAS, the procedures described in this annex which relate to the sensor end of the cable (see Figure G.1 for example) should be followed when possible.

The routing of the cable or cables exiting the dummy may vary depending upon the DAS, vehicle, or test, but in all cases the cable should be secured to the dummy such that the motion of dummy components of interest (e.g. impact side ribs) are not affected and also such that cable tension is not applied to sensors.

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Annex H
(informative)

WorldSID temperature information

H.1 Temperature sensitivity of WorldSID

It is believed that the WorldSID components with the most sensitivity to temperature change are the inner ribs, as related to the energy absorbing material which covers the inner ribs.

H.2 Monitoring of temperature variations of WorldSID

As specified in Annex E, the recommended chest cavity air temperature operating range for the WorldSID is 20,6 °C to 22,2 °C. This was based on a study of the influence of temperature variations on the performance of the shoulder, thorax, abdomen, and pelvis, as noted in ISO 15830-1:2005, Annex B.7.

In addition, in order to quantify air temperature variations within the chest cavity, internal air temperatures were measured by placing a thermocouple on each of the inner ribs in the locations shown in Figure H.1, which are in the vicinity of typical maximum bending stress. From the results, it was determined that the air temperature in the chest cavity has a relatively uniform distribution.

The WorldSID has a permissible (i.e. optional) chest cavity air temperature sensor mounted on the non-impact side of the spine box which can be read directly through the TDAS G5 hardware and software. This temperature sensor has an internal log function where it stores temperature variation data from the last 24 h.

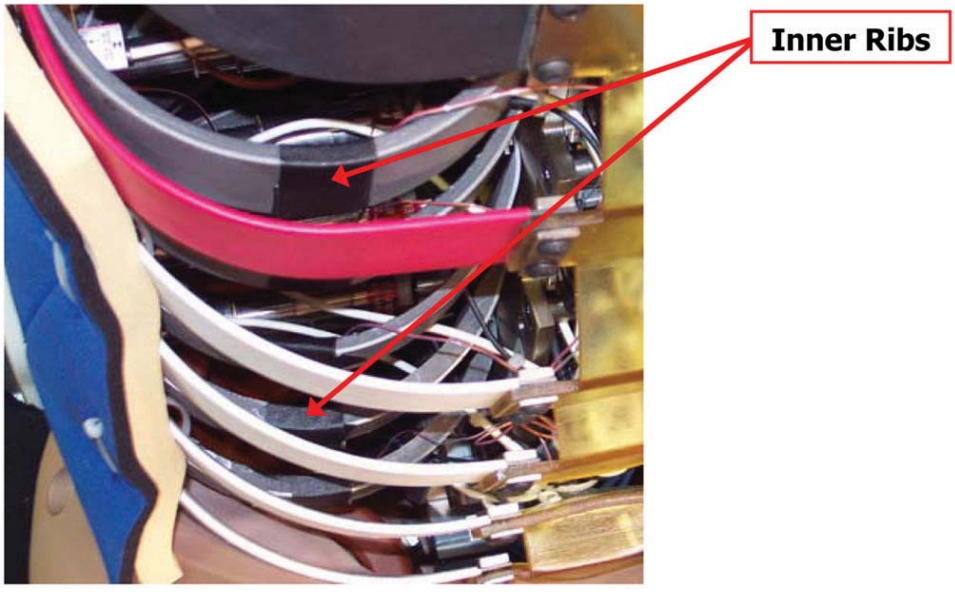

Figure H.1 — Location of temperature sensors used for internal temperature survey

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H.3 Effect of internal DAS on dummy temperature

Extensive testing was performed to determine the effects on internal air temperature due to operation of the permissible internal TDAS G5 system. Based on this testing, changes were made to the pre-production TDAS G5 design so that it would draw much less power. The internal DAS heating was compared to heating created by running a typical external DAS with 10 V excitation and with the same set of sensors. A summary of the results is given in Table H.1.

Table H.1 — Effect of internal and external DAS on WorldSID internal air temperature

Condition	Temperature increase in thorax
Production TDAS G5 with 5 V excitation, system in fully armed mode	1,34 degrees ° C/h
External DAS with 10 V excitation	1,32 degrees ° C/h

H.4 Practical notes for full body testing related to temperature

The following notes are provided for the information of users performing full body testing with the WorldSID:

— Similar temperature increases occur when the same set of sensors is used, regardless of whether a typical external DAS or the internal TDAS G5 system is used.

— Since the temperature specification is 20,6 °C to 22,2 °C, the dummy can be temperature soaked near the lower end of this range to allow for heating during a test.

— Once the internal or external DAS is armed and sensor excitations are powered, it is recommended that the test be performed within 30 min in order to minimize temperature effects (i.e. there is an approximately 0,7 °C increase in 30 min).

— If the permissible internal TDAS G5 system is used, the software will provide a real-time internal chest cavity air temperature measurement to the user. The previous 24 h temperature time history will also be automatically downloaded with the test data.

— If a different temperature sensor and recording method is used, it is recommended that the internal chest cavity air temperature be measured and monitored during the test.

— When testing with other DAS hardware, the effect of DAS heating on WorldSID temperatures should be investigated.

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Annex I
(normative)

Recommended WorldSID grounding scheme

I.1 Parts list

The parts given in Table I.1 should be used to provide electrical continuity between the dummy components and an off-dummy electrical ground point.

Table I.1 — List of ground cables

Cable number	Part number	Description	Quantity
1	W50-75801	head to thorax	1
2	W50-75802	torso to sacrum	1
3	W50-75803	sacrum to pubic	1
4	W50-75804	sacrum to upper leg	2
5	W50-75805	upper leg to lower leg	2
6	W50-75806	torso to external ground	1

I.2 Grounding procedures

The WorldSID dummy should be grounded as follows.

1) Attach cable 1 to the right side rear mounting screw of the upper neck load cell as shown in Figure I.1.

Figure I.1 — Cable attachment to the upper neck load cell

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2) Route cable one with the other cables around the neck and through the spine box as shown in Figure I.2.

Figure I.2 — Spine box cable routing

3) Attach the other end of cable 1 and one end of cable 2 to the spine box with a SHCS M5 × 6 mm as shown in Figure I.3. In addition, attach one end of cable 6 (not shown) to this same screw.

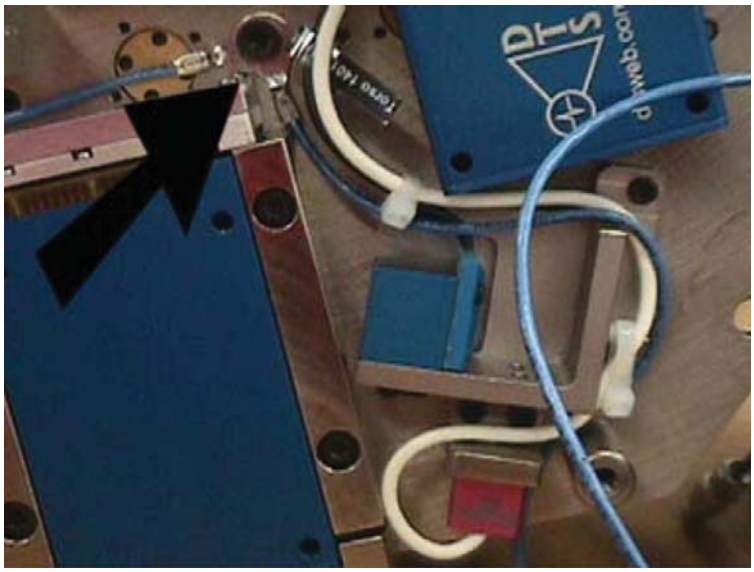

Figure I.3 — Spine box cable attachment

4) Route cable 2 through the spine box as shown in Figure I.4.

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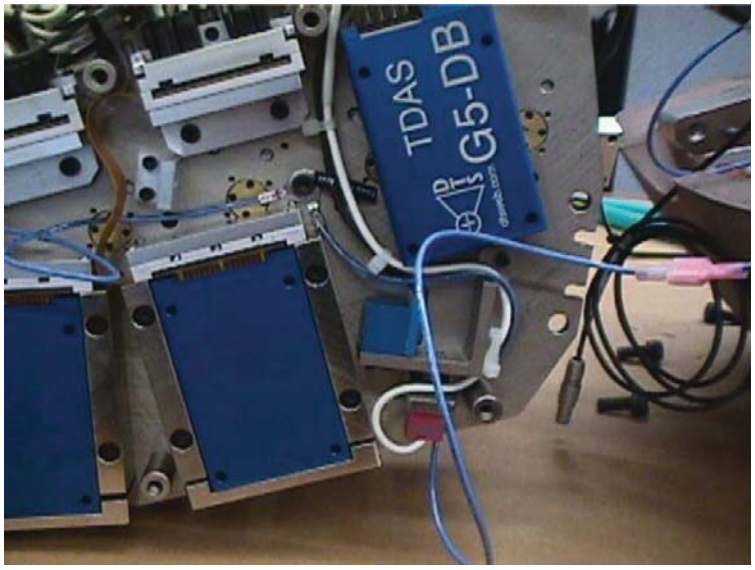

Figure I.4 — Cable 2 spine box routing

5) Attach the other end of cable 2 to the front lumbar to sacrum attachment screw on the non-struck side along with one end of cable 3 and one end of cable 4 as shown in Figure I.5.

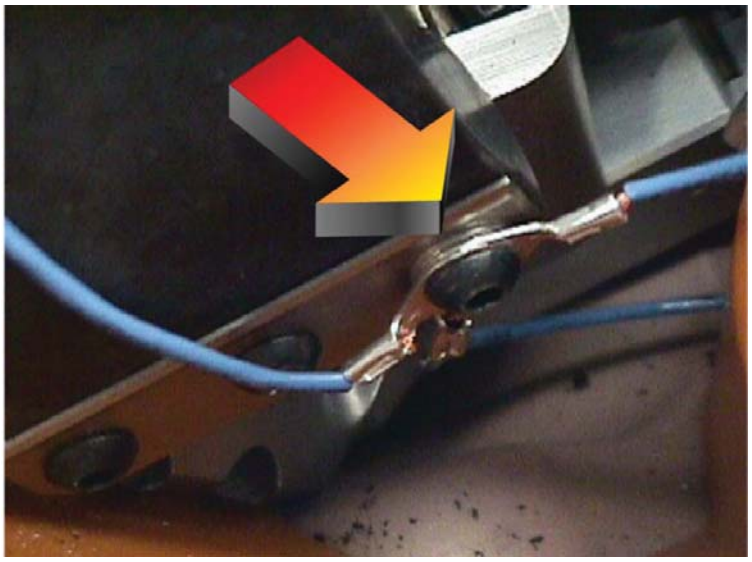

Figure I.5 — Lumbar cable attachment

6) Attach the other end of cable 3 to the top inner pubic load cell attachment bolt on the non-struck side as shown in Figure I.6.

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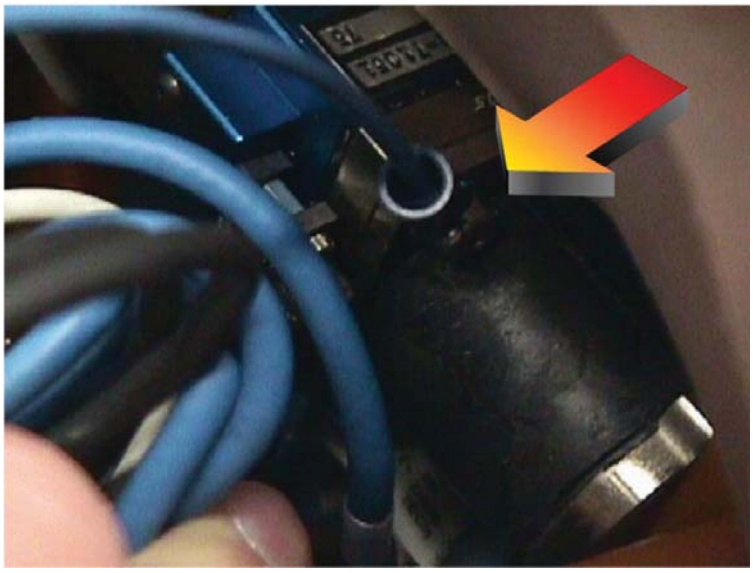

Figure I.6 — Pelvic load cell cable attachment

7) Attach the other end of cable 4 to the non-struck side knee clevis using a BHCS M3 × 6 mm along with one end of cable 5 as shown in Figure I.7.

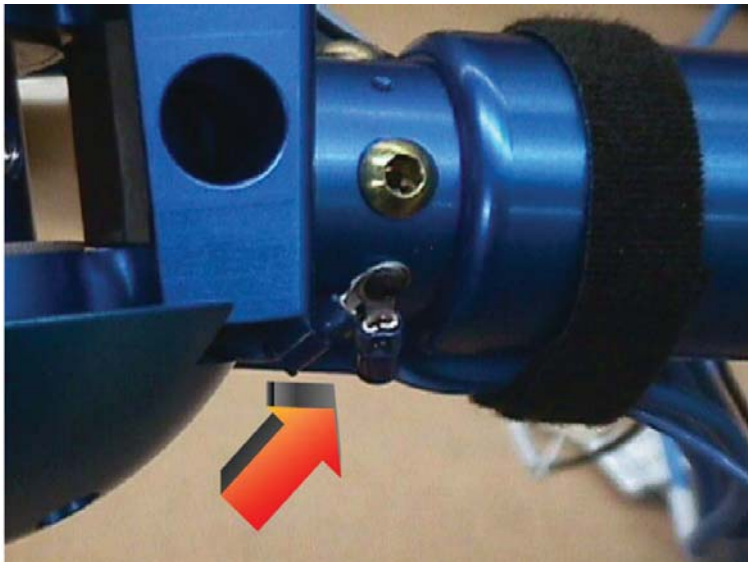

Figure I.7 — Knee cable attachment

8) Attach one end of the second cable 4 to the front lumbar to sacrum attachment screw on the struck side as shown in Figure I.8

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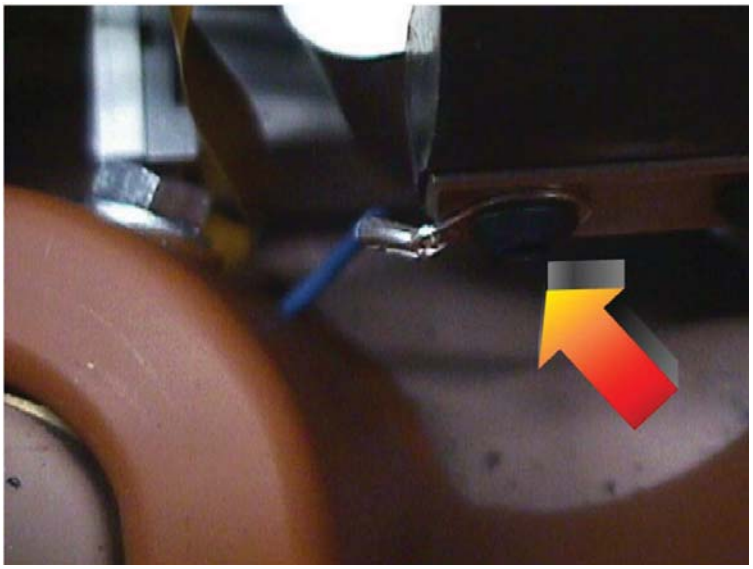

Figure I.8 — Cable attachment

9) Attach the other end of the second cable 4 to the struck side knee clevis using a BHCS M3 × 6 mm along with one end of the second cable 5 as shown in Figure I.7.

10) For each of the legs, attach the other end of cable 5 to the strain relief attachment screw just below the upper tibia load cell as shown in Figure I.9.

Figure I.9 — Tibia cable attachment

11) Attach the other end of cable 6 to an off dummy earth ground point. The same ground point should be used as for the DAS.

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